UPDATE ON FSA'S ACTIVITIES CONCERNING ANTIMICROBIAL RESISTANCE

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1. SUMMARY

1.1. This paper sets out the FSA's activities concerning antimicrobial resistance (AMR). Details of these activities are in an Annex to this paper and provide an update on progress since the Board last discussed this issue in September 2016. We have made significant progress with our surveillance activities in this area, publishing findings and initiating a new survey taking account of the findings from our systematic review of antimicrobial resistance in bacteria from retail foods. We have identified a way in which one of our current research projects can provide important new information on antimicrobial resistance in *Campylobacter* alongside our existing work including engagement with the different food production animal sectors.

1.2. We are encouraged by the recent progress in reducing sales of antibiotics for food production animals and the recently published work of the Targets Task Force which has considered the different sectors in detail. The Advisory Committee on the Microbiological Safety of Food (ACMSF) Task and Finish Group have made good progress and we look forward to their report which will be discussed by the ACMSF in January. In addition to working across government to help deliver the antimicrobial resistance strategy, the Agency is continuing its international engagement work including the Codex Task Force on antimicrobial resistance.

1.3. The Board is asked to:

- **Comment on** the progress which has already been made in the areas of evidence generation, bridging the animal production and public health sectors, and international engagement which the Board identified as priorities for the FSA in its substantive discussion of antimicrobial resistance in September 2016.

- **Endorse** our planned future AMR activities, which focus on furthering our understanding of a) the ecology of AMR in key microorganisms (commensals and pathogens), b) understanding the relative contribution of the food chain when compared to other routes (direct contact with farm animals/pets, environment, hospital settings, etc.) and, c) understanding the relative importance of

different food chains as pathways for the transmission of AMR to humans and the impact of interventions on these sources.

- **Agree** that we should also continue to participate in both national and international engagement work including surveillance and in seeking to address the issue of AMR collaboratively.

- **Endorse** the assessment that in taking this direction, the FSA is making the right and best contribution we can to cross-Government work on countering the threat of AMR.

2. INTRODUCTION

2.1. The emergence and spread of resistance to antimicrobial agents, particularly to those drugs which are critically important in human medicine, continues to pose a significant global threat both in terms of public health and economic impact. There are few signs of new antibiotics becoming available in the foreseeable future to support the treatment of serious infections in people, and this underlines the urgency of tacking the AMR problem on all fronts. International organisations such as WHO, FAO, the World Organisation for Animal Health (OIE) and the European Commission have published reports on AMR and action plans seeking to address the problem in different sectors and on a global scale.

2.2. Addressing the threat of AMR is a priority for the UK Government and the devolved administrations, which are committed to an integrated approach at national and international levels, through actions set out in the UK Five Year Antimicrobial Resistance Strategy[1]. A progress report on this five year strategy was published in September 2016[2]. This is an ambitious strategy aimed at slowing the development and spread of AMR. It takes a "One-Health" approach spanning people, animals, agriculture and the wider environment. The FSA is contributing to the delivery of the strategy and progress reports alongside other departments including DH, PHE, DEFRA and the VMD. The FSA's role working with other Government departments is to contribute to reducing levels of AMR and specifically working to fully establish the link with food. The Strategy has the goal of slowing the development and spread of AMR, focusing action across all sectors on:

- improving the knowledge and understanding of AMR;

- conservation and stewardship of the effectiveness of existing treatments; and

- stimulating the development of new antibiotics, diagnostics and novel therapies.

[1] See https://www.gov.uk/government/publications/uk-5-year-antimicrobial-resistance-strategy-2013-to-2018
[2] See https://www.gov.uk/government/publications/progress-report-on-the-uk-5-year-amr-strategy-2015

2.3. The FSA has a role in the first two of these areas through furthering our understanding of the role of the food chain and AMR, encouraging momentum in the food industry to reduce usage of antimicrobials where possible and not using them as a substitute for poor hygiene. The Board discussed the issue of antimicrobial resistance at their meetings in July and September 2016. These meetings provided an opportunity to consider the recently published O'Neill report recommendations in relation to Agriculture and some of the activities which the FSA has been involved in as part of delivering the Governments 5 year strategy to tackle AMR[1]. This paper provides a detailed update on FSA activities in those areas which the Board highlighted as a priority going forward.

3. DISCUSSION

3.1. The Government response to Lord O'Neill's Review on AMR was published in September 2016[3] and gives a commitment to work nationally and internationally to meet the significant threat that AMR poses to global health, prosperity and security. Whilst it is currently not possible to determine what contribution the use of antimicrobials in agriculture is making to the problem of AMR, the FSA agrees with the consensus that unnecessary use of antimicrobials in animals and agriculture is a concern. Reducing use of antimicrobials in food production animals is part of the Government's strategy for tackling AMR. In protecting consumer's interest, the FSA is working with the food industry to encourage reductions in the use of antimicrobials in food production and to offset this with improvements in animal care and biosecurity. Greater attention to these areas will underpin a reduced use of antimicrobials in food production animals.

3.2. The FSA is continuing to work to try and reduce levels of AMR and is specifically working to fully establish the link with food. Our priorities in this area, as highlighted by the Board, are being taken forward through a number of routes and in working with key partners in government, industry and academia. These activities are summarised in the following table (**Box1**) and the Annex. The key elements are:

- Making our contribution to the delivery of the Government's strategy on tackling AMR through taking forward our element of the action plan and in the response to the O'Neill report recommendations

- A continued focus on improving the scientific evidence base relating to antimicrobial resistance in the food chain through supporting relevant research and improving surveillance;

- Encouraging the adoption of clear transparent reporting standards that help consumers have access to and understand information about the responsible use of antibiotics in the food chain;

[3] See https://www.gov.uk/government/publications/government-response-the-review-on-antimicrobial-resistance

- Convening a task and finish group drawing on the membership of the existing AMR sub-group of the Advisory Committee on Microbiological Safety of Food, to advise us on responsible use of antibiotics in agriculture to support the above work.

- Our role as UK lead in Codex where we, jointly with Australia and the US, convened a meeting to set the objectives for a Codex Task Force on AMR.

Box1. Update on FSA's progress in tackling AMR

Priorities	Working with	Progress
Working across government to deliver the 5 year AMR strategy	DH, VMD, PHE, DEFRA, APHA, EA. Member of the High Level Steering Group implementing the strategy. Member of the DARC group and MRC led AMR funders forum	• Contributed to progress report on 5 year strategy published September 2016 • Contributed to response to O'Neill report published Sept 2016 • Chief Scientific Advisor's report on AMR published September 2016
Improving the scientific evidence base relating to antimicrobial resistance in the food chain	DH, PHE, APHA, universities (RVC, Oxford) and Quadram Institute	• Published RVC systematic review (Nov 2017) • Published surveillance reports on AMR in retail meats (Sept 2016; Nov 2017), *Campylobacter* in retail chicken (Sept 2016) • New retail survey of AMR bacteria in retail chicken and pork mince (began Sept 2017) • Contributed to DH project on ESBL *E.coli* in fresh produce (paper published Jan 2017) • Building on existing FSA research to fill evidence gap on attribution of AMR *Campylobacter.* • FSA part funding 5 year research fellowship at the Quadram Institute, Norwich on AMR bacteria in the food chain (from Oct 2017) **(see Annex section A)**
Working to encourage the adoption of clear transparent reporting standards	Animal sector groups covering poultry pigs and cattle, RUMA, retailers, research fora	• Hosted a Universities of Southampton and Newcastle meeting to address the role of retailers and food suppliers in tackling the AMR challenge in the context of global food supply chains (Nov 2016)

		• Stakeholder meeting with retailers to discuss FSA AMR surveillance (March 2017). • Participation in N8 AgriFood Industry Innovation Forum sponsored by NFU and AHDB (May 2017) • Dialogue with retailers including participation in Sainsbury's R&D conference (May 2017) and Tesco shared conversations meeting (July 2017). • RUMA 2017 Targets report (published October 2017) • Voluntary industry antimicrobial usage data published for first time in 2016 VARSS report (Nov 2017) **(see Annex section C)**
Task and finish group to advise us on responsible use of antibiotics in agriculture to support the above work.	ACMSF AMR subgroup together with additional expertise drawn from academia and PHE. DH and VMD also attend meetings	• Established in March 2017 - the group has received evidence from the poultry, pig, cattle and sheep sectors. Paper to ACMSF in January 2018. **(see Annex section B)**
International engagement to help meet the global challenge of AMR	Codex Alimentarius (Task Force on AMR); G20 countries, EU (AMR surveillance)	• UK lead in Codex where we, jointly with Australia and the US, convened a meeting to set the objectives for a Codex Task Force on AMR. First Task Force meeting held in Korea November 2017. • Participated in meeting of the national Public Health and Veterinary Public Health-Institutes of the G20 countries in Berlin in September 2017. • Contributing to the EU-wide surveillance of AMR bacteria in retail meats **(see Annex section D and A)**

ANNEX: DETAILS OF FSA ACTIVITIES ON AMR

A. AMR SURVEILLANCE AND RESEARCH

Our understanding of the ecology and transfer of antimicrobial resistant bacteria in the food chain is improving but remains incomplete. Differences in surveillance systems, methodology, target organisms, and drugs often make it difficult to align information and make comparisons particularly between countries or at different times. Understanding better the contribution of food and food production animals in the spread of antimicrobial resistant organisms and genes will require the development and application of scientific predictive methods and models that quantify the transfer of antimicrobial resistant commensal, and pathogenic organisms and genes along the food chain from primary production to consumer. Such data is key to informing new food chain risk assessments or building on those previously established for pathogens and products of animal origin (e.g. *Salmonella* and the pork chain, *Campylobacter* and the poultry chain).

AMR surveillance is potentially more challenging than traditional microbiological food surveillance. There are more parameters to consider and foodborne pathogens are not the only source of antimicrobial resistance in the food chain, since resistance can arise in, or be acquired by, non-pathogenic (commensal) bacteria including for example, certain strains of *E.coli* and *Enterococcus* spp. In many cases these will be more numerous than pathogens in food and therefore, potentially a larger reservoir of antimicrobial resistance. EFSA has recently published an Opinion on a list of outcome indicators as regards surveillance of antimicrobial resistance and antimicrobial consumption in humans and food-producing animals.

Systematic review

In November 2016, the FSA published on its website the final report of a systematic review to assess the significance of the food chain in the context of antimicrobial resistance (AMR) with particular reference to pork, poultry meat, dairy products, seafood and fresh produce on retail sale in the UK[4]. This review was carried out by the Royal Veterinary College (RVC).

Given the broad nature of the subject matter, the systematic review focused on the occurrence of AMR in *Campylobacter* (in poultry meat), *Salmonella* (in pork meat) and in selected commensal bacteria; *Enterococcus faecalis*, *Enterococcus faecium* and *E. coli* (in poultry and pork meat, vegetables and fruit, dairy and fish and shellfish) at retail level that could pose a risk to UK consumers. The review focussed on the critically important antimicrobial groups (i.e. beta-lactams, fluoroquinolones, macrolides and carbapenems) and multi-drug resistance (resistance to 3 or more different classes of antimicrobial drugs).

The review confirmed that there is a lack of AMR prevalence data for UK-produced food and, to a lesser extent, in countries that export food to the UK. The review

[4] See www.food.gov.uk/science/research/foodborneillness/b14programme/b14projlist/fs102127/a-systematic-review-of-amr-in-pork-and-poultry-dairy-products-seafood-and-fresh-produce.

recommended developing surveillance programmes that will identify trends in the prevalence of AMR bacteria in foods (in particular for retail poultry and pork meat) which could be used to assess potential risks associated with exposure to such hazards among UK consumers. Of nearly 5920 studies identified in the peer reviewed and grey literature between 1999 and 2015 only 304 studies (from 58 countries) met the systematic review criteria for further consideration. Of these only 15 studies (4.9%) which included 5 FSA surveillance studies, were included in the accepted studies.

Findings from the systematic review indicate that there is a real paucity of high quality information on the prevalence of antimicrobial resistance in bacteria from UK retail food. We have therefore prioritised improving the information available on this topic as we develop our new strategic approach to surveillance.

New survey of AMR bacteria in UK retail chicken and pork

Following the AMR systematic review recommendation for further surveillance on AMR bacteria in chicken and pork on retail sale in the UK, the FSA has commissioned a new survey to look at AMR in selected pathogens and commensal bacteria in fresh and frozen retail poultry meat and pork mince. The survey is being carried out by Public Health England (PHE) in collaboration with the Animal and Plant Health Agency (APHA), the Agri-Food and Biosciences Institute (AFBI) and with Hallmark Meat Hygiene Ltd who have undertaken the retail sampling. The main objective of this surveillance is to fill knowledge gaps to stengthen the evidence base in this area to inform risk assessments in order to inform more targeted and proportionate interventions. It will provide a baseline for future surveys on AMR in raw meat allowing trends to be monitored and emerging AMR risks to be identified.

Foodborne pathogens are not the only source of antimicrobial resistance in the food chain since resistance can arise in, or be acquired by, non-pathogenic (commensal) bacteria including for example, certain strains of *E.coli, Klebsiella* spp. and *Enterococcus* spp. Such commensal strains may not necessarily cause disease in humans or animals but they can act as a vehicle for a variety of drug resistance genes some of which can be passed to other bacteria. These recipients may then cause serious disease often in sites other than the gastrointestinal tract. One example of this phenomenon is the *mcr-1* gene for colistin resistance which was first reported from food animals, meat and humans in China in November 2015[5] and has now been found in many countries worldwide in people, animals and food and now further *mcr* genes (*mcr-2, mcr-3*) have also been reported. Colistin is one of the very few antimicrobial drugs of last resort and there is a concern that colistin use in animal production could drive the horizontal spread of *mcr* genes to reach those pathogens for which colistin may be the only treatment option.

The AMR surveillance study is therefore looking at a range of target pathogenic and commensal bacteria in samples of fresh and frozen retail poultry meat and fresh

[5] See Liu, Yi-Yun *et al*., (2015). Emergence of plasmid-mediated colistin resistance mechanism MCR-1 in animals and human beings in China: a microbiological and molecular biological study. *The Lancet Infectious Diseases* **16**:161-168.

retail pork mince for evidence of AMR. Details of the target microorganisms, samples and AMR traits of particular interest are set out in **Box 2.** The survey has been designed to be representative of the UK market share data. Sampling took place over a 2 month period and was completed at the end of October 2017. In total, 340 samples of chicken and 340 samples of pork mince have been tested and isolates of target bacteria are being screened for antimicrobial susceptibility and/or the presence of certain genes which could confer resistance to certain antimicrobial drugs (e.g. *mcr-1*). The findings from the study are expected to published in early 2018.

Box 2. FSA retail survey for antimicrobial resistant bacteria in meat

Food and target pathogens and commensals	Sampling/ Testing	Antimicrobials of particular interest (including ECDC panel of antimicrobials)
Chicken	• Fresh/Frozen • Whole/portion • N = 340 • UK wide	
Campylobacter spp.	Detection Enumeration	• Fluoroquinolones (Ciprofloxacin) • Macrolides
Pork	• Fresh • Minced • N = 340 • UK wide	
Salmonella spp	Detection Enumeration	• ESBLs • Ciprofloxacin/ Nalidixic acid • Carbapenems
Commensals in chicken and pork		
Escherichia coli *Klebsiella* spp.	Detection Enumeration	• Tetracycline • ESBLs • Polymyxins (Colistin, • Colistin resistance genes *mcr1, mrc2*) • Ciprofloxacin • Piperacillin • Carbapenamase
Enterococcus spp.	Detection Enumeration	• Glycopeptides (vancomycin)

Other AMR surveillance and research activities

<u>EU harmonised survey of AMR *E.coli* in retail meat (chicken, beef, pork)</u>

The European Commission has set-up a 7-year mandatory Member State surveillance for antimicrobial resistance in specific pathogens in food production animals within slaughterhouse environments. The FSA is leading on an additional component of this survey by analysing retail meats (beef, pork & poultry) in the UK

for ESBL, AmpC and Carbapenemase-producing *E. coli*. Testing for colistin resistance and the colistin resistance genes (*mcr-1*, *mcr-2*) in *E. coli* has also been included since January 2016. The EU harmonised survey on AMR in retail meats is currently in its third year, for which retail beef & pork are being sampled and analysed. Sampling of the different meat types alternates annually, so year 1 looked at retail beef & pork and year 2 looked at retail chicken meat.

The year 1 (beef & pork) findings were published in September 2016[6] (These results showed about 1% of retail beef and pork samples in the UK that were tested were positive for AmpC or ESBL-producing *E. coli*. None of the isolates were resistant to the last resort carbapenem antibiotics or to colistin. Comparison with results from other European countries can be seen on pages 167-178 in the EU Summary Report (EUSR) on AMR for 2015[7].

The year 2 (chicken) findings were published in November 2017[8]. These results showed that 29.7% and 16.3% of retail chicken samples were positive for ESBL or AmpC-producing *E. coli* respectively. Results showed a decrease in the proportion of samples positive for ESBL-producing *E. coli* compared to a previous (2013-2014) UK study, which reported that 65.4% of 159 retail chicken samples were positive for ESBL-producing *E. coli*. None of the isolates were resistant to the last resort carbapenem antibiotics or to colistin. Comparison with results from other European countries should be available in early 2018.

AMR findings from the *Campylobacter* retail chicken surveys

A subset of the *Campylobacter* isolates from the FSAs *Campylobacter* retail survey of UK-produced fresh whole chicken have been tested for their resistance to a range of antimicrobial agents. Data from year 1 of the survey was published in September 2016[9] and suggests that the proportion of ciprofloxacin resistant *C. jejuni* and *C. coli* strains has increased significantly since 2007-08 while the proportion of erythromycin resistant *C. coli* appears to be unchanged and may even be decreasing in *C. jejuni*. In comparison with findings from a previous retail chicken survey in 2007-08 there was no significant change in the level of resistance found to aminoglycosides, chloramphenicol or tetracycline. This survey provides evidence that AMR *Campylobacter* isolates are found on whole UK-produced fresh chickens sold at retail in the UK and will contribute to assessing evidence gaps as outlined later in this paper. The year 2 findings will be published in early 2018.

Contribution to DH study on ESBL *E.coli*

The Department of Health (DH) has funded Public Health England (PHE) to carry out a three-year project (041/0039) on 'Defining reservoirs of ESBL *E.coli* and the threat posed to personal, animal and public health in the UK'. The FSA has supported DH in this work by providing a financial contribution to a specific work package on quantifying ESBL-producing *E. coli* in raw meats and fresh produce including

[6] See https://www.food.gov.uk/science/research/foodborneillness/b14programme/fs102109
[7] See https://www.efsa.europa.eu/en/efsajournal/pub/4694
[8] See https://www.food.gov.uk/science/research/foodborneillness/b14programme/fs102109
[9] See https://www.food.gov.uk/science/research/foodborneillness/b14programme/b14projlist/fs241044amr

imported berries (FS101071). The project has provided a good opportunity to screen fresh produce sold in the UK for ESBL *E.coli* as AMR bacteria in fresh produce was identified as a gap in the FSA's systematic review of AMR bacteria in foods at UK retail level (FS102127). It is encouraging that no ESBL *E.coli* were found in 400 samples of fresh fruit and vegetables[10].

Evidence gap: source attribution of *Campylobacter* AMR

Significant progress has been made in tackling *Campylobacter* and contamination levels on retail chicken are now lower than several years ago[11]. Contamination levels on retail chicken provide one indicator of progress in tackling this problem but another area the FSA is exploring is through monitoring the proportion of *Campylobacter* clinical isolates which can be attributed to chicken. This is being explored through an FSA project (FS101013) being undertaken by the University of Oxford in collaboration with Public Health England. The project has established sentinel surveillance for human *Campylobacter* infections in rural and urban populations in the Oxford and Tyneside areas and is comparing clinical isolates from these areas to a reference dataset for key food and animal sources using whole genome sequencing (WGS) and multi-locus sequence typing (MLST).

This approach is enabling attribution of human cases to food animals and other sources, thereby mapping the contribution to human infection and changes over time[12]. Historical data from Oxfordshire, and by extension ongoing Oxfordshire and Tyneside surveillance, has been shown to be informative on national patterns of human *Campylobacter* infection.

Campylobacter has been identified by the WHO as a high priority antibiotic- resistant pathogen due to fluoroquinolone resistance. EFSA data demonstrates that rates of *Campylobacter* resistance to these drugs, a critical class of antimicrobials for human therapy, has continued to rise in isolates from humans and poultry with these rates varying across Europe. Our own surveys of retail chicken have also found that rates of resistance to the fluoroquinolone ciprofloxacin have increased significantly since the retail chicken survey in 2007-08 and the longitudinal surveillance in Oxfordshire has also confirmed the emergence of this problem in the UK[13].

Recent work has shown that bioinformatics analysis of WGS data is able to accurately predict the presence of antimicrobial resistance traits in *Campylobacter* spp[14]. This provides the opportunity to look at antimicrobial resistance traits in clinical *Campylobacter* isolates and the attribution of these isolates to different sources (e.g. poultry, ruminant etc.). This approach will increase our understanding of the pattern

[10] See Randles L *et al*., (2016). Evaluation of meat, fruit and vegetables from retail stores in five United Kingdom regions as sources of extended-spectrum beta-lactamase (ESBL)-producing and carbapenem-resistant *Escherichia coli. Int. J. Food Microbiol.,* **241**:283–290.
[11] See https://www.food.gov.uk/news-updates/news/2017/16629/final-results-third-annual-retail-survey
[12] See Sheppard SK *et al*., (2010). Host association of *Campylobacter* genotypes transcends geographic variation. *Appl. Environ. Microbiol*., **76**(15):5269-5277.
[13] See Cody AJ *et al.,* (2012). A longitudinal 6-year study of the molecular epidemiology of clinical *Campylobacter* isolates in Oxfordshire, United Kingdom. *J. Clin. Microbiol*., **50**(10):3193-3201.
[14] See Zhao S *et al*., (2015). Whole-Genome Sequencing analysis accurately predicts antimicrobial resistance phenotypes in *Campylobacter* spp. *Appl. Environ. Microbiol.,* **82**(2):459-466.

of drug resistance in *Campylobacter* isolates from different sources. It will also enable historical isolates and datasets to be screened which will improve our understanding of changes in resistance over time.

The FSA is planning to expand the scope of the existing project to analyse the existing *Campylobacter* sequences (2009-2015) for the presence of antimicrobial resistance genes. This would include fluoroquinolones, macrolides, tetracyclines, aminoglycosides and evidence of multi-resistance (resistance in 3 or more classes of antimicrobials). Sequencing of older human *Campylobacter* isolates (2003-2009) will provide information on trends in antimicrobial resistance over time and this data rich resource can be modelled to track the sources and reservoirs of AMR in *Campylobacter* which will help define the risk factors which are driving this.

By adding this work to the current project, we are maximising the outputs of the existing work to gather extra intelligence on the attribution of AMR genes in *Campylobacte*r found in the food chain and the impact of this to public health - this is the most cost effective way of generating this additional data. This project will make use of existing data and influence our approach to AMR in the food chain as well as feed into the overall UK Government strategy on AMR i.e. One Health.

This additional work will provide key information on long-term monitoring of AMR in human *Campylobacter* infections. The approach will link with future surveillance plans about data analysis/modelling and more fully exploit new technologies such as whole genome sequencing to better understand food chain sources and drivers of infections including those involving AMR. This approach is likely to be complimentary to the work undertaken by the ACMSF "Task and Finish" group.

Research fellowship

The FSA is part-funding a 5 year research fellowship at the Quadram Institute (formally Institute of Food Research), Norwich through the FSA's strategic evidence fund. Dr Alison Mather has been appointed to this role and began her work at the Insitute in October 2017[15]. The focus of this work will be to better understand the contribution of food to the burden of pathogens and AMR in humans, the contribution of imported vs domestic food, how much AMR is carried by non-pathogenic bacteria in food and how new technologies such as Whole Genome Sequencing can be utilised to identify pathogens and AMR in food.

B. ACMSF "TASK AND FINISH" GROUP

Following discussions about AMR and responsible use of antimicrobials at FSA Board, the FSA established a new 'Task and Finish' group using expertise from the existing ACMSF AMR group together with additional co-opted experts to reflect the wider range of expertise needed for this task.

The terms of reference of the group are as follows**:**

[15] See https://quadram.ac.uk/qi-welcomes-new-research-leader-genomics-antimicrobial-resistance-bacteria/

(i) Decrease uncertainty about any linkage between use of antimicrobials in food production, the incidence of antimicrobial resistance in pathogens and commensals in food production, and the growing AMR-related public health burden, and
(ii) Allow us to model the impacts of changes in use of antimicrobials in food production.

Given the short term nature of this group, rather than carrying out a comprehensive literature review, the group has focused on key pieces of evidence in this area and building on this information and using the evidence that members have heard at meetings, combined with their own expertise in order to produce an up to date picture for the UK, keeping in mind the overall term of reference. The group has been receiving evidence from the key food animal sectors in order to assess the current state of play relating to AMR in food production in the UK plus the use of expertise from individual members. The group met in May, July, September and November this year and has received evidence from the main animal sectors; pig, cattle, sheep and poultry.

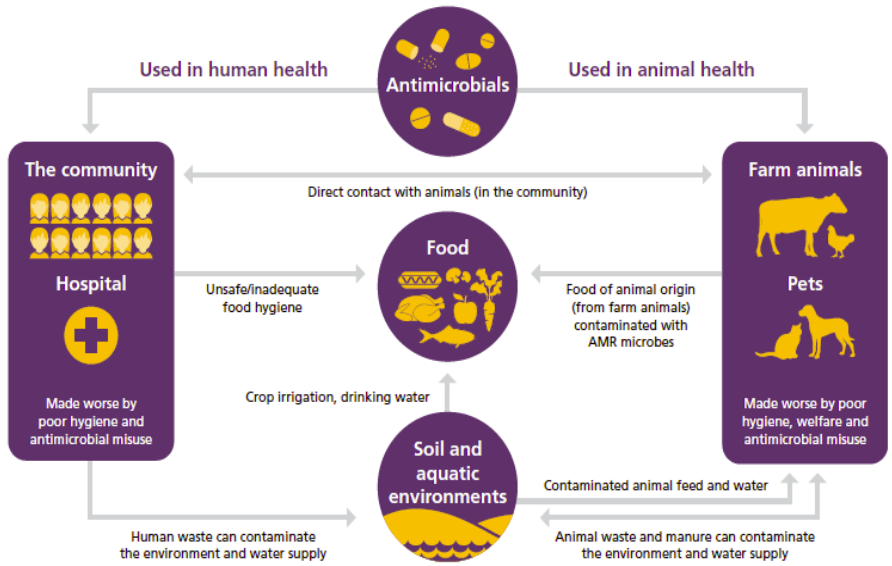
The relationship between different reservoirs and pathways for AMR are recognised as being interlinked as represented by the diagram from the CSA report on AMR[16] in **Box 3**. The Task and Finish group have examined this issue focussing particularly on the food chain aspects. A workshop was held to update a previous cross governmental AMR systems map focussing in particular on food animals and the environment.

The map was then further refined to focus on the food chain showing the main reservoirs for AMR, the main influences on these reservoirs, and the pathways leading to exposure of people to AMR organisms. As part of this exercise the group has been considering knowledge gaps around each of these areas which could be targeted with further research or surveillance.

The group is producing a paper to be presented to ACMSF in January and subject to any amendments the outcome will be brought to the FSA Board's attention thereafter. It is anticipated that an AMR systems map relating to the food chain will be included. The paper will identify areas which are important but where there is already good research evidence with no obvious need for more work, and important gaps where we are unaware of work being undertaken and are for the FSA, other government departments or other organisations to consider as priorities for funding.

[16] See https://www.food.gov.uk/news-updates/news/2016/15523/challenges-of-antimicrobial-resistance

Box 3: How can antimicrobial resistance spread through food? [16]



C. UK 5 YEAR AMR STRATEGY: PROGRESS BY THE LIVESTOCK SECTORS

As part of the FSA contribution to the UK Strategy, we are exploiting our capability in bridging agricultural production and public health interests to make the case for parallel action in the poultry, pig and cattle sectors, convening and participating in influential discussions within government and more widely, and being clear on what is expected of producers, retailers and other players in the food system. Good progress has been made in these areas and we note the commitment of the agricultural sector to identify and agree sector-specific targets for "reduction, refinement or replacement" of antimicrobials in food animal production which is key to delivering a Government objective in this area. An important element of this which the FSA has been able to observe is the progress made by the Targets Task Force under the auspices of the Responsible Use of Medicines in Agriculture (RUMA) alliance. The 2017 report of the Task Force was published in October this year and provides plans covering the main food animal sectors (beef, pig, dairy, poultry meat, egg, fish and game bird)[17].

In the UK, data on sales of antibiotics for use in animals is collected by the Veterinary Medicines Directorate (VMD)(**Box 4**). The most recent data is encouraging as it indicates that total sales of antibiotics for use in food-producing animals in the UK decreased by 17% between 2015 and 2016[18]. In terms of antibiotic sales per kg of food producing animal this decreased by 10% from 57 to 45 mg/kg which is now below the 50mg/kg target set by government. Sales of priority critically important antibiotics (3rd and 4th generation cephalosporins,

[17] See http://www.ruma.org.uk/wp-content/uploads/2017/10/RUMA-Targets-Task-Force-Report-2017-FINAL.pdf
[18] See https://www.gov.uk/government/publications/veterinary-antimicrobial-resistance-and-sales-surveillance-2016

fluoroquinolones and colistin) also fell with sales of colistin in the UK (0.02 mg/kg in 2016) being well below the target of 1mg/kg recommended by the European Medicines Agency. A breakdown of total sales of active ingredient by antimicrobial class in 2016 is shown **in Box 5.**

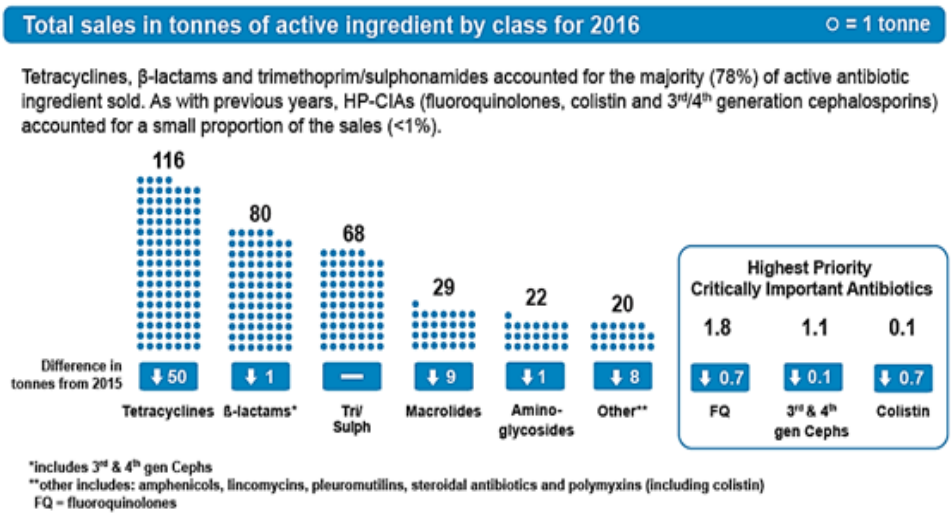
Box 4: Trend in antibiotic sales for food-producing animals in the UK

	2012	2013	2014	2015	2016	2016 compared with 2015
Total sales in tonnes	464	436	445	408	337	-17%
Total in mg/kg	66	62	62	57	45	-21%
Fluoroqunolones* in mg/kg	0.33	0.36	0.35	0.34	0.24	-29%
3rd and 4th generation cephalosporins* in mg/kg	0.20	0.18	0.19	0.17	0.15	-12%
Colistin* in mg/kg	0.09	0.11	0.12	0.12	0.02	-17%

* Critically important antimicrobials (CIAs)

Source: UK-VARSS 2016 Highlights Report

Box 5: UK-VARSS 2016 Highlights report



However, reducing antimicrobial use is only part of the issue. Whilst antimicrobial resistance arises as a consequence of any antimicrobial use it is the way in which antimicrobials are used which can have an important impact on the development of

resistance. We recognise that action to reduce use of antimicrobials in agriculture will require changes to husbandry and biosecurity practices that reduce the prevalence and incidence of diseases that require treatment with antimicrobials. These improved controls would be likely to increase costs in the short term, which may lead to increases in price for some foods. In terms of benefits, in addition to reductions in the emergence and amplification of antimicrobial resistance, we anticipate that there would be some gains in animal health and welfare through reduction of disease, and a more efficient use of feed resulting in more sustainable production.

At their meeting in July 2016 the Board were informed of the progress being made by the poultry meat industry to tackle the antimicrobial resistance issue particularly through the Antibiotic Stewardship Scheme which the British Poultry Council formed in 2011. This initially focused on data collection recognising that this was relatively easier for an integrated sector such as poultry. The data collected was shared on a quarterly basis with the Veterinary Medicines Directorate and the latest VARSS report now includes voluntary data from the different sectors. The Scheme has sought to prioritise its actions by focusing first on four Critically Important Antibiotics (CIAs). Glycopeptides were not used, use of cephalosporins had been banned, macrolide use stopped voluntarily, and fluoroquinolone use only retained as a treatment option in turkeys. The Scheme had also focused on significantly reducing overall use of antibiotics, for example through the removal of in-feed antibiotics. Prophylactic and metaphylactic administration of antimicrobials to day-old chicks had been curtailed and work was now focusing on further reductions in antibiotic use through the application of alternative therapies which included nutritional support with the diet such as butyric acid supplementation. The recently published VARSS report includes for the first time voluntary data on antimicrobial usage from the food animal sectors. In 2016 reports data covering 90% of the poultry sector showed a 37% and 57% reduction in usage of antimicrobial in broilers and turkeys respectively, when compared to usage in 2015. In June 2017 the BPC published its 2017 Antibiotic Stewardship Report with details of their achievements to date and signalled that the next phase of their work would be to look at the link between antimicrobial use and resistance in poultry production[19].

Other food animal sectors have also contributed voluntary data published in the 2016 VARSS report. In the case of the pig sector the data represented 62% coverage of the industry and showed a 34% reduction in usage of antimicrobials in 2016 compared to 2015. The FSA has discussed AMR issues at meetings of the Chief Executive and other senior officials with stakeholders including industry representatives from the different animals sectors and RUMA. We welcome the adoption and publication of 'The British Poultry Council BPC Antibiotic Stewardship scheme', an electronic Medicine Book for Pigs, 'eMB-pigs' [20] and more recently the report of the RUMA targets Task Force covering the main food producing animal sectors, looking at the scope for change and setting targets in each sector. The ACMSF "Task and Finish" group has also taken evidence from the main food animal sectors (poultry, pigs, cattle, sheep) who have outlined steps they have taken to

[19] See http://www.britishpoultry.org.uk/british-poultrys-successful-stewardship-on-antibiotic-use/
[20] See https://emb-pigs.ahdb.org.uk/

tackle the AMR issue. Industry has also published progress updates by sector and examples of cases studies for poultry, pig, cattle, sheep and fish [21, 22].

In terms of the manufacturing and retail sectors the FSA has continued to raise the issue of the unnecessary use of antibiotics in our engagements with representative trade bodies such as the British Retail Consortium and the Food and Drink Federation and with individual companies including the major retailers. We aim to shape the debate and influence the issues that matter to the consumer and the industry and set clear expectations about the information on usage of antibiotics that industry should publish transparently.

In March 2017 we held a stakeholder meeting with retailers to set out our plans for surveillance of retail foods within the wider context of the Government's work on AMR. The FSA has subsequently participated in a couple of meetings on AMR which have been organised by retailers. FSA officials along with other government and industry participants attended a workshop on AMR as part of Sainsbury's R&D conference in May 2017 [23] and also a meeting on AMR organised by Tesco in July.

The FSA has participated in an N8 AgriFood AMR/AMU Industry Innovation Forum sponsored by the NFU and AHDB held at Stoneleigh Park on 4 May with academic scientists and researchers, food businesses including representative from the key food animal sectors, policy makers and NGOs. The workshop focused on the complexity of the antimicrobial usage and resistance issue and on developing collaborative science needed to understand the impact of the measures aimed at tackling AMR so that future action can be directed in the right way.

The O'Neill review highlighted that for food production animals there is the opportunity to improve biosecurity and other husbandry practices to reduce the pressure of infection and as a result decrease the use and consumption of antimicrobials. In this respect the latest VARSS figures showing a fall in antibiotic sales in 2016 and the publication of targets by RUMA for the main food animal sectors is encouraging. Responsible use particularly minimising unnecessary and inappropriate use of antimicrobials is an integral component of the UK AMR strategy and global initiatives aimed at conserving antimicrobials generally and particularly those that are critical for treating serious human infections.

A key consideration is whether the important reductions seen in sales of antibiotic for use in food animals will lead to a reduction in antimicrobial resistance in the food chain. Surveillance for AMR bacteria in food production animals and their products will be key to assessing the impact of these measures and the FSA clearly has a role to play in gathering such evidence. The work of the ACMSF "Task and Finish " group is also likely to be important in focussing on those areas which are likely to require the most attention in understanding the relationship between use of antimicrobials and antimicrobial resistance.

[21] See http://www.farmantibiotics.org/media-news-updates/progress-by-sector/
[22] See http://www.farmantibiotics.org/ideas-hub/antibiotics-case-studies/
[23] See https://www.workingtogether.sainsburys.co.uk/amr

D. INTERNATIONAL WORK

There is a significant level of cross government international activity on AMR. The FSA has continued to contribute to this work to tackle AMR globally and is working through the AMR Cross-Whitehall International Steering Group convened by FCO. Examples of specific initiatives are the meeting of G20 countries and our involvement in Codex Alementarius. The FSA along with representatives from DH, PHE, VMD and Public Health Wales participated in a meeting of the national Public Health and Veterinary Public Health-Institutes of the G20 countries on the subject of AMR which was held in Berlin in September 2017 [24]. This meeting was as a result of the declaration of the G20 health ministers in Berlin in May 2017.

Codex Alimentarius is an intergovernmental body administered by the United Nations Food and Agriculture Organisation (FAO) and the World Health Organisation (WHO) that develops harmonised science based food standards to protect consumer health and protect fair practices in international food trade. Codex has been developing a task force for governments to revise the code of practice on use antibiotics in agriculture and develop guidelines on integrated surveillance of AMR. Last year (29 Nov - 2 Dec 2016) we organised and hosted an international meeting under the scope of *Codex Alimentarius* to plan a revision of the code of practice on the use of antibiotics in agriculture and to develop guidelines on integrated surveillance of AMR. The UK (Steve Wearne) chaired the meeting with the support of Australia and USA (co-chairs), EU, WHO, OIE, FAO, Codex secretariat and member countries attended the meeting with VMD representing the UK position.

The feedback from participants was overwhelmingly positive and in July 2017 the Plenary of the *Codex Alimentarius* Commission adopted the outputs produced in the task group without further amendments. The UK is now well positioned to continue influencing this work when it is picked up by the newly established Codex AMR Task Force meeting which was held in the Republic of Korea at the end of November 2017. The UK has contributed to an electronic working group providing input for the meeting.

The UK leading on Codex AMR work last year was a contributory factor in the UK's successful bid for Steve Wearne's election as one of three Vice-Chairs of the Codex Commission in July of this year.

[24] See http://www.bundesgesundheitsministerium.de/health/g20-health/public-health.html