USDA

United States Department of Agriculture

One Team, One Purpose

Food Safety and Inspection Service

Protecting Public Health and Preventing Foodborne Illness

Food Safety and Inspection Service



Salmonella Update from USDA's Food Safety and Inspection Service

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USAHA, Salmonella Subcommittee
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Topics

- Background
- Adoption of Neutralizing Buffered Peptone Water (nBPW)
- Update on Whole Genome Sequencing
- Latest on National Antimicrobial Resistance Monitoring System (NARMS)

Food Safety and Inspection Service:

Mission in Action

The public health agency in the USDA responsible for ensuring that meat, poultry, and processed egg products are safe, wholesome, and accurately labeled

Our Authority

Through a series of Acts, Congress empowers FSIS to inspect all meat, poultry, and processed egg products in interstate commerce

- Federal Meat Inspection Act (FMIA)
- Agricultural Marketing Act (AMA)
- Poultry Products Inspection Act (PPIA)
- Humane Methods of Slaughter Act (HMSA)
- Egg Products Inspection Act (EPIA)

Food Safety and Inspection Service:

Salmonella Developments in Recent Years

- FSIS released *Salmonella* Action Plan in 2014
- Key accomplishments included:
  - New poultry performance standards to include poultry carcasses, chicken parts and comminuted
  - Revised compliance guidelines for poultry slaughter and processing
  - Increased consumer education on *Salmonella*
  - Modernized poultry slaughter inspection
  - Continuous sampling (“moving windows”) for verifying process control

Food Safety and Inspection Service:

2017-2021 Strategic Plan

Paving the way for more progress in *Salmonella* reduction

Food Safety and Inspection Service:

nBPW

Food Safety and Inspection Service:

Research into Antimicrobial Carryover

Starting in 2013, ARS investigated whether antimicrobial carry-over negatively impacted pathogen recovery in sampled carcasses using the conventional sampling and transport medium (Buffered Peptone Water)

Study objectives:

- I. Determine the potential volume of intervention chemical solution carry-over to carcass rinsates
- II. Determine if antimicrobial intervention carry-over has the potential to impact *Salmonella* monitoring

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Development and Evaluation of nBPW

Phase III:

After results showed a significant carry-over effect, researchers assessed *Salmonella* recovery after reformulation of BPW with neutralizing agents (nBPW)

Conclusions:

- Recovery of *Salmonella* superior to BPW
- Carcasses showed no carry-over effect when sampled using nBPW, based on performance relative to controls

Food Safety and Inspection Service:

FSIS Adoption of nBPW

- In July 2016, FSIS began use of nBPW for carcass rinse and sponge samples
- Aggregate data in the first year indicates *Salmonella* recovery is relatively unchanged in chicken parts, but higher in carcasses
- To allow time for industry to update food safety systems after nBPW implementation, FSIS announced in Nov. 2016 temporarily replacement of individual establishment category postings on FSIS website with aggregate

Food Safety and Inspection Service:

Whole Genome Sequencing (WGS)

Food Safety and Inspection Service:

FSIS Strategic Plan 2017-2021: Where does WGS fit in?

Objective 1.2.2: Enhance Response to Foodborne Illness Outbreaks and Adulteration Events

- Increase use of new technologies, such as whole genome sequencing, to supplement information obtained during an investigation and to improve the effectiveness of responses to outbreaks

Objective 2.1.1: Modernize Scientific Techniques and Inspection Procedures

- FSIS has started building WGS capacity and intends to have WGS fully implemented into its sampling programs—to generate real-time analysis to inform FSIS' food safety and public health regulatory decisions

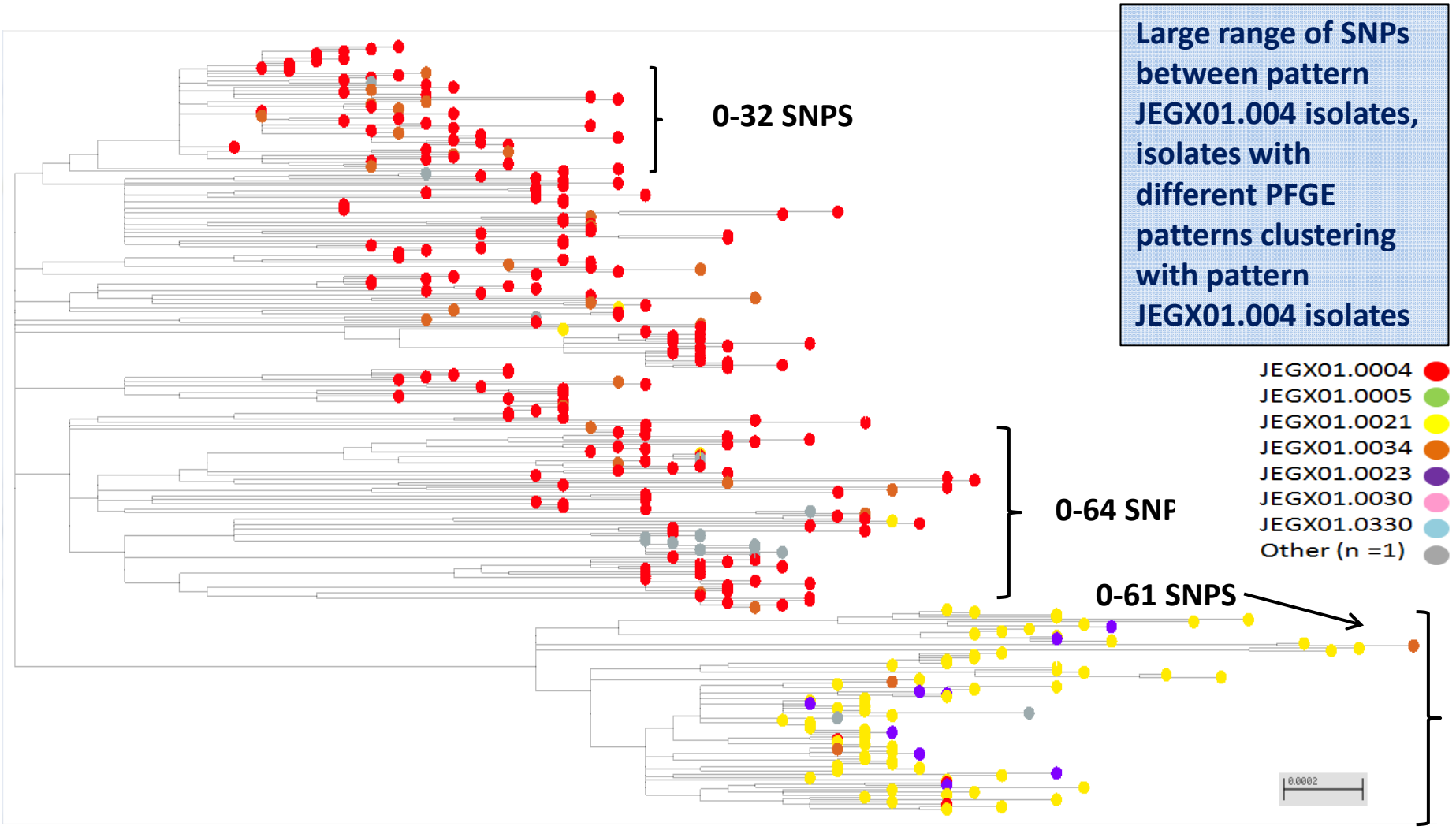
Food Safety and Inspection Service:

Why WGS?

- Improved resolution for foodborne illness investigations
- Supports FSIS mission goals
- Alignment of pathogen surveillance with public health and regulatory partners

Food Safety and Inspection Service

Discriminatory Power of WGS vs. PFGE



Food Safety and Inspection Service:

FSIS Collaborations for WGS Efforts

- FSIS is actively engaged in partnerships/collaborations with:
  - Gen-FS: An interagency collaboration on genomics and food safety
  - IFSH: An FDA/Industry/IIT collaboration
  - GMI: Global Microbial Identifier - Global initiative for furthering whole genome sequencing as a tool for diagnostics and epidemiological surveillance
  - WHO: Joint effort with WHO/PAHO/FDA to develop guidance for implementation of WGS for developing countries
  - IRAC: Interagency group discussing how WGS can be used for QMRA
  - APHIS and ARS

Food Safety and Inspection Service:

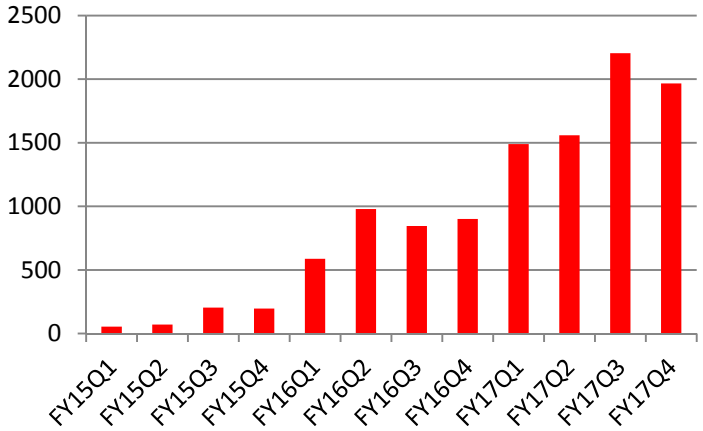
WGS at FSIS: Current Status

- FSIS has built capacity for conducting WGS on all pathogens obtained from FSIS sampling programs
  - Currently 12 sequencers in FSIS Field Service Laboratories, and expect all to be operational in early FY18
  - In FY17, FSIS sequenced 7282 isolates
- In collaboration with our public health and regulatory partners, FSIS currently considers available WGS analyses in addition to PFGE, epidemiological and traceback information to further understand the relationship between clinical and food isolates
- FSIS works with National Antimicrobial Resistance Monitoring System (NARMS) partners (FDA, CDC) to understand the occurrence or introduction of antimicrobial resistance genes in pathogens of interest

Food Safety and Inspection Service

WGS Milestones and Uploads in to the National Center for Biotechnology Information (NCBI) Genomic Database

Isolates Sequenced



Milestone Dates

- July 2014: *Salmonella* and *Listeria monocytogenes*
- December 2014: STECs
- February 2015: *Campylobacter*
- May 2015: Capability to directly upload WGS files to NCBI

As of 10/01/2017: 10,935 FSIS isolates have been sequenced and uploaded to NCBI

	Listeria monocytogenes	STEC	*Salmonella*	*Campylobacter*	Total
Routine/Special Projects	**435**	**482**	**3825**	**1007**	**5749**
NARMS Cecal Sampling			**2396**	**2790**	**5186**
Total	**435**	**482**	**6221**	**3797**	**10935**
Total for FY 2017	**7219** (Note: In FY 2016 we completed 3313 WGS and in 2015 it was 524. About 121 WGS from NARMS 'E. coli + Enterococcus' are not included in the 10935 total)				

Food Safety and Inspection Service:

Using WGS to Identify Other Pathogen Characteristics

- FSIS is beginning to explore using genotypic data to predict phenotypic characteristics
  - Previous examples of antimicrobial resistance markers
  - Resistance to other environmental factors (i.e. heat, acid, certain chemicals, etc)
- Example: Locus of Heat Resistance (LHR)
  - Present in a diverse group of Enterobacteriaceae, including *Cronobacter sakazakii*, *Klebsiella pneumoniae*, *Enterobacter cloacae*, *E. coli*, and *Salmonella*
  - A BLAST database including genes contained in the LHR was built based on the published sequence of *E. coli* AW1.7
  - *Salmonella* isolates from FSIS-regulated products were sequenced, assembled and queried against the LHR BLAST database
  - Additional phenotypic testing required to determine if isolates exhibit resistance to heat
- Heat resistance can be linked to different biological pathways/genes
  - Advantage of WGS: As new pathways/genes are identified, data can be queried again

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WGS in Conclusion

- FSIS' new strategic plan is focused on the use of new technology to prevent foodborne illnesses and protect public health
- FSIS has built sufficient capacity for conducting WGS on all FSIS pathogen isolates
- FSIS is exploring how we can use WGS data beyond outbreak investigations, including understanding the link between genotypes and phenotypes of interest
- FSIS continues to engage with national and international partners
- FSIS continues to use WGS analyses in conjunction with other metadata, including epidemiological and traceback information, to further understand the relationship between clinical, food and environmental isolates

Food Safety and Inspection Service:

NARMS

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FSIS Role in National Antimicrobial Resistance Monitoring System

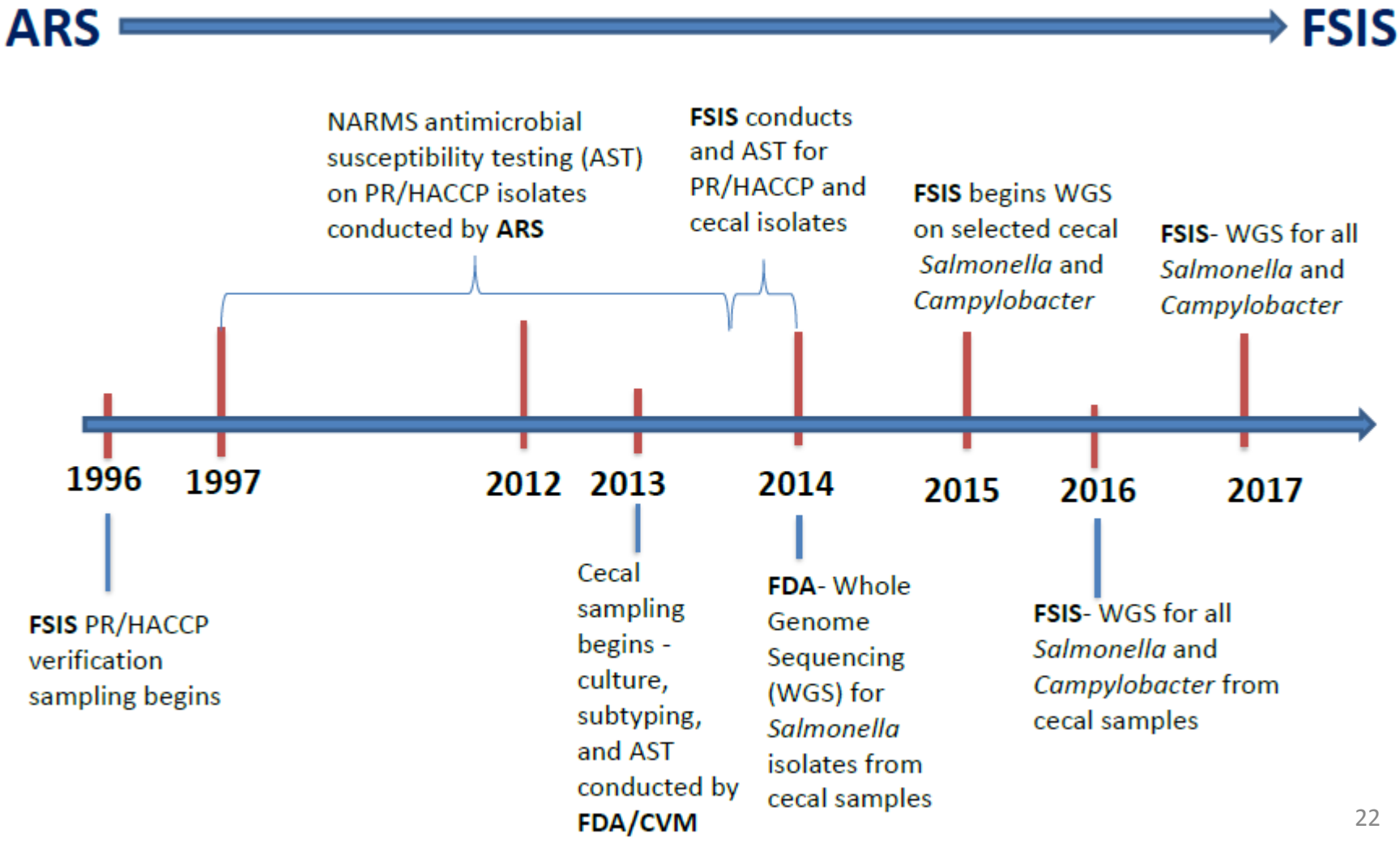
FSIS Surveillance Data Sampling Sources

Pathogen Reduction/Hazard Analysis and Critical Control Point (PR/HACCP) Program (1997-Present)	Cecal Sampling Program (2013-Present)

Samples are collected from federally inspected slaughter and processing plants throughout U.S. Target all four major food animal species and antimicrobial susceptibility data on all four bacteria

Food Safety and Inspection Service:

FSIS NARMS Milestones



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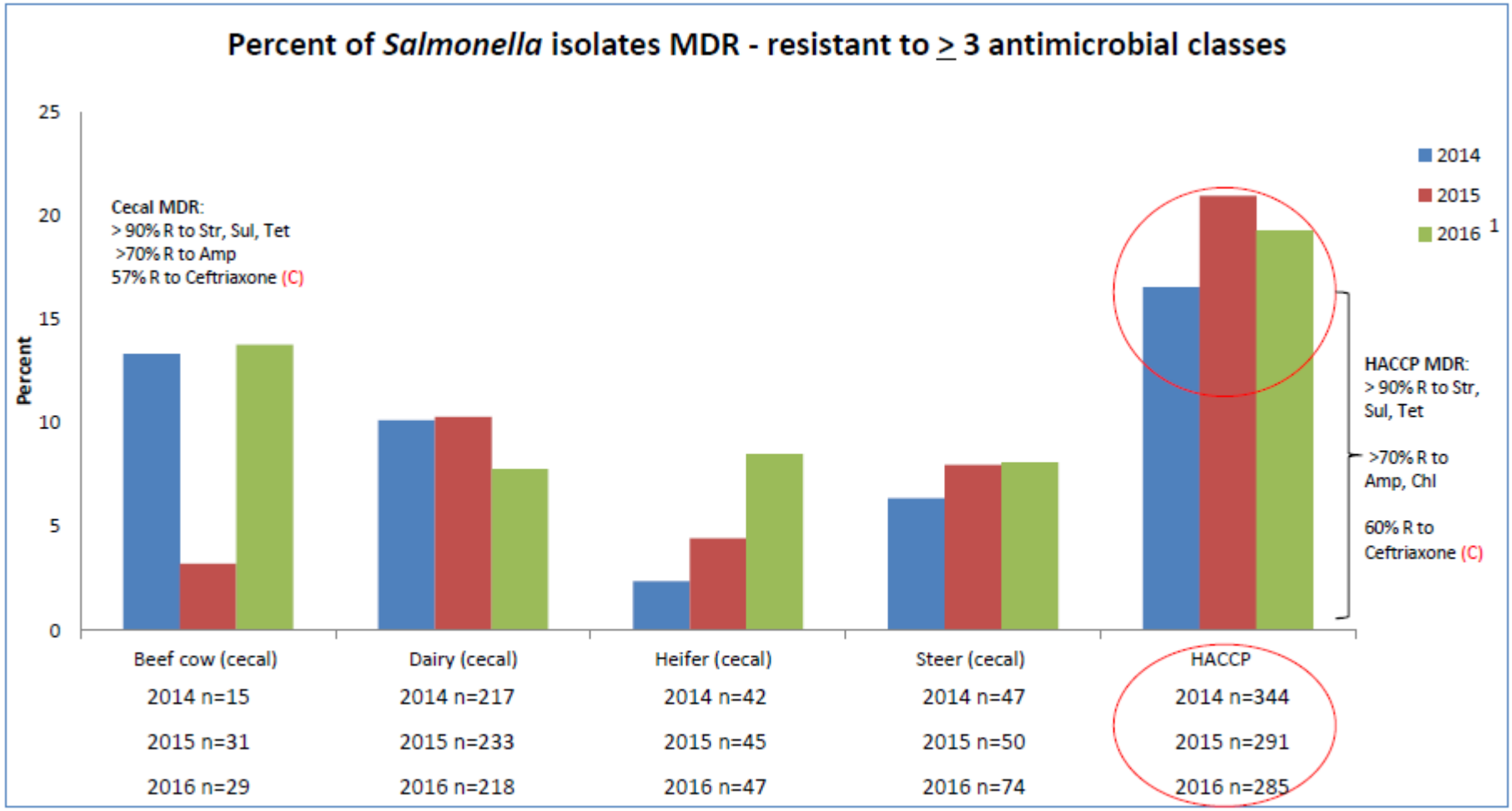
NARMS *Salmonella*

		2014			2015			2016[1]		
		No. Samples	No. Isolates	Percent Positive	No. Samples	No. Isolates	Percent Positive	No. Samples	No. Isolates	Percent Positive
HACCP	Chickens	10,446	936	9.0%	11,453	1,491	13.0%	16,973	1,857	10.9%
	Turkey	3,374	299	8.9%	2,505	185	7.4%	2,739	136	5.0%
	Cattle	16,720	344	2.1%	14,824	291	2.0%	15,256	285	1.9%
	Total	30,540	1579		28,782	1967		34,968	2278	
Ceca	Chickens	575	103	17.9%	553	130	23.5%	568	133	23.4%
	Turkey	264	45	17.0%	266	25	9.4%	265	50	18.9%
	Beef	1,798	104	5.8%	1,678	126	7.5%	1,741	150	8.6%
	Dairy	1,069	217	20.3%	1,055	233	22.1%	1,080	218	20.2%
	Swine	1,295	606	46.8%	1,179	494	41.9%	1,295	619	47.8%
	Total	5,001	1,075	21.5%	4,731	1,008	21.3%	4,949	1,170	23.6%

[1]Preliminary 2016 Data

Food Safety and Inspection Service:

MDR *Salmonella*: Cattle-Associated Isolates

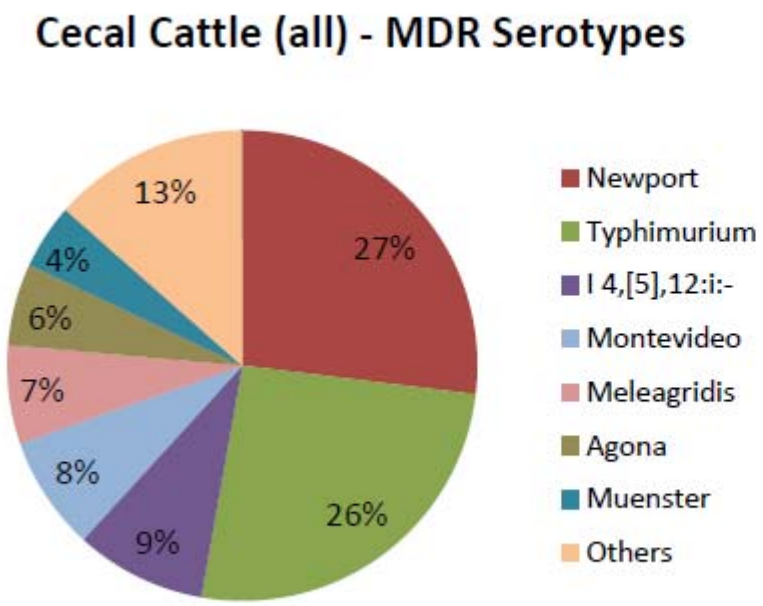


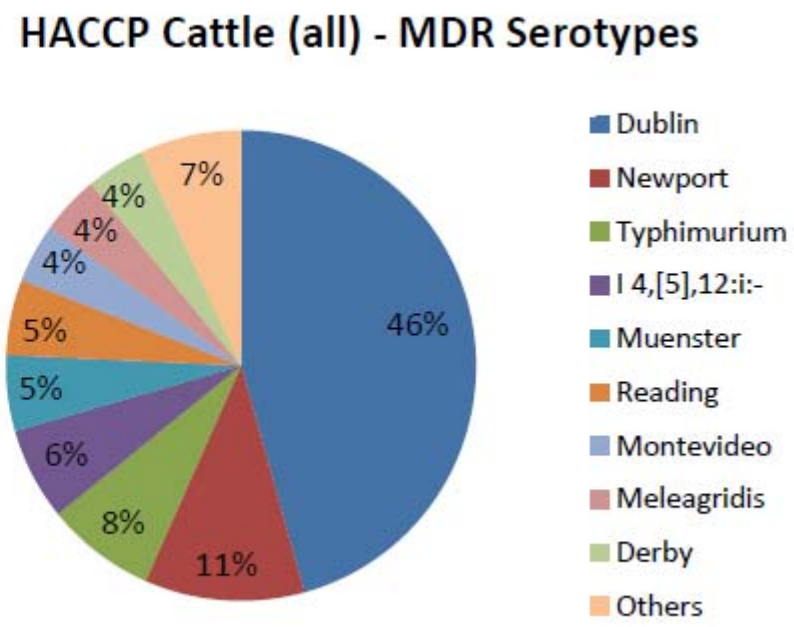
[1]Preliminary 2016 Data

Food Safety and Inspection Service:

MDR *Salmonella*: Cattle-Associated Serotypes

2014-2016[1]

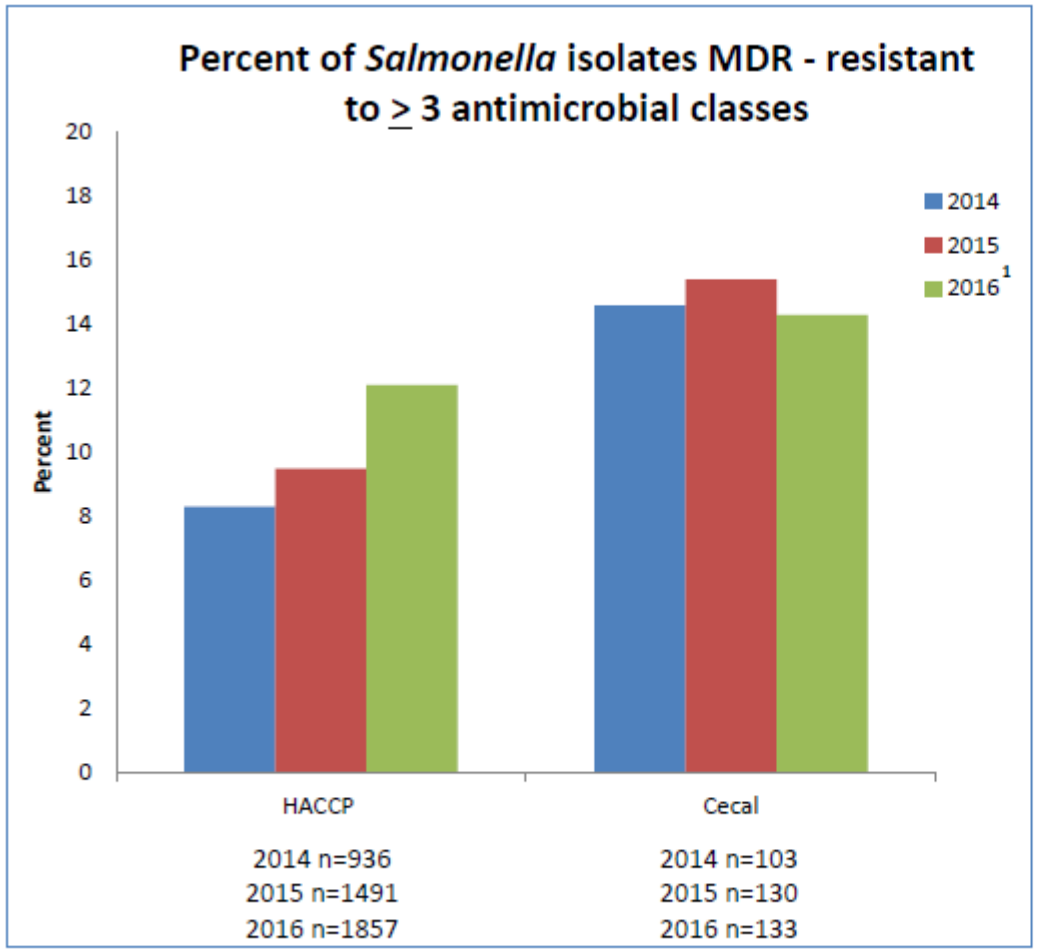


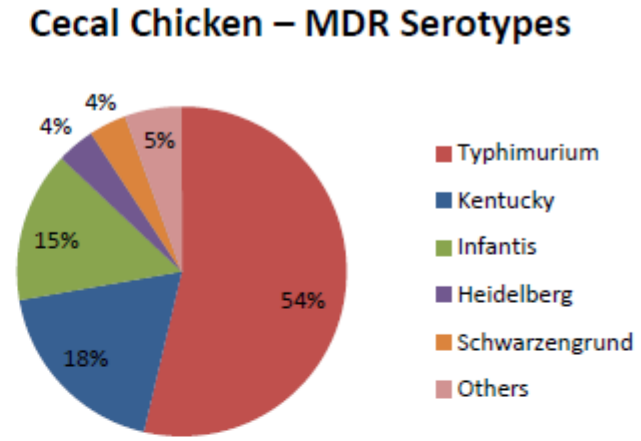


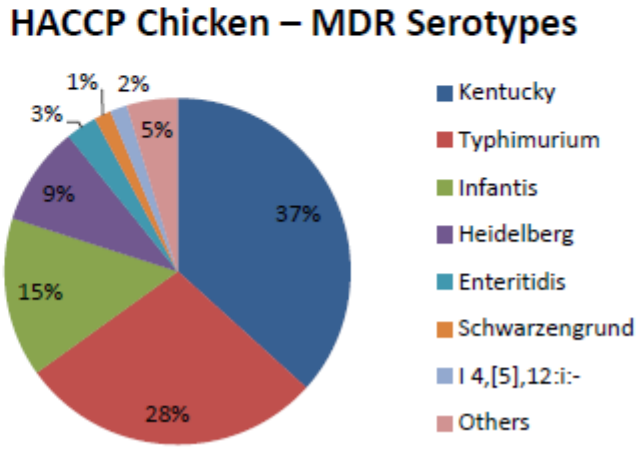
[1]Preliminary 2016 Data

Food Safety and Inspection Service:

MDR *Salmonella* in Chicken



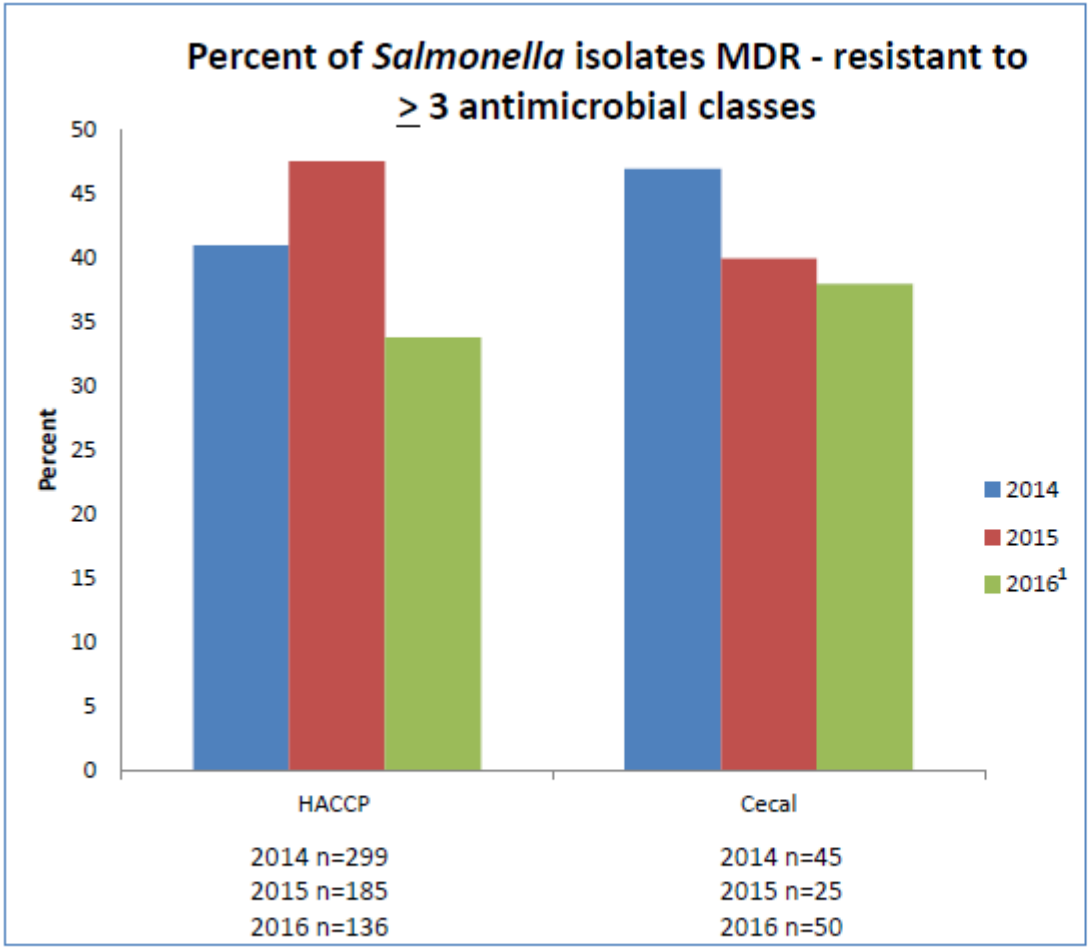


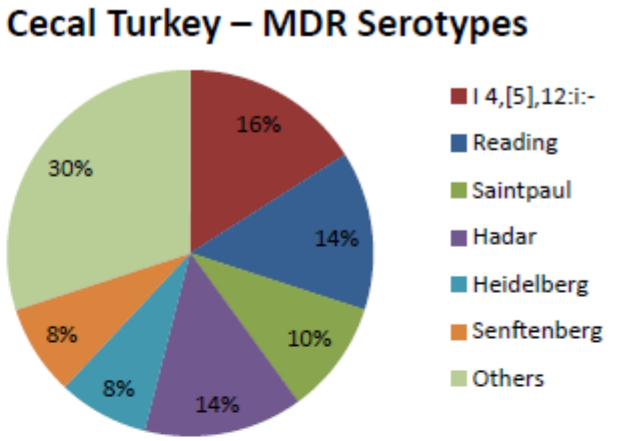


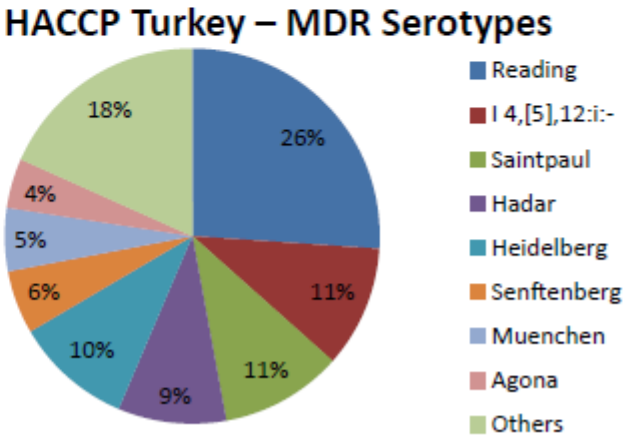
[1]Preliminary 2016 Data

Food Safety and Inspection Service:

MDR *Salmonella* in Turkey



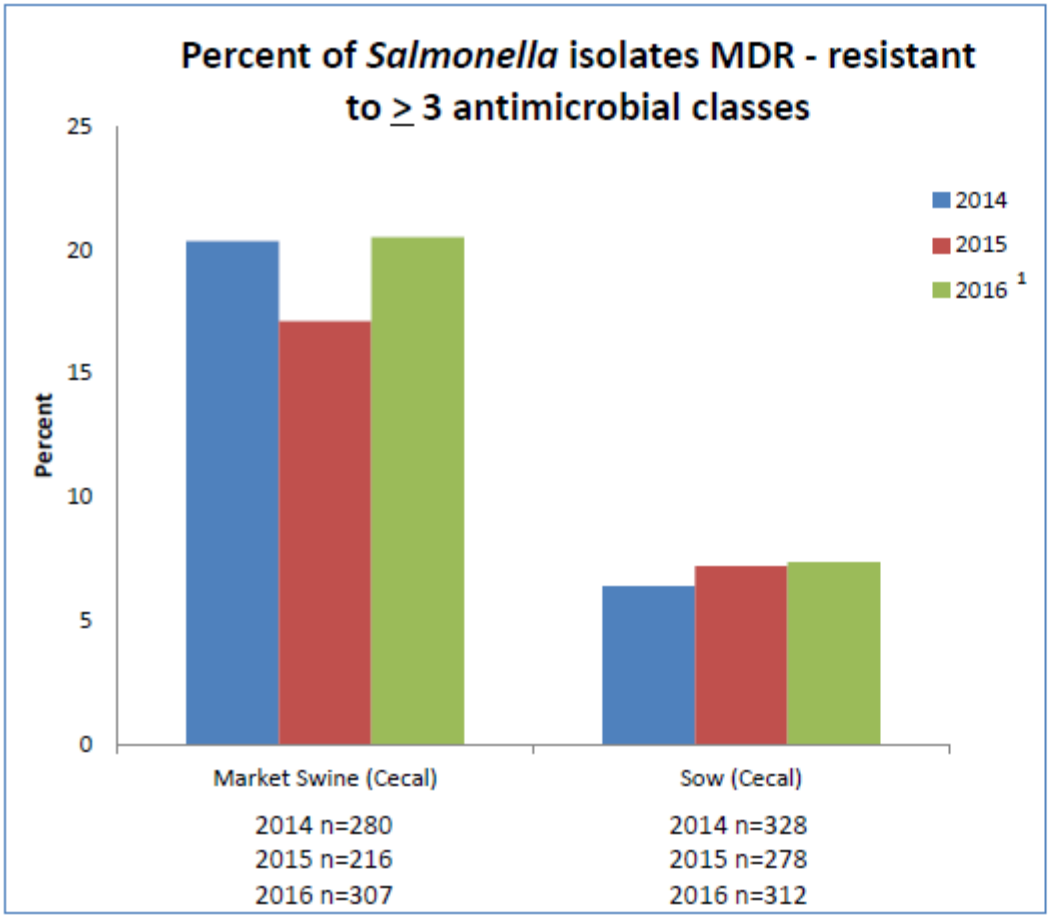


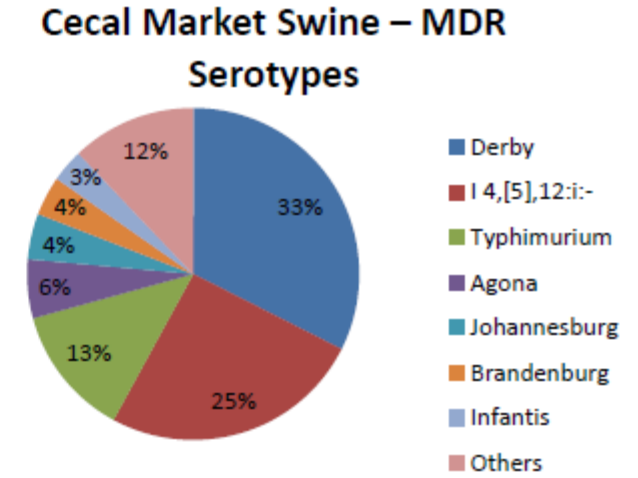


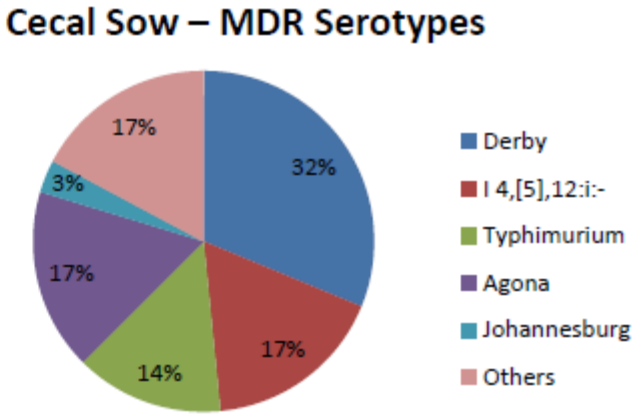
[1]Preliminary 2016 Data

Food Safety and Inspection Service:

MDR *Salmonella* in Swine







[1]Preliminary 2016 Data

Food Safety and Inspection Service:

Future Directions

- Continuation of WGS and timely sequence uploads into NCBI
- Work with NARMS to monitor resistomes and mobilomes
- Develop a mechanism to inform regulated industry of new findings of concern
- FSIS NARMS webpage and publications

Food Safety and Inspection Service:

Upcoming Public Meetings

- NARMS Public Meeting hosted by FDA - Oct 24th and 25th
  - This two day NARMS meeting will cover topics related to partner agency and stakeholder perspectives, genomics, recommendations from the science board and data needs to make the necessary AMR linkages
- WGS Public Meeting hosted by FSIS - Oct 26th and 27th
  - This two day meeting will cover topics related to WGS – the big picture, Federal and State WGS collaborations, international and stakeholder perspectives and a roundtable to broadly discuss significant WGS issues in a regulatory context

Questions?

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