UNITED STATES
National Residue Program for Meat, Poultry, and Egg Products

FY 2018 RESIDUE SAMPLE RESULTS

United States Department of Agriculture
Food Safety and Inspection Service
Office of Public Health Science

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Preface

The 2018 Food Safety and Inspection Service (FSIS) National Residue Program Data publication (the 'Red Book'), explains FSIS' chemical residue sampling plans and presents National Residue Program (NRP) testing results by fiscal year. [For those reading this electronically, this document has been commonly known as the "Red Book" because the covers of the previously printed versions were red.] In addition, the following appendices are included for the convenience of the reader: Appendix I, NRP Positive Non-Violative and Positive Violative Residue Samples Results; Appendix II, Number of Samples Required to Detect Violations with Predefined Probabilities; Appendix III, FY 2018 List of Chemical Residues by Class/Method; Appendix IV, Summary of Scheduled Sampling Data from 2014 to 2018; Appendix V, Summary of Import Re-inspection Sampling Data from 2014 to 2018; and Appendix VI, Inspector Generated Sampling Data from 2014 to 2018 (includes KIS™ test).

Acknowledgements

We would like to extend our gratitude to the thousands of FSIS field inspection personnel who collected and submitted the residue samples and to all the laboratory staff who prepared, analyzed and documented the results of the residue samples. We would like to acknowledge the Office of Planning, Analysis and Risk Management (OPARM) for providing the data.

Contacts and Comments

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Acronyms

AMDUCA – Animal Medicinal Drug Use Clarification Act
CSI – Consumer Safety Inspector
DW – FSIS Data Warehouse
EPA – Environmental Protection Agency
FDA – Food and Drug Administration
FSIS – Food Safety and Inspection Service
FY – Fiscal Year
HACCP – Hazard Analysis and Critical Control Point
IPP – Inspection Program Personnel
KIS™ Test – Kidney Inhibition Swab Test
MRM – Multi-Residue Method
ND – Non-detect
NRP – National Residue Program
OPHS – Office of Public Health Science
PHIS – Public Health Information System
PHV – Public Health Veterinarian
PPB – parts per billion
PPM – parts per million
RVT- Residue Violator Tracking
SAT – Surveillance Advisory Team

Executive Summary

The U.S. National Residue Program (NRP) is comprised of the following programs:

- Domestic Sampling Plan
    - Scheduled
    - Inspector-Generated
- Import Reinspection Sampling Plan

Domestic Scheduled Sampling

In FY 2018, eleven (11) analytical methods were used by FSIS that can collectively detect approximately 250 different chemical residues, including veterinary drug, pesticide and environmental contaminant residues, to analyze domestic samples collected by the Agency and several States. Of the 7,908 samples analyzed by FSIS (7,425 from U.S. Federal plants and 484 from U.S. State inspected plants), 26 chemical residue violations were found. The residue violations consisted of seven (7) piperonyl butoxide, seven (7) moxidectin, four (4) carbadox, two (2) crystal violet, and one (1) each doramectin, leucocrystal violet, leucomalachite green, meloxicam, salbutamol, and sulfadoxine.

In some cases, chemical residues were detected in samples at levels below the set tolerance (non-violative levels). In FY 2018, 19 samples were considered non-violative.

Inspector-Generated Sampling

In FY 2018, of the 172,792 Kidney Inhibition Swab (KIS™) tests conducted on suspect animals by the FSIS IPP, 3,845 samples were submitted to FSIS field laboratories for further analysis and of these 815 chemical residue violations were reported in 644 samples. (Note: multiple residue violations may be found in the same samples).

The predominant violative residues were ceftiofur (235), penicillin (168) and sulfadimethoxine (79), which account for 29%, 21%, and 10% of total violative residues, respectively. IPP submitted 227 samples from suspect animals (including samples collected under the collector-generated and show animal sampling projects) directly to FSIS field laboratories for residue analysis, resulting in 11 chemical residue violations. The residue violations consisted of three (3) sulfamethazine, two (2) each ceftiofur and tilmicosin and one (1) each of permethrin, piperonyl butoxide, sulfadimethoxine and sulfamethroxazole.

In FY 2018, 724 samples with non-violative positives residue were observed in the Inspector-generated Sampling Plan.

Import Reinspection Sampling

In FY 2018, ten (10) analytical methods were used by FSIS that can collectively detect approximately 230 different veterinary drug, pesticide and environmental contaminant residues, to analyze import samples collected by the Agency. In FY 2018, 3,409 import samples were analyzed, under the FY 2018 Import Reinspection Sampling Program seven (7) of these samples were violative for residues. These violative samples originated from: Bangladesh (1), Brazil (2), Mexico (1), and Vietnam (3).

All violations are entered in the Residue Violator Tracking (RVT) system, an FSIS/Food and Drug Administration (FDA) interagency database.

These reports and previous years' residue sample results are publicly available on the FSIS website at: http://www.fsis.usda.gov/wps/portal/fsis/topics/data-collection-and-reports/chemistry/residue-chemistry

Introduction

The U.S. National Residue Program (NRP) for Meat, Poultry, and Egg Products – administered by the U.S. Department of Agriculture's (USDA), Food Safety and Inspection Service (FSIS) – is an interagency program designed to identify, rank, and analyze for chemical contaminants in meat, poultry, and egg products. FSIS publishes the NRP Residue Sampling Plans (traditionally known as the Blue Book) each year to provide information on the process used to select and prioritize the sampling of meat, poultry, and egg products for chemical contaminants of public health concern.

Background

An essential aspect of food safety in meat, poultry, and egg products is the control of residues that may result from the use of animal drugs and pesticides, or from incidents involving environmental contaminants. The United States has a complex residue control system, with rigorous processes for approval, sampling and testing, and enforcement.

FSIS administers this regulatory program under the Federal Meat Inspection Act (FMIA) (21 U.S.C. 601 et seq.), the Poultry Products Inspection Act (PPIA) (21 U.S.C. 453 et seq.), and the Egg Products Inspection Act (EPIA) (21 U.S.C. 1031 et seq.). Note that on December 2, 2015, FSIS published the final rule, "Mandatory Inspection of Fish of the Order Siluriformes and Products Derived from Such Fish" after the 2008 Farm Bill amended the FMIA to make all fish of the order Siluriformes amenable under the FMIA and, therefore, subject to FSIS inspection. As a result, FSIS now also samples and tests domestic and imported Siluriformes fish products for residues. The NRP assists FSIS in meeting its mission of protecting the health and welfare of the American public by preventing the distribution into commerce of domestic and imported meat, poultry and egg products that are adulterated because they contain violative residues.

The NRP requires the cooperation and collaboration of several agencies for its successful design and implementation. FSIS, along with the Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA), are the primary Federal agencies managing this program. The FDA, under the Federal Food, Drug, and Cosmetic Act (FFDCA), establishes tolerances for veterinary drugs and action levels for food additives and environmental contaminants. The EPA, under the FFDCA and the Federal insecticide, Fungicide, and Rodenticide Act (FIFRA) establishes tolerances for registered pesticides. Title 21 and Title 40 of the Code of Federal Regulations (CFR) includes tolerance levels established by FDA and EPA, respectively.

The Surveillance Advisory Team (SAT)- which includes representatives from USDA's FSIS, Agricultural Research Service (ARS) and Agricultural Marketing Service (AMS), the Department of Health and Human Services (HHS') FDA and Centers for Disease Control and Prevention (CDC), and EPA— meets annually to evaluate chemical compounds for inclusion in the NRP scheduled sampling plans. The SAT consists of experts in veterinary medicine, toxicology, chemistry, and public health who provide professional advice, as well as information on veterinary drug and pesticide use in animal husbandry. SAT discussions are used to decide which compounds represent a public health concern and warrant inclusion in the NRP scheduled sampling plans. In addition, the SAT may propose, based on professional judgment and reliable field information, the initiation of exploratory assessments for directed sampling on

a production class or region of the country. These agencies work together to create the annual sampling plan, based on the following: prior NRP findings of chemical residues in meat, poultry, and egg products; FDA veterinary drug inventories obtained during on-farm visits and investigations; and pesticides and environmental contaminants of current importance to EPA (see Appendix I for a description of the statistical analysis to determine the number of samples required to detect a given number of expected violations).

The range of chemical compounds evaluated for inclusion in the NRP is comprehensive in scope. It includes approved and unapproved pharmaceutical drugs and pesticides, and environmental contaminants known or suspected to be present in food animals in the United States and in countries exporting products to the United States. The NRP is designed to: (1) provide a structured process for identifying and evaluating chemical compounds intentionally and unintentionally present in food animals; (2) analyze chemical compounds of concern; (3) collect, analyze, and report results; and (4) identify the need for appropriate regulatory follow-up subsequent to the identification of violative levels of chemical residues.

Actions Taken on Violations

A violation occurs when an FSIS laboratory detects a chemical compound at a level in excess of an established tolerance or action level, as well as if the residue detected has no established tolerance. Once the laboratory analysis is complete, FSIS enters the detailed residue violation information into the Residue Violator Tracking (RVT) system, an FSIS/FDA interagency database. For violative samples, IPP are notified via PHIS and provides establishment with analytical results. Under best practices, the establishment should also notify the producer that an animal from that business has been identified as having a residue violation. In addition, FSIS shares relevant information regarding violative residue samples with EPA and FDA, where the latter Agency has on-farm jurisdiction. FDA and cooperating State agencies investigate producers linked to residue violations and, if conditions leading to residue violations are not corrected, can take legal action.

To notify the public and the industry of repeated residue violations by the same producer, FSIS posts a weekly Residue Repeat Violators List on its Web site that identifies producers with more than one violation in a rolling 12-month period. In addition, this list provides helpful information to AMS School Lunch Program processors and producers that want to avoid illegal levels of residues; serves as a deterrent for violators; and enables FSIS and FDA to better target resources. It is important to note that because FSIS updates the Residue Repeat Violators List weekly, FDA may not have investigated each violation at the time of publication.

FSIS Laboratory Analytical Methods

Minimizing food safety hazards from farm-to-fork protects consumers from the public health risks associated with chemical contaminants in food. In 1996, FSIS published the Hazard Analysis and Critical Control Point (HACCP) Rule (9 CFR Part 417). This regulation requires FSIS-inspected slaughter and processing establishments to identify all food safety hazards (including animal drug, pesticide and environmental contaminant residues) reasonably likely to occur before, during, and after the food animal or product enters the slaughter establishment. The regulation also requires establishments to identify

preventive measures to control these hazards. FSIS can take regulatory action against establishments that do not have an effective chemical residue control program in place.

With ever greater public concern about the risks of chemical contaminants, regulatory agencies such as FSIS, EPA and FDA focus on continually strengthening the identification, prioritization, and testing for chemical hazards in regulated commodities. To achieve this goal, FSIS uses multi-residue methods for the detection, identification, quantification, and confirmation of veterinary drug, pesticide, and environmental contaminant residues (see APPENDIX III). The veterinary drug, pesticide and environmental contaminant multi-residue methods screen and confirm over 80, 100 and 17 analytes, respectively.

The FSIS Chemistry Laboratory Guidebook lists and describes the analytical methods, analytical processes, and performance characteristics used. One key performance element is the Minimum Level of Applicability (MLA). FSIS defines an MLA as the lowest level at which a method has been successfully validated for a residue in a given matrix. It is also the lowest level at which a laboratory analyst is expected to maintain ongoing proficiency in the method.

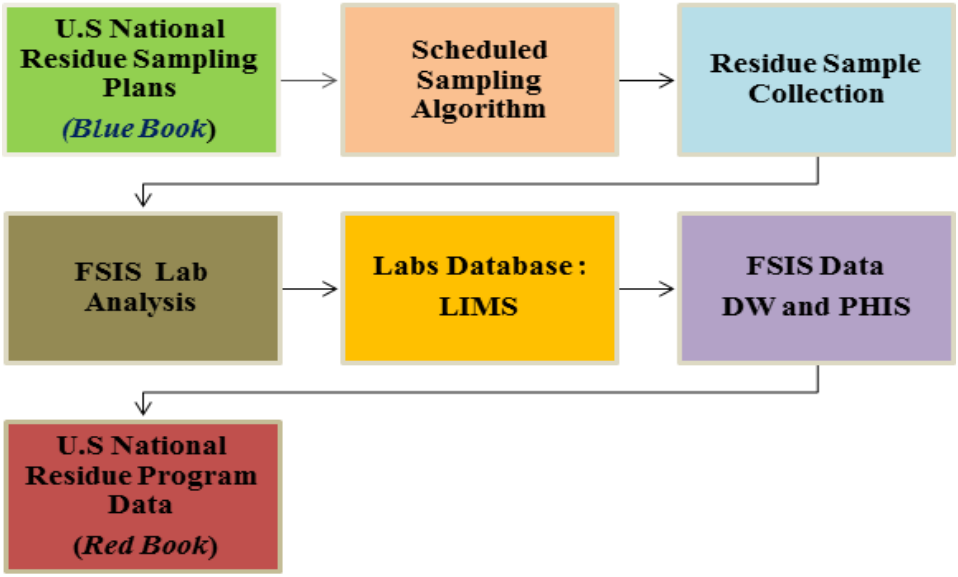

Figure 1. NRP: This figure illustrates the steps of the NRP. The NRP begins with interagency development of a sampling program plan (Blue Book) and ends by developing a report summarizing the collection and analysis of samples and the results of analysis (Red Book).

Overview of the Sampling Plans

The 2018 NRP was implemented for the U. S. Government fiscal year from October 1, 2017 to September 30, 2018 and focused on chemical residues in samples of domestic meat, poultry, and egg products collected at Federally and State inspected establishments and samples of imported meat, poultry, and egg products collected during FSIS re-inspection at import inspection establishments. All of these samples were tested in FSIS laboratories. FSIS Directive 10,800.1 and FSIS Directive 9900.6 provide further details on sampling collection procedures for domestic and imported products.

Domestic Sampling Plan

1. Tier 1

The Tier 1 sampling plan is the scheduled, or "directed" sampling of specified slaughter subclasses at the time of slaughter, after they have passed ante-mortem inspection. Within the subclass, inspectors randomly select carcasses for sampling. The number of samples scheduled each year is based on the probability of detecting at least one violation (APPENDIX II). Sampling tasks are assigned each month through the Public Health Information System (PHIS), an FSIS database designed to collect, consolidate and analyzed data in order to improve public health. The sampling task provides information to the FSIS inspection program personnel (IPP) on when to collect the sample (collection window) and which production class to sample. The establishment holds, or controls livestock carcasses selected for testing pending the results of analysis. For directed testing of poultry, the IPP recommends to the establishment that the establishment holds the specific poultry carcasses selected for residue testing pending the analysis results.

Tier 1 sampling results also can be used to identify producers or other entities marketing animals with violative levels of residues. Thus, the Tier 1 sampling plan not only gathers information, but also assists in deterring practices that lead to violative residues.

In FY 2018, the Tier 1 sampling plan included collection and testing of samples from the following production classes: bob veal, beef cows, dairy cows, steers/ heifers, goats, market swine, sows, Siluriformes fish, young chickens, and young turkeys. These production classes represent 95 percent of domestic meat and poultry consumption.

2. Tier 2

a. Inspector-Generated Sampling

FSIS IPP conducts inspector-generated sampling when it is suspected that animals may have violative levels of chemical residues. Currently, such sampling targets individual suspect animals, suspect populations of animals, and/or animals condemned for specific pathologies listed in FSIS Directive 10,800.1 (i.e., animal with disease signs and symptoms, producer history, or as a follow-up to results from random scheduled sampling). When Public Health Veterinarians (PHVs) detect evidence of a disease that may have been treated or suspect the administration of a veterinary drug, they retain the

carcass and analyze samples using an in-plant method - the Kidney Inhibition Swab test (KIS™ test)[1] - to screen for the presence of chemical residues. If the in-plant test is negative for veterinary drug residues included in the screen, the carcass is released to the establishment. If there are screen positive results, samples are sent to FSIS laboratory testing and the carcass is held pending results. Based on violative laboratory results, the PHV condemns carcasses and/or parts of animals.

i. Sampling of Individual Suspect Animals

Under the direction of the PHV, IPP conduct a KIS™ test on any carcass that, based on herd history or ante-mortem or post-mortem inspection findings, may contain a violative drug residue. IPP follow instructions in FSIS Directive 10,800.1, relative to circumstances warranting a KIS ™ test and for performing KIS™ tests and documenting the task in PHIS. The PHV selects a carcass for sampling based on the criteria outlined in FSIS Directive 10,800.1. Usually, the sample is screened in the plant by the IPP and the screen-result verified when necessary by a PHV. Other samples are sent directly to the FSIS laboratory for analysis. For example, if the IPP suspects the misuse of a veterinary drug in an animal, she/he can perform the relevant in-plant screening analysis. If the result of a screening analysis is positive, the carcass is held (if it is not already condemned for other pathology or conditions that would make it unfit for human consumption), and the liver, kidney, and muscle samples from the carcass are then sent to an FSIS laboratory for analysis. If IPP suspect that there is misuse of drugs that cannot be detected by the KIS™ test, the samples are sent directly to the laboratory for appropriate analysis. These samples are reported under the **Collector-Generated** program.

ii. Sampling of Suspect Animal Populations

a. KIS™ Testing of Bob Veal Calves

Bob veal calf carcasses for KIS™ testing are selected from healthy appearing calves, as determined by the IPP or PHV, during ante-mortem inspection. Sampling is directed by the FSIS regulation 9 CFR 310.21 and FSIS Directive 10,800.1.

b. Sampling of Show Animals

Show animals, such as cattle, hogs, sheep, and goats presented for inspection, from a single fair or livestock show are selected for the KIS™ test whenever an establishment presents show animals for slaughter. When show animals appear otherwise healthy, the PHV selects animals at random from the entire lot of show animals for testing at the frequency specified in FSIS Directive 10,800.1. When show animals appear unhealthy or are suspected of having antibiotic residues (e.g., injection sites, evidence of a disease process), IPP tags the animals as "U.S. Suspect" and perform a KIS™ test.

iii. Sampling of Animals from State-Inspected Slaughter Establishments

Inspectors from State inspected establishments that operate under inspection systems "at least equal to" the Federal requirements collect and submit samples of kidney, liver and muscle from animals suspected of having violative residues directly to the FSIS laboratory.

[1] The KIS™ test is an antibiotic detection test for kidney tissue. Its principle of detection is microbial inhibition. Bacteria, cultured in agar with purple pH indicator media and kidney extract, generate acid that produces a yellow color. In the presence of antibiotic, the bacterial growth is inhibited and the test remains blue/purple.

b. Targeted Sampling

FSIS implements targeted sampling plans, also known as exploratory assessments, in response to information obtained by FDA and EPA and provided to FSIS about misuse of animal drugs and/or exposure to environmental chemicals, as well as in response to Tier 1 analytical results. The duration of these sampling plans varies based on the situation. FSIS may conduct studies to determine the frequency and concentration at which some residues like trace metals and industrial components are present in animals. These sampling plans could be designed to distinguish components of meat, poultry and egg products in which residue problems exist, to measure the extent of problems, and to evaluate the impact of actions taken to reduce the occurrence of residues in the food animal population.

For this targeted sampling, the sampling tasks are assigned through PHIS. The sampling task provides instructions to the IPP on when to collect the sample (collection window) and from which slaughter production class to collect the sample. The establishment holds, or controls livestock carcasses selected for testing pending the test results. For directed residue testing of poultry, the IPP recommends to the establishment that the plants hold the specific poultry carcasses selected for residue testing pending the test results.

In FY 2018, targeted sampling included sheep, bull, roaster swine, formula-fed veal, non-formula fed veal, and heavy calves from randomly selected U.S Federal plants (please refer to FY 2018 Blue Book for further details).

3. Tier 3

The Tier 3 sampling plan is similar in structure to the targeted sampling / exploratory assessment program in Tier 2, with the exception that Tier 3 encompasses targeted testing at a herd or flock level. A targeted testing program designed for livestock or flocks originating from the same farm or geographic region may be necessary on occasion to determine the level of exposure to a chemical or chemicals. For instance, producers may administer some veterinary drugs to a herd or a flock (for example, growth promotants or antibiotics given in the feed) in a way that involves misuse. In addition, livestock and birds may be exposed unintentionally to an environmental contaminant. Tier 3 provides a vehicle for obtaining information that will support future policy development within the NRP.

In FY 2018, The NRP consisted of Tier 3 sampling of feral swine samples for pesticides (please refer to FY 2018 Blue Book for details on sampling plan.

Import Reinspection Sampling Plan

Imported meat (including Siluriformes fish), poultry, and egg products are sampled through the port-of-entry Import Reinspection Sampling Plan, a chemical residue monitoring program conducted to verify the equivalence of inspection systems in exporting countries to the U.S. standards. All imported products are subject to reinspection and one or more types of inspection (TOI) are conducted on every lot[2] of product

[2] An import lot is a group of products defined statistically and/or scientifically by production segments and certified from one country and one establishment. A lot consists entirely of the same species, process category, and product standard of identity (sub-category). A single lot can contain shipping cartons with varying sizes of immediate containers.

before it enters the United States. FSIS Directive 9900.6 provides instructions to IPP on collecting laboratory sampling and testing of imported meat, poultry, and egg products. Chemical residue sampling is included in the reinspection of imported products. There are three levels of chemical residue reinspection for imported products that include:

- normal sampling: random sampling from a lot;
- increased sampling: above-normal sampling resulting from an Agency management decision; and
- intensified sampling: additional samples taken when a previous sample for a TOI that failed to meet U.S. requirements.

The data obtained from laboratory analyses are entered into PHIS, an FSIS database designed to generate reinspection assignments, receive and store results, and compile histories for the performance of foreign establishments certified by the central competent authority in the exporting country.

The import reinspection sampling program is structured using the same Tier 1 and Tier 2 (targeted) criteria used to develop the domestic plan. In FY 2018, FSIS collected approximately **3,409** import samples for residue analysis.

Policy and Procedures for Holding or Controlling Product under the NRP

As of February 2013, the Agency requires official plants and importers of record to hold or maintain control of lots of product tested for adulterants until acceptable results become available. FSIS stated that this policy would applies to domestic livestock carcasses subject to FSIS testing for residues. FSIS explained that it will not hold poultry carcasses pending test results for residues due to historically low residue problems and the large lot size. This was outlined in a published Federal Register Notice 76 FRN 19955.

The Hold and Test policy also applies to normal and increased import reinspection sampling. Additionally, for intensified import sampling, the lot must be retained pending laboratory results.

Summary of Domestic Residue Sampling Program

This section reports the summary results from the FSIS Domestic Scheduled Sampling Plan. The summary results are associated with a specific Animal Class. All data reported in the following tables were extracted from the FSIS Data Warehouse and PHIS databases.

Table 1 identifies the animal classes and methods/chemical classes which are in the FY 2018 NRP.

Table 2 summarizes the number of Domestic Scheduled samples and Inspector-generated samples tested by animal class.

Table 3 summarizes the number of residue Domestic Scheduled samples analyzed by animal class, including summary results.

Table 4 summarizes the number of residue Domestic Scheduled samples tested per chemical method by animal class.

Table 5 summarizes Domestic Scheduled Sampling -number of chemical analyses tested per chemical method by animal class.

Table 6 summarizes domestic scheduled sampling violation results by animal class.

Table 1. FY 2018 Tier 1 and 2 List of Animal Class by Method/Chemical Class (Analyses Performed)

Animal Category	Animal Class	Chemical Method										
		Aminoglycosides	**Arsenic**	**Avermectins**	**βeta-Agonists**	**Carbadox**	**Dyes**	**Hormones**	**Metals**	**MRM**	**Nitrofurans**	**Pesticides**
Bovine	Beef Cows	√	√	√	√	--	--	√	√	√	--	√
	Bob Veal	√	√	√	√	--	--	√	√	√	--	√
	Bulls	√	√	√	--	--	--	--	--	√	--	√
	Dairy Cows	√	√	√	√	--	--	√	√	√	--	√
	Formula-Fed Veal	√	--	--	√	--	--	--	--	√	--	--
	Heavy Calves	√	--	--	√	--	--	--	--	√	--	--
	Heifers	√	√	√	√	--	--	√	√	√	--	√
	Non-Formula-Fed Veal	√	--	--	√	--	--	--	--	√	--	--
	Steers	√	√	√	√	--	--	√	√	√	--	√
Porcine	Feral Swine **	--	--	--	--	--	--	--	--	--	--	√
	Market Swine	√	√	√	√	--	--	--	√	√	--	√
	Roaster Swine	√	--	--	--	√	--	--	--	√	--	√
	Sows	√	--	--	--	--	--	--	--	√	--	√
Poultry	Young Chickens	√	√	--	--	--	--	--	√	√	√	√
	Young Turkeys	√	√	--	--	--	--	--	√	√	√	√
Minor Species	Goats	√	√	√	--	--	--	--	--	--	--	√
	Sheep	√	--	--	--	--	--	--	--	√	--	√
	Siluriformes Fish	--	--	--	--	--	√	--	√	√	√	√

Note: The results include Tier 1 and Tier 2 (targeted) animal classes.
**Tier 3 animal class.

Table 2. FY 2018 Number of Domestic Residue Samples Tested, by Animal Class

Animal Category	Animal Class	Domestic Scheduled Sampling	
		Tier 1 & Tier 2** U.S. Federal Establishments	Tier 1 U.S. State Establishments
Bovine	Beef Cows	785	57
	Bob Veal	328	--
	Bulls*	172	--
	Dairy Cows	834	39
	Formula-Fed Veal	52	--
	Heavy Calves *	59	--
	Heifers	374	95
	Non-Formula-Fed Veal*	49	--
	Steers	389	114
Porcine	Feral Swine **	**77**	--
	Market Swine	743	115
	Roaster Swine *	310	--
	Sows	640	45
Poultry	Young Chickens	700	15
	Young Turkeys	774	4
Minor Species	Goats *	332	--
	Lambs/Sheep *	170	--
	Siluriformes Fish	636	--
	Total	**7,425**	**484**

* Animal Classes associated with NRP Tier 2 "targeted" domestic sampling.
** **77** Feral Swine samples were from Tier 3 domestic sampling.

Table 3. FY 2018 NRP Domestic Scheduled Samples Analyzed by Animal Class

Animal Category	Animal Class	Number of Non-Detect Samples	Number of Non-Violative Positives Samples	Number of Violative Samples	Total Samples
Bovine	Beef Cows	838	1	3	842
	Bob Veal	325	2	1	328
	Bulls	171	1	--	172
	Dairy Cows	871	1	1	873
	Formula Fed Veal	52	--	--	52
	Heavy Calves	58	1		59
	Heifers	464	1	4	469
	Non- Formula Fed Veal	49	--	--	49
	Steers	503	--	--	503
Porcine	Feral Swine **	76	1	--	77
	Market Swine	853	5	--	858
	Roaster Swine	305	1	4	310
	Sows	682	1	2	685
Poultry	Young Chickens	714	1	--	715
	Young Turkeys	778	--	--	778
Minor Species	Goats	326	--	6	332
	Sheep	168	1	1	170
	Siluriformes Fish	630	2	4	636
	Total	**7,863**	**19**	**26**	**7,908**

Note: The results include Tier 1 and Tier 2 "targeted" animal classes.
Data Source: FSIS Data Warehouse and PHIS databases.
**Tier 3 animal class

Table 4. FY 2018 NRP Residue Scheduled Samples -Number of Residue Samples Tested Per Chemical Method per Animal Class

Animal Class / (# Samples Collected)	Number of Residue Samples per Chemical Method										
	Aminoglycosides	Arsenic	Avermectins	βeta-Agonists	Carbadox	Dyes	Hormones	Metals	MRM	Nitrofurans	Pesticides
Beef Cows (842)	842	469	469	374	-	-	463	9	842	-	373
Bob Veal (328)	328	189	189	139	-	-	187	5	328	-	139
Bulls (172)	172	46	46	126	-	-	46	3	172	-	126
Dairy Cows (873)	873	472	472	401	-	-	464	7	873	-	401
Formula Fed Veal (52)	52	17	17	35	-	-	17	-	52	-	35
Heavy Calves (59)	59	22	22	37	-	-	22	-	59	-	37
Heifers (469)	468	261	261	207	-	-	256	1	469	-	206
Non- Formula Fed Veal (49)	49	21	21	28	-	-	21	2	49	-	27
Steers (503)	503	282	282	221	-	-	278	6	503	-	221
***Feral Swine * (77)**	-	-	-	-	-	-	-	-	-	-	77
Market Swine (858)	858	519	519	338	-	-	-	7	858	-	338
Roaster Swine (310)	6	-	-	-	310	-	-	-	6	-	-
Sows (685)	685	388	388	297	-	-	-	7	685	-	297
Young Chickens (715)	715	394	-	-	-	-	-	5	715	319	321
Young Turkeys (778)	778	407	-	-	-	-	-	11	778	345	358
Goats (332)	332	196	199	1	-	-	-	-	332	-	136
Sheep (170)	170	87	88	-	-	-	-	-	170	-	83
Siluriformes Fish (636)	-	-	-	-	-	470	-	470	635	166	166
Total (7,908)	**6,890**	**3,770**	**2,973**	**2,204**	**310**	**470**	**1,754**	**533**	**7,527**	**830**	**3,342**

Note: The results include Tier 1 and Tier 2 "targeted" animal classes.
Data Source: FSIS Data Warehouse and PHIS databases.
* Tier 3 animal class

Table 5. FY 2018 NRP Residue Scheduled Samples - Number of Chemical Analytes Tested Per Chemical Method per Animal Class

Animal Class / (# Samples Collected)	Number of Chemical Analytes per Chemical Method											
	Aminoglycosides	Arsenic	Avermectins	βeta-Agonists	Carbadox	Dyes	Hormones	Metals	MRM	Nitrofurans	Pesticides	Total
Beef Cows (842)	7,578	469	1,876	1,875	-	-	1,852	152	66,943	-	31,975	112,720
Bob Veal (328)	2,952	189	756	695	-	-	748	82	26,067	-	11,926	43,415
Bulls (172)	1,548	46	184	630	-	-	188	50	13,475	-	10,739	26,860
Dairy Cows (873)	7,875	472	1,888	2,005	-	-	1,856	114	69,536	-	34,492	118,238
Formula Fed Veal (52)	468	17	68	175	-	-	68	-	4,083	-	2,993	7,872
Heavy Calves (59)	531	22	88	185	-	-	88	-	4,636	-	3,166	8,716
Heifers (469)	4,212	261	1,044	1,035	-	-	1,024	17	37,367	-	17,721	62,681
Non- Formula Fed Veal (49)	441	21	84	140	-	-	84	33	3,847	-	2,277	6,927
Steers (503)	4,527	282	1,128	1,105	-	-	1,112	101	39,977	-	19,081	67,313
Feral Swine * (77)	-	-	-	-	-	-	-	-	-	-	6,522	6,522
Market Swine (858)	7,722	519	2,069	1,687	-	-	-	116	73,251	-	29,106	114,470
Roaster Swine (310)	54	-	-	-	313	-	-	-	548	-	-	915
Sows (685)	6,165	388	1,550	1,485	-	-	-	118	58,361	-	25,544	93,611
Young Chickens (715)	6,434	394	-	-	-	-	-	83	59,103	1,280	27,777	95,071
Young Turkeys (778)	6,768	407	-	-	-	-	-	165	62,201	1,380	29,747	100,668
Goats (332)	2,988	196	-	10	-	-	-	-	26,755	-	11,666	42,419
Sheep (170)	1,530	87	804	-	-	-	-	-	13,185	-	7,055	22,206
Siluriformes Fish **(636)**	-	-	349	-	-	1,880	-	7,836	56,674	664	14,088	81,142

Note: * Tier 3 animal class.
Multiple analytes may be associated with the same sample. Not all samples are tested using all chemical methods. Number of samples per chemical method is indicated in Table 4. **Data Source:** FSIS Data Warehouse and PHIS databases.

Table 6. FY 2018 Domestic Scheduled Sampling Violations by Animal Class

Animal	Tissue	Compound	Concentration	Units	Tolerance Level Value	Authority (CFR Citation)
Beef Cows	Liver	Doramectin	121.5	PPB	100	21 CFR 556.225
Beef Cows	Muscle	Piperonyl butoxide	0.122	PPM	0.1	40 CFR 180.127
Beef Cows	Muscle	Salbutamol	*		Not Approved	
Bob Veal	Muscle	Meloxicam	*		Not Approved	
Dairy Cows	Muscle	Piperonyl butoxide	0.144	PPM	0.1	40 CFR 180.127
Heifers	Muscle	Piperonyl butoxide	0.1001	PPM	0.1	40 CFR 180.127
Heifers	Muscle	Piperonyl butoxide	0.1518	PPM	0.1	40 CFR 180.127
Heifers	Muscle	Piperonyl butoxide	0.133	PPM	0.1	40 CFR 180.127
Heifer	Muscle	Piperonyl butoxide	0.135	PPM	0.1	40 CFR 180.127
Goats	Muscle	Moxidectin	114.5	PPB	0	21 CFR 556.426
Goats	Liver	Moxidectin	107.15	PPB	0	22 CFR 556.426
Goats	Liver	Moxidectin	38.25	PPB	0	23 CFR 556.426
Goats	Muscle	Moxidectin	60.0	PPB	0	24 CFR 556.426
Goats	Liver	Moxidectin	31.85	PPB	0	25 CFR 556.426
Goats	Liver	Moxidectin	52.3	PPB	0	26 CFR 556.426
Sheep	Muscle	Moxidectin	114	PPB	50	21 CFR 556.426
Roaster Swine	Liver	Carbadox	97.66	PPB	30	21 CFR 556.100
Roaster Swine	Liver	Carbadox	68.16	PPB	30	21 CFR 556.100
Roaster Swine	Liver	Carbadox	275.16	PPB	30	21 CFR 556.100
Roaster Swine	Liver	Carbadox	65.26	PPB	30	21 CFR 556.100
Sows	Muscle	Sulfadoxine	0.1258	PPM	0	
Sows	Muscle	Piperonyl butoxide	0.1852	PPM	0.1	40 CFR 180.127
Siluriformes Fish	Muscle	Crystal violet	*		0	
Siluriformes Fish	Muscle	Crystal violet	*		0	
Siluriformes Fish	Muscle	Leucocrystal Violet	*		0	
Siluriformes Fish	Muscle	Leucomalachite Green	*		0	

Note:
The results include Tier 1 and Tier 2 "targeted" animal classes.
***:** Violative residue results were residue were detected but not quantified.
Not Approved- Residue detected is not approved for the animal class.
Data Source: FSIS Data Warehouse and PHIS databases.

Summary of Domestic Inspector-Generated Sampling Program

PHVs, and IPP under the guidance of a PHV, conduct Inspector-generated residue sampling when an animal is suspected to have undergone drug treatment and may possibly contain violative levels of chemical residues. The PHVs and IPP also are encouraged to collect samples for residue testing at an FSIS laboratory when a chemical contaminant is suspected. Samples are typically first screened using the KIS™ test. If KIS™ test kits are not available; the PHV submits the sample directly to the FSIS laboratory for testing. Data in this document were obtained from the FSIS Data Warehouse and PHIS databases.

Table 7 summarizes the total number of in-plant screening tests performed using the KIS™ test, and includes the number of in-plant screens with negative results; the number of in-plant screens with positive results and sent to an FSIS laboratory for conformation; and the number of carcasses with violations for each animal class.

Table 8 summarizes the total number of samples analyzed and the number of carcasses with violations for each animal class under additional inspector-generated program projects. The samples were sent to an FSIS laboratory for analyses.

Table 9 summarizes the results for specific chemical compounds that were detected **(violative**) within inspector-generated sampling projects across animal class.

Table 10 summarizes the results for specific chemical compounds that were detected (**non-violative**) within inspector-generated sampling projects across animal class.

Table 11 summarizes the results for specific chemical compounds that were detected (**non-violative**) within inspector-generated sampling projects across animal class.

Table 12 summarizes the number of Domestic Scheduled samples and Inspector-generated samples tested by animal class.

Table 7. Summary of FY 2018 Tier 2 Inspector-Generated Sampling (KIS ™) Test and Confirmatory Tests

Animal Category	Animal Class	KIS ™ Test			
		Total Number of In-plant Samples	Number of In-plant Negative Samples	Number of In-plant Positive Samples	Number of Samples With Confirmed Lab Violations
Bovine	Beef Cows	13,665	13,197	468	57
	Bob Veal	24,233	24,043	190	77
	Bulls	1,460	1,416	44	10
	Dairy Cows	98,077	95,426	2,651	484
	Formula-Fed Veal	247	243	4	0
	Heavy Calves	243	223	20	1
	Heifers	3,062	2,969	93	6
	Non-Formula-Fed Veal	169	161	8	2
	Steers	7,681	7,489	192	17
Porcine	Boars/Stags	123	123	0	0
	Feral Swine	4	4	0	0
	Market Swine	14,917	14,707	210	3
	Roaster Swine	1373	1,366	7	0
	Sows	5685	5,640	45	5
Minor Species	Goats	584	580	4	1
	Lambs	971	964	7	1
	Sheep	298	295	3	0
	Total	**172,792**	**168,846**	**3,946**	**664***

* **815** KIS ™ test violative analytes in **664** lab confirmed KIS ™ test violative carcasses**.** Multiple violative residues may be associated with a single carcass sample.

Data Source: FSIS Data Warehouse and PHIS databases.

Table 8. FY 2018 Tier 2 Suspect Animal Samples sent Directly to FSIS Laboratory

Animal Category	Animal Class	Collected-generated	Show Animals
		Number of Samples	Number of Samples
Bovine	Beef Cows	10	--
	Bob Veal	4	--
	Bulls	5	1
	Dairy Cows	20	--
	Formula-Fed Veal	3	--
	Heavy Calves	3	--
	Heifers	3	2
	Non-Formula-Fed Veal	1	--
	Steers	16	14
Porcine	Boars/Stags	7	--
	Market Swine	24	40
	Roaster Swine	2	2
	Sows	5	1
Poultry	Young Chickens	32	--
	Young Turkeys	1	--
Minor Species	Goats	2	9
	Lambs	5	12
	Sheep	2	1
Total		**145**	**82**

Note: 11 residue violations were found in the above **227** samples sent directly to the laboratory.
Data Source: FSIS Data Warehouse and PHIS databases.

Table 9. FY 2018 Number of Residue Violations results in Inspector-Generated Sampling by Chemical Residue and Animal Class (*KIS™ Test Samples*)

Chemical Residue	Beef Cows	Bob Veal	Bulls	Dairy Cow	Goat	Heavy Calves	Heifer	Market Swine	Non Formula Fed Veal	Sheep	Sows	Steer	**Total**
Ampicillin	-	-	-	28	-	-	-	-	-	-	-	1	**29**
Cefazolin	-	-	-	3	-	-	-	-	-	-	-	-	**3**
Ciprofloxacin	5	12	-	1	1	-	1	-	-	-	-	2	**22**
Desethylene ciprofloxacin	-	6	-	-	-	-	-	-	-	-	-	-	**6**
Desfuroylceftiofur	9	5	3	210	-	-	3	1	1	-	-	3	**235**
Dihydrostreptomycin	-	2	-	2	-	-	-	-	-	-	-	-	**4**
Doxycycline	-	-	-	1	-	-	-	-	-	-	-	-	**1**
Enrofloxacin	-	11	-	-	1	-	-	-	-	-	-	-	**12**
Florfenicol	4	4		10	-	-	-	-	-	-	-	2	**20**
Flunixin	6	11	4	35	1	-	-	1	-	-	-	2	**60**
Gamithromycin	-	2	-	-	-	-	-	-	-	-	-	-	**2**
Gentamycin sulfate	3	2	-	12	-	-	-	-	-	-	-	1	**18**
Ketoprofen	-	-	-	3	-	-	-	-	-	-	-	-	**3**
Lincomycin	-	1	-	1	-	-	-	-	-	-	-	-	**2**
Meloxicam	-	3	-	8	-	-	-	-	-	-	-	1	**12**
Neomycin	-	37	-	2	-	-	-	-	-	-	-	-	**39**

Note: Multiple violative residues may be associated with a single carcass sample

Data Source: FSIS Data Warehouse and PHIS databases.

Table 9. FY 2018 Number of Residue Violations results in Inspector Generated Sampling by Chemical Residue and Animal Class (*KIS™ Test Samples*)

Chemical Residue	Beef Cows	Bob Veal	Bulls	Dairy Cow	Goat	Heavy Calves	Heifer	Market Swine	Non Formula Fed Veal	Sheep	Sows	Steer	**Total**
Oxyphenylbutazone	-	-	-	1	-	-	-	-	-	-	-	-	**1**
Oxytetracycline	1	4	2	2	1	-	1	-	-	-	-	-	**11**
Penicillin	15	-	2	139	1	-	2	-	-	1	4	4	**168**
Phenylbutazone	-	-	-	1	-	-	-	-	-	-	-	-	**1**
Sulfadimethoxine	5	6	-	64	-	1	1	-	-	-	-	2	**79**
Sulfadoxine	-	-	-	4	-	-	-	-	-	-	1	-	**5**
Sulfamethazine	13	2	3	21	-	-	-	1	2	-	-	4	**46**
Sulfamethoxazole	1	7	-	-	-	-	-	-	-	-	-	-	**8**
Sulfamethoxypyridazine	-	-	-	1	-	-	-	-	-	-	-	1	**2**
Tetracycline	1	-	-	3	-	-	-	-	-	-	-	-	**4**
Tildipirosin	-	1	-	-	-	-	-	-	-	-	-	-	**1**
Tilmicosin	10	4	1	4	-	-	-	-	-	-	-	2	**21**
Total	**73**	**120**	**15**	**556**	**5**	**1**	**8**	**3**	**3**	**1**	**5**	**25**	**815**

Note: Multiple violative residues may be associated with a single carcass sample

Data Source: FSIS Data Warehouse and PHIS databases.

Table 10. FY 2018 Number of Residue Violations results in Suspect Animal Samples sent Directly to FSIS Laboratory by Chemical Residue and Animal Class (*Non- KIS™ tests Samples*)

Chemical residue	Bob Veal	Bulls	Dairy Cow	Market Swine	Steer	**Total**
Desfuroylceftiofur	-	-	1	-	1	**2**
Permethrin (Cis and Trans)	-	-	-	-	-	**1**
Piperonyl butoxide	-	-	-	-	1	**1**
Sulfadimethoxine	-	-	-	1	-	**1**
Sulfamethazine	-	-	-	2	1	**3**
Sulfamethoxazole	1	-	-	-	-	**1**
Tilmicosin	-	2	-	-	-	**2**
Total	**1**	**2**	**1**	**4**	**3**	**11**

Note: Multiple violative residues may be associated with a single carcass sample
Data Source: FSIS Data Warehouse and PHIS databases.

Table 11. FY 2018 Number of Non-Violative results in Inspector Generated Sampling by Chemical Residue and Animal Class *(includes both KIS ™ and Non- KIS™ tests Samples)*

Chemical Residue	Beef Cows	Bob Veal	Bulls	Dairy Cows	Heavy Calves	Heifers	Non Formula Fed Veal	Market Swine	Roaster Swine	Sows	Steer	**Total**
Ampicillin	-	-	-	8	-	-	-	-	-	-	-	**8**
Chlortetracycline	-	1	-	-	-	1	-	-	1	-	-	**3**
Desfuroylceftiofur	3	-	-	40	-	1	-	-	-	-	1	**45**
Dihydrostreptomycin	-	-	-	2	-	-	-	-	-	-	-	**2**
Doramectin	1	-	-	-	-	-	-	-	-	-	-	**1**
Enrofloxacin	4	-	-	1	-	2	-	2	-	1	2	**12**
Eprinomectin	5	-	2	15	1	1	-	-	-	-	2	**26**
Fenbendazole	1	-	-	-	-	-	-	-	-	-	-	**1**
Florfenicol	7	-	-	6	-	-	-	-	-	-	2	**15**
Flunixin	4	-	1	32	-	1	1	-	-	-	4	**43**
Gamithromycin	3	-	-	5	1	1	-	-	-	-	3	**13**
Levamisole	-	-	-	1	-	-	-	-	-	-	-	**1**
Lincomycin	-	-	-	-	-	-	-	10	-	-	-	**10**

Note: Multiple violative residues may be associated with a single carcass sample
Data Source: FSIS Data Warehouse and PHIS databases.

Table 11. FY 2018 Number of Non--Violative results in Inspector Generated Sampling by Chemical Residue and Animal Class *includes both KIS™ and Non- KIS™ tests Samples) (cont.)*

Chemical Residue	Beef Cows	Bob Veal	Bulls	Dairy Cows	Heavy Calves	Heifers	Non Formula Fed Veal	Market Swine	Roaster Swine	Sows	Steer	**Total**
Neomycin	2	17	-	7	-	-	-	-	-	-	1	**27**
Oxytetracycline	65	18	5	45	2	2	-	-	-	1	3	**141**
Penicillin	6	2	1	66	-	1	-	-	-	-	2	**78**
Piperonyl butoxide	-	-	-	-	-	-	-	1	-	-	-	**1**
Pirlimycin	-	-	-	6	-	-	-	-	-	-	-	**6**
Ractopamine	-	-	-	-	-	-	-	4	-	-	-	**4**
Spectinomycin	3	4	-	14	-	-	-	-	-	-	-	**21**
Sulfadimethoxine	3	-	-	24	-	-	-	-	-	-	1	**28**
Sulfamethazine	4	-	2	3	-	-	-	-	-	-	1	**10**
Tetracycline	2	6	-	20	-	-	-	-	-	-	-	**28**
Tildipirosin	4	-	1	3	2	5	-	-	-	-	7	**22**
Tilmicosin	5	-	2	1	-	1	-	-	3	3	-	**15**
Tulathromycin	32	10	4	25	2	27	1	9	-	3	50	**163**
Total	**154**	**58**	**18**	**324**	**8**	**43**	**2**	**26**	**4**	**8**	**79**	**724**

Note: Multiple violative residues may be associated with a single carcass sample

Data Source: FSIS Data Warehouse and PHIS databases.

Table 12. Summary of FY 2018 Domestic Residue Samples Tested, by Animal Class

Animal Category	Animal Class	Domestic Scheduled Sampling		Inspector-generated Sampling Tier 2 Suspect Animals	
		Tier 1 & Tier 2** U.S. Federal Plants	Tier 1 U.S. State Plants	KIS™ Test	Non- KIS™ Samples ***
Bovine	Beef Cows	785	57	13,665	10
	Bob Veal	328	--	24,233	4
	Bulls*	172	--	1,460	6
	Dairy Cows	834	39	98,077	20
	Formula-Fed Veal	52	--	247	3
	Heavy Calves *	59	--	243	3
	Heifers	374	95	3,062	5
	Non-Formula-Fed Veal*	49	--	169	1
	Steers	389	114	7,681	30
Porcine	Boars/Stags	--	--	123	7
	Feral Swine **	77	--	4	--
	Market Swine	743	115	14,917	64
	Roaster Swine *	310	--	1373	4
	Sows	640	45	5685	6
Poultry	Young Chickens	700	15	--	32
	Young Turkeys	774	4	--	--
Minor Species	Goats *	332	--	584	11
	Lambs/Sheep *	170	--	1,269	20
	Siluriformes Fish	636	--	--	--
	Total	**7,425**	**484**	**172,792**	**227**

* Animal Classes associated with NRP Tier 2 domestic sampling
** **77** Feral Swine samples were from Tier 3 domestic sampling
*** **227** suspect animal samples sent directly to FSIS Laboratory (**Non-KIS™ test)** were collected and directly sent to FSIS labs for analysis.

Import Residue Reinspection Sampling Program

In FY 2018, FSIS collected 3,409 (*includes* 580 Siluriformes fish samples) import residue samples representing product from 32 export countries and analyzed for 272,035 residue analytes. Seven violations were detected: (1) from Bangladesh, (2) from Brazil, (1) from Mexico, and (3) from Vietnam respectively. For more information, refer to the list of tables below.

Table 13 summarizes the number of import residue samples tested per chemical method by Production Class and Product Type.

Table 14 summarizes the number of import residue samples by inspection level, per exporting country and Production Type.

Table 15 summarizes the number of import residue samples analyzed, by exporting country and Production Type.

Table 16 summarizes the number of import residue samples analyzed, number of chemical analytes tested per exporting country and Production Type.

Table 17 summarize number of samples and chemical residues under the import residue sample program, by exporting country.

Information for countries wanting to import to the United States can be found at:
Importing products to the United States

Table 13. FY 2018 NRP Import Residue Samples - Number of Residue Samples Tested Per Chemical Method by Production Class and Product Type

Methods	Number of Samples Tested*														
	Beef		Chicken		Goat	Lamb	Mutton		Pork		*Siluriformes* Fish	Turkey		Veal	
	Fresh	Processed	Fresh	Processed	Fresh	Fresh	Fresh	Processed	Fresh	Processed	Fresh	Fresh	Processed	Fresh	Total
Aminoglycosides	344	1	235	-	57	63	10	-	256	2	-	44	-	198	1,210
Arsenic	172	164	150	43	37	48	9	2	144	110	-	23	25	76	1,004*
Avermectins	172	165	1	-	37	48	9	2	144	111	-	-	-	76	765
βeta-Agonists	172	-	2	-	17	15	1	-	118	-	-	-	-	123	448
Dyes	-	-	-	-	-	-	-	-	-	-	335	-	-	-	335
Hormones	254	-	-	-	-	-	-	-	-	-	-	-	-	-	254
Metals	-	-	-	-	-	-	-	-	-	-	335	-	-	-	335
MRM	349	63	234	1	57	63	10	-	256	45	337	44	14	198	1,671
Nitrofurans	-	-	-	-	-	-	-	-	-	-	245	-	-	-	245
Pesticides	264	-	150	-	45	50	9	-	201	-	245	28	-	149	1,141

Data Source: FSIS Data Warehouse and PHIS databases.

* Inlcudes one Duck sample analyzed for arsenic

Table 14. FY 2018 Number of Import Residue Samples by Inspection Level, per Exporting Country and Production Type

(*includes 580 Siluriformes samples*)

Country	Inspection Level / Product Type					
	Normal		Increased*	Intensified		
	Fresh	Processed	Fresh	Fresh	Processed	**Total**
Australia	200	17	-	-	-	217
Bangladesh	6	-	-	-	-	6
Brazil	40	74	-	14	30	158
Canada	795	135	-	-	-	930
Chile	201	7	-	-	-	208
China	18	-	16	-	-	34
Costa Rica	57	-	-	-	-	57
Croatia	-	1	-	-	-	1
Denmark	54	9	-	-	-	63
Finland	3	-	-	-	-	3
France	39	-	-	-	-	39
Germany	-	5	-	-	-	5
Guyana	2	-	10	-	-	12
Honduras	36	-	-	-	-	36
Hungary	-	3	-	-	-	3
Iceland	6	-	-	-	-	6
Ireland	35	-	-	-	-	35
Israel	-	22	-	-	-	22
Italy	-	16	-	-	-	16
Japan	15	-	-	-	-	15
Korea, Republic of	-	3	-	-	-	3
Lithuania	-	10	-	-	-	10
Mexico	144	21	-	5	-	170
Netherlands	259	-	-	-	-	259
New Zealand	216	15	-	-	-	231
Nicaragua	75	-	-	-	-	75
Northern Ireland	17	-	-	-	-	17
Poland	28	36	-	-	-	64
Spain	17	13	-	-	-	30
United Kingdom	48	-	-	-	-	48
Uruguay	55	33	5	5	10	108
Vietnam	444	-	25	59	-	528
Total	**2,810**	**420**	**56**	**83**	**40**	**3,409**

Data Source: FSIS Data Warehouse and PHIS databases.

* During FY 2018 there were no countries with "increased" sampling for processed products

Table 15. FY 2018 Number of Import Residue Samples Analyzed, by Exporting Country and Production Type

Country	Production Type														
	Beef		Chicken		Goat	Lamb	Mutton		Pork		*Siluriformes*	Turkey		Veal	
	Fresh	Processed	Fresh	Processed	Fresh	Fresh	Fresh	Processed	Fresh	Processed	Fresh	Fresh	Processed	Fresh	Total
Australia	102	15	-	-	55	25	9	2	-	-	-	-	-	9	**217**
Bangladesh	-	-	-	-	-	-	-	-	-	-	6	-	-	-	**6**
Brazil	-	104	-	-	-	-	-	-	54	-	-	-	-	-	**158**
Canada	288	46	240	18	-	31	-	-	152	56	-	59	19	25	**935***
Chile	8	-	148	7	-	11	-	-	21	-	-	13	-	-	**208**
China	-	-	-	-	-	-	-	-	-	-	34	-	-	-	**34**
Costa Rica	57	-	-	-	-	-	-	-	-	-	-	-	-	-	**57**
Croatia	-	-	-	-	-	-	-	-	-	1	-	-	-	-	**1**
Denmark	-	-	-	-	-	-	-	-	54	9	-	-	-	-	**63**
Finland	-	-	-	-	-	-	-	-	3	-	-	-	-	-	**3**
France	-	-	-	-	-	-	-	-	-	-	-	-	-	39	**39**
Germany	-	-	-	-	-	-	-	-	-	5	-	-	-	-	**5**
Guyana	-	-	-	-	-	-	-	-	-	-	12	-	-	-	**12**
Honduras	36	-	-	-	-	-	-	-	-	-	-	-	-	-	**36**
Hungary	-	-	-	-	-	-	-	-	-	3	-	-	-	-	**3**
Iceland	-	-	-	-	-	6	-	-	-	-	-	-	-	-	**6**
Ireland	25	-	-	-	-	-	-	-	10	-	-	-	-	-	**35**
Israel	-	-	-	9	-	-	-	-		-	-	-	17	-	**26**
Italy	-	-	-	-	-	-	-	-	-	16	-	-	-	-	**16**
Japan	15	-	-	-	-	-	-	-	-	-	-	-	-	-	**15**
Korea, Republic of	-	-	-	3	-	-	-	-	-	-	-	-	-	-	**3**

Country	Production Type														
	Beef		Chicken		Goat	Lamb	Mutton		Pork		*Siluriformes*	Turkey		Veal	
	Fresh	Processed	Fresh	Processed	Fresh	Fresh	Fresh	Processed	Fresh	Processed	Fresh	Fresh	Processed	Fresh	Total
Lithuania	-	1	-	-	-	-	-	-	-	9	-	-	-	-	**10**
Mexico	99	4	-	7	11	-	-	-	39	7	-	-	3	-	**170**
Netherlands	-	-	-	-	-	-	-	-	19	-	-	-	-	240	**259**
New Zealand	109	15	-	-	36	27	10	-	-	-	-	-	-	34	**231**
Nicaragua	75	-	-	-	-	-	-	-	-	-	-	-	-	-	**75**
Northern Ireland	-	-	-	-	-	-	-	-	17	-	-	-	-	-	**17**
Poland	-	-	-	-	-	-	-	-	28	36	-	-	-	-	**64**
Spain	-	-	-	-	-	-	-	-	17	13	-	-	-	-	**30**
United Kingdom	-	-	-	-	-	-	-	-	48	-	-	-	-	-	**48**
Uruguay	52	43	-	-	-	13	-	-	-	-	-	-	-	-	**108**
Vietnam	-	-	-	-	-	-	-	-	-	-	528	-	-	-	**528**
Total	**866**	**228**	**388**	**44**	**102**	**113**	**19**	**2**	**462**	**155**	**580**	**72**	**39**	**347**	**3,418***

Data Source: FSIS Data Warehouse and PHIS databases.

* Includes one Duck sample from Canada.

Table 16. FY 2018 Number of Chemical Analytes Tested Per Exporting Country and Production Type

Country	Production Type														
	Beef		Chicken		Goat	Lamb	Mutton		Pork		*Siluriformes*	Turkey		Veal	
	Fresh	Processed	Fresh	Processed	Fresh	Fresh	Fresh	Processed	Fresh	Processed	Fresh	Fresh	Processed	Fresh	Total
Australia	6,626	74	-	-	5,246	2,379	849	12	-	-	-	-	-	892	**16,078**
Bangladesh	-	-	-	-	-	-	-	-	-	-	640	-	-	-	**640**
Brazil	-	541	-	-	-	-	-	-	5,443	-	-	-	-	-	**5,984**
Canada	20,374	188	23,095	18	-	2,913	-	-	15,055	255	-	5,727	32	2,316	**69,974***
Chile	610	-	14,243	7	-	1,050	-	-	2,017	-	-	1,234	-	-	**19,161**
China	-	-	-	-	-	-	-	-	-	-	3,897	-	-	-	**3,897**
Costa Rica	4,239	-	-	-	-	-	-	-	-	-	-	-	-	-	**4,239**
Croatia	-	-	-	-	-	-	-	-	-	6	-	-	-	-	**6**
Denmark	-	-	-	-	-	-	-	-	5,423	44	-	-	-	-	**5,467**
Finland	-	-	-	-	-	-	-	-	305	-	-	-	-	-	**305**
France	-	-	-	-	-	-	-	-	-	-	-	-	-	3,862	**3,862**
Germany	-	-	-	-	-	-	-	-	-	30	-	-	-	-	**30**
Guyana	-	-	-	-	-	-	-	-	-	-	1,285	-	-	-	**1,285**
Honduras	2,709	-	-	-	-	-	-	-	-	-	-	-	-	-	**2,709**
Hungary	-	-	-	-	-	-	-	-	-	13	-	-	-	-	**13**
Iceland	-	-	-	-	-	560	-	-	-	-	-	-	-	-	**560**
Ireland	1,900	-	-	-	-	-	-	-	945	-	-	-	-	-	**2,845**
Israel	-	-	-	9	-	-	-	-	-	-	-	-	17	-	**26**
Italy	-	-	-	-	-	-	-	-	-	176	-	-	-	-	**176**
Japan	887	-	-	-	-	-	-	-	-	-	-	-	-	-	**887**
Korea, Republic of	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**3**

Country	Production Type														
	Beef		Chicken		Goat	Lamb	Mutton		Pork		*Siluriformes*	Turkey		Veal	
	Fresh	Processed	Fresh	Processed	Fresh	Fresh	Fresh	Processed	Fresh	Processed	Fresh	Fresh	Processed	Fresh	Total
Lithuania	-	6	-	-	-	-	-	-	-	34	-	-	-	-	**40**
Mexico	6,945	19	-	7	1,106	-	-	-	3,849	37	-	-	3	-	**11,966**
Netherlands	-	-	-	-	-	-	-	-	1,879	-	-	-	-	23,272	**25151**
New Zealand	7,388	74	-	-	3,530	2,543	916	-	-	-	-	-	-	3,333	**17,784**
Nicaragua	5,080	-	-	-	-	-	-	-	-	-	-	-	-	-	**5,080**
Northern Ireland	-	-	-	-	-	-	-	-	1,690	-	-	-	-	-	**1,690**
Poland	-	-	-	-	-	-	-	-	2,774	189	-	-	-	-	**2,963**
Spain	-	-	-	-	-	-	-	-	1,545	44	-	-	-	-	**1,589**
United Kingdom	-	-	-	-	-	-	-	-	4,790	-	-	-	-	-	**4,790**
Uruguay	3,612	194	-	-	-	1,227	-	-	-	-	-	-	-	-	**5,033**
Vietnam	-	-	-	-	-	-	-	-	-	-	57,802	-	-	-	**57,802**
Total	**60,370**	**1,096**	**37,338**	**44**	**9,882**	**10,672**	**1,765**	**12**	**45,715**	**828**	**63,624**	**6,961**	**52**	**3,3675**	**272,035***

Note: Multiple violative analytes in different tissue types may be associated with a single product sample
Data Source: FSIS Data Warehouse and PHIS databases.
* Includes one Duck sample from Canada.

Table 17. FY 2018 Number of Samples and Chemical Residues under the Import Residue Sample Program, by Exporting Country

(Includes 580 Siluriformes Samples)

Country	Number of Samples	Samples with Detected Non-Violative	Samples with Residue Detected Violative	Chemical Residues Analysis *
Australia	217	1 (Beef-Avermectins)	--	16,078
Bangladesh	6	--	1 (Siluriformes-Dye)	640
Brazil	158	10 (Beef-Avermectins)	1 (Pork-Pesticides) 1 (Beef-Avermectins)	5,984
Canada	930	--	--	69,974
Chile	208	--	--	19,161
China	34	--	-	3,897
Costa Rica	57	--	--	4,239
Croatia	1	--	--	6
Denmark	63	--	--	5,467
Finland	3	--	--	305
France	39	--	--	3,862
Germany	5	--	--	30
Guyana	12	--	--	1,285
Honduras	36	--	--	2,709
Hungary	3	--	--	13
Iceland	6	--	--	560
Ireland	35	--	--	2,845
Israel	22	--	--	26
Italy	16	--	--	176
Japan	15	--	--	887
Korea, Republic of	3	--	--	3
Lithuania	10	--	--	40
Mexico	170	--	1 (Goat-Avermectins)	11,966
Netherlands	259	--	--	25,151
New Zealand	231	1 (Beef-Avermectins)	--	17,784
Nicaragua	75	--	--	5,080
Northern Ireland	17	--	--	1,690
Poland	64	1	--	2,963
Spain	30	--	--	1,589
United Kingdom	48	--	--	4,790
Uruguay	108	1 (Beef-Avermectins)	--	5,033
Vietnam	528	4 (Siluriformes –Pesticide	2 (Siluriformes-Dye) 1 (Siluriformes -Pesticide)	57,802
Total	**3,409**	**18**	**7**	**272,035**

Note: * Multiple violative analytes in different tissue types may be associated with a single product sample.

Data Source: FSIS Data Warehouse and PHIS databases.

Appendix I

NRP Non-Violative Positive and Violative Residue Samples Results

In addition to the publication of the FY 2018 NRP samples results, FSIS will post the details of each positive non-violative, and positive violative residue result associated with the NRP sampling program in a spreadsheet format on the FSIS website at:

https://www.fsis.usda.gov/wps/portal/fsis/topics/data-collection-and-reports/chemistry/red-books/red-book

This speadsheet includes detailed information regarding samples collected and analyzed by FSIS under both the "scheduled" sampling and the "inspector-generated" sampling programs. FSIS plans to update this spreadsheet on an ongoing basis so as to increase program transparency for all stakeholders. The spreadsheet includes the following data fields: sample collection and reviewed date, the project code, the animal class, tissue type, chemical residue name, concentration values, sample results (whether positive non-violative or postive violative), chemcial concentration values (if any) and the CFR reference for each chemical listed.

Appendix II

Number of Samples Required to Detect Violations with Predefined Probabilities

Scheduled sampling is conducted to provide some assurance that FSIS would detect a violation that affects a given percentage of the sample population.

Prior to FY 2012, FSIS tested 230 or 300 samples from each production class/residue compound class pairing to obtain results that were statistically meaningful. The testing sample sizes of 230 or 300 ensured FSIS a 90 percent or 95 percent probability, respectively, of detecting at least one chemical residue violation if the violation rate is equal to or greater than one percent in the population being sampled. Starting in FY 2012, as stated in its residue sampling plan, FSIS increased the sample size selected/tested to about 800 samples for each of the nine major production class tested under Tier 1.

Table A-1 provides the calculated number of samples required to ensure detection of at least one violation that affects a given percentage of the sampled population. Statistically, for a binomial distribution with sample size "n" and violation rate "v" (in decimal), if v is the true violation rate in the population and n is the number of samples, the probability, p, of finding at least one violation among the n samples (assuming random sampling) is $p = 1 - (1 - v)^n$

For example, if the true violation rate is 1% the probability of detecting at least one violation with sample sizes of 230,300,390,460, and 800 are 90%, 95%, 98%, 99%,and 99.97% respectively.

In the table below the probability of detecting at least one violation with a sample size of 800 is italicized and bolded.

Table A-1: Number of Samples Required to Detect Violations with Predefined Probabilities FY 2018 NRP

Percentage % Violative in the population (v)	Number of samples required to detect at least one violation in (n) samples with a probability (p)				
	0.90	0.95	0.98	0.99	0.9997
	Sample Size required "n"				
10	22	29	37	44	77
5	45	59	76	90	158
1	230	300	389	459	***807***
0.57	403	525	684	***806***	1,419
0.50	460	598	***780***	919	1,618
0.37	620	***808***	1,055	1,242	2,188
0.29	***793***	1,032	1,347	1,586	2,793
0.10	2,302	2,995	3,910	4,603	8,108

The procedure to calculate the required sample size needed is as follows:

$p = 1 - (1 - v)^n$ ← Probability of detecting at least one violation in n sample of binomial distribution with violation rate v

$1 - p = (1 - v)^n$ ← Subtract one from both side of the equation. This gives the probability of detecting No violations in n samples

$\log(1 - p) = \log(1 - v)^n$ ← Apply logarithmic function to both side of the equation

$\log(1 - p) = n * \log(1 - v)$ ← A logarithmic function property

$n = \frac{\log(1 - p)}{\log(1 - v)}$ ← Sample size based on violation rate (v) and probability of detecting (p)

Appendix III

List of Chemical Residues by Class/Method

i. Veterinary Drugs

For FY 2018 sampling, FSIS used the following methods to test for veterinary drugs: the multi-residue method, the aminoglycoside method, the hormones method, the beta-agonist method, the avermectin method, the nitrofuran method, and the carbadox method. The detailed lists veterinary drug analytes tested for in each of those methods are listed below.

Multi-residue method

2-Aminosulfone Albendazole	DCCD	Gamithromycin	Oxytetracycline	Sulfamethoxypyridazine
2-Amino-Flubendazole	Desethylene Ciprofloxacin	Haloperidol	Penicillin G	Sulfanitran
2-Quinoxaline Carboxylic Acid (QCA)	Diclofenac	Ipronidazole	Phenylbutazone	Sulfapyridine
Abamectin	Dicloxacillin	Ipronidazole - OH	Pirlimycin	Sulfaquinoxaline
Acepromazine	Difloxacin	Ketamine	Prednisone	Sulfathiazole
Albendazole	Dimetridazole	Ketoprofen	Ractopamine	Tetracycline
Amoxicillin	Dimetridazole - OH	Levamisole	Ronidazole	Thiabendazole
Ampicillin	Dipyrone	Lincomycin	Salbutamol	Tildipirosin
Azaperone	Doramectin	Melengestrol Acetate	Sarafloxacin	Tilmicosin
Butorphanol	Doxycycline	Meloxicam	Selamectin	Tolfenamic Acid
Carazolol	Emamectin Benzoate	Metronidazole	Sulfachloropyridazine	Tulathromycin A
Cefazolin	Enrofloxacin	– Metronidazole-OH	Sulfadiazine	Tylosin
Chloramphenicol	Eprinomectin	Morantel tartrate	Sulfadimethoxine	Tyvalosin
Chlortetracycline	Erythromycin A	Moxidectin	Sulfadoxine	Virginiamycin
Cimaterol	Fenbendazole	Nafcillin	Sulfaethoxypyridazine	Xylazine
Ciprofloxacin	Fenbendazole sulphone	Norfloxacin	Sulfamerazine	β-Zearalanol
Clindamycin	Florfenicol	Orbifloxacin	Sulfamethazine	
Cloxacillin	Flubendazole	Oxacillin	Sulfamethizole	
Danofloxacin	Flunixin	Oxyphenylbutazone	Sulfamethoxazole	

Aminoglycoside Method

Amikacin	Gentamicin	Neomycin
Apramycin	Hygromycin B	Spectinomycin
Dihydrostreptomycin	Kanamycin	Streptomycin

Hormones Method

Megestrol	Melengestrol Acetate	Hexestrol	Zeranol

βeta-Agonists Method

Cimaterol	Ractopamine	Zilpaterol
Clenbuterol	Salbutamol	

Avermectin Method

Doramectin	Ivermectin	Moxidectin

Nitrofuran Method

3-Amino-2-oxazolidinone (AOZ)	1-Aminohydantoin (AHD)	Semicarbazide (SEM)
3-Amino-5-morpholinomethyl-2-oxazolidinone (AMOZ)		

Carbadox Method

Quinoxaline-2-carboxylic acid

ii. Pesticides and environmental contaminants

For FY 2018 sampling, FSIS used the following methods to test for pesticides and environmental contaminants: the pesticide method and the metals method. The detailed lists of pesticides and environmental contaminant analytes tested for in each of those methods are listed below.

a. *Pesticide Method*

1-Naphthol	Coumaphos O	Fluroxypyr-1-Methylhepyl-Ester	Pentachlorobenzene (PCB)
3-Hydroxycarbofuran	Coumaphos S	Fluvalinate	Permethrin (cis&trans)
Acephate	DDD o,p'	Heptachlor	Piperonyl butoxide
Acetamiprid	DDD p,p' + DDT, o,p'	Heptachlor epoxide (cis+ trans) or (B+A)	Pirimiphos methyl
Alachlor	DDE o,p'	Hexachlorobenzene (HCB)	Prallethrin
Aldicarb	DDE p,p'	Hexazinone	Profenofos
Aldicarb sulfone	DDT p,p'	Hexythiazox	Pronamide
Aldicarb sulfoxide	Deethylatrazine	Imazalil	Propachlor
Aldrin	Diazinon	Imidacloprid	Propanil
Atrazine	Dichlorvos (DDVP)	Indoxacarb	Propetamphos
Azinphos methyl	Dieldrin	Lindane (BHC gamma)	Propiconazole
Azoxystrobin	Difenoconazole	Linuron	Pyraclostrobin
Benoxacor	Diflubenzuron	Malathion	Pyrethrin I
Bifenthrin	Dimethoate	Metalaxyl	Pyrethrin II
Boscalid	Diuron	Methamidophos	Pyridaben
Buprofezin	Endosulfan I	Methomyl	Pyriproxyfen
Carbaryl	Endosulfan II	Methoxyfenozide	Resmethrin (cis&trans)
Carbofuran	Endosulfan sulfate	Metolachlor	Simazine
Carfentrazone ethyl	Ethion	Metribuzin	Sulprofos
Chlordane cis	Ethion monoxon	MGK-264 (isomers 1 & 2)	Tebufenozide
Chlordane trans	Ethofumesate	Myclobutanil	Tefluthrin
Chloroneb	Fenoxaprop ethyl	Nonachlor cis	Tetrachlorvinphos
Chlorothalonil	Fenpropathrin	Nonachlor trans	Tetraconazole
Chlorpropham	Fipronil	Norflurazon	Thiabendazole
Chlorpyrifos	Fipronil desulfinyl	Omethoate	Thiamethoxam
Chlorpyrifos methyl	Fipronil sulfide	Oxychlordane	Thiobencarb
Clothianidin	Fluridone	Pentachloroaniline (PCA)	Trifloxystrobin
1-Naphthol	Coumaphos O	Fluroxypyr-1-Methylhepyl-Ester	Pentachlorobenzene (PCB)
3-Hydroxycarbofuran	Coumaphos S	Fluvalinate	Permethrin (cis&trans)

Acephate	DDD o,p’	Heptachlor	Piperonyl butoxide
Acetamiprid	DDD p,p’ + DDT, o,p'	Heptachlor epoxide (cis+ trans) or (B+A)	Pirimiphos methyl
Alachlor	DDE o,p’	Hexachlorobenzene (HCB)	Prallethrin
Aldicarb	DDE p,p’	Hexazinone	Profenofos
Aldicarb sulfone	DDT p,p’	Hexythiazox	Pronamide
Aldicarb sulfoxide	Deethylatrazine	Imazalil	Propachlor
Aldrin	Diazinon	Imidacloprid	Propanil
Atrazine	Dichlorvos (DDVP)	Indoxacarb	Propetamphos
Azinphos methyl	Dieldrin	Lindane (BHC gamma)	Propiconazole
Azoxystrobin	Difenoconazole	Linuron	Pyraclostrobin
Benoxacor	Diflubenzuron	Malathion	Pyrethrin I
Bifenthrin	Dimethoate	Metalaxyl	Pyrethrin II
Boscalid	Diuron	Methamidophos	Pyridaben
Buprofezin	Endosulfan I	Methomyl	Pyriproxyfen
Carbaryl	Endosulfan II	Methoxyfenozide	Resmethrin (cis&trans)
Carbofuran	Endosulfan sulfate	Metolachlor	Simazine
Carfentrazone ethyl	Ethion	Metribuzin	Sulprofos
Chlordane cis	Ethion monoxon	MGK-264 (isomers 1 & 2)	Tebufenozide
Chlordane trans	Ethofumesate	Myclobutanil	Tefluthrin
Chloroneb	Fenoxaprop ethyl	Nonachlor cis	Tetrachlorvinphos
Chlorothalonil	Fenpropathrin	Nonachlor trans	Tetraconazole
Chlorpropham	Fipronil	Norflurazon	Thiabendazole
Chlorpyrifos	Fipronil desulfinyl	Omethoate	Thiamethoxam
Chlorpyrifos methyl	Fipronil sulfide	Oxychlordane	Thiobencarb
Clothianidin	Fluridone	Pentachloroaniline (PCA)	Trifloxystrobin

b. *Metals Method*

Aluminum (Al)	Copper (Cu)	Selenium (Se)
Barium (Ba)	Iron (Fe)	Strontium (Sr)
Boron (B)	Lead (Pb)	Thallium (Tl)
Cadmium (Cd)	Manganese (Mn)	Vanadium (V)
Chromium (Cr)	Molybdenum (Mo)	Zinc (Zn)
Cobalt (Co)	Nickel (Ni)	

Appendix IV

NRP – Domestic Scheduled Sampling Program

Year	Number of Samples	Number of Violative Samples	Number of Non-Violative Positive Analytes	Number of Violative Chemical Residues
FY 2014	6,066	10	34	10
FY 2015	6,445	12	23	8
FY 2016	7,067	26	24	11
FY 2017	7,029	22	17	12
FY 2018	7,909	26	19	26

Appendix V

NRP – Import Re-inspection Sampling Program

Year	Number of Samples	Number of Violative Samples	Violative Residues
FY 2014	1,967	8	Ivermectin (7), Zilpaterol (1)
FY 2015	2,922	7	Abamectin (1) Ethion (5), Piperonyl Butoxide (1)
FY 2016	2,676	22	Ethion (21), Diazinon (1)
FY 2017	2,720	24	Dyes (22), Nitrofurans (1), Pesticide(2)
FY 2018	3,409	7	Avermectin (2), Dyes (3), MRM(1) ,Pesticide(1)

Appendix VI

NRP – Domestic Inspector Generated Sampling Program (*include* KIS™ and Non- KIS™ *test*) & lab confirmed residue results

Year	Number of Samples (Include In-plant KIS™ Screens Tests)	Number of Samples Tested in FSIS Labs (include in-plant KIS™ screens positive)	Lab-Confirmed Positives			
			Number of Violative Analytes (Number of Violative Carcasses)	Top Three Violative Analytes	Number of Non-Violative Analytes	Top Three Non-Violative Analytes
FY2014	210,705 (210,516)	5,048 (4,859)	1,408 (1,136)	Ceftiofur Penicillin Neomycin	1,150	Oxytetracyline Tulathromycin Penicillin
FY2015	184,167 (184,010)	4,179 (4,022)	1,024 (796)	Ceftiofur Penicillin Sulfamethazine	873	Tulathromycin Oxytetracyline Neomycin
FY 2016	182,313 (182,184)	3,778 (3,649)	893 (732)	Ceftiofur Penicillin Sulfadimethoxine	728	Oxytetracycline Tulathromycin Penicillin
FY 2017	177,238 (177,138)	4,262 (4,162)	843 (681)	Ceftiofur Penicillin Sulfadimethoxine	714	Tulathromycin Oxytetracycline Penicillin
FY 2018	179,730 (179,503)	4,727 (4,505)	826 (674)	Ceftiofur Penicillin Sulfadimethoxine	724	Tulathromycin Oxytetracycline Penicillin

Note:

- Multiple violative analytes in different tissue types may be associated with a single carcass