

Monitoring of pesticide chemical residues in domestic and imported human foods (FY 2009 to 2017)

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Abstract

Growers often use pesticides to protect their crops from insects, weeds, fungi, and other pests. U.S. regulators help ensure that food produced with the use of pesticides is safe to eat by setting allowable levels called tolerances for pesticide chemical residues and by monitoring foods in the market to determine if those levels are being met. The Food and Drug Administration (FDA) is responsible for enforcing pesticide chemical residue tolerances established by the Environmental Protection Agency (EPA) for food. FDA publishes annual reports summarizing the results of FDA pesticide testing. In order to identify trends not apparent in annual reports, pesticide chemical residue findings of 56,593 samples (13,718 domestic and 42,875 import) collected over approximately 10 years from the FDA pesticide regulatory monitoring program were analyzed. The overall violation rate during Fiscal Year (FY) 2009-2017 was 2.0% for domestic samples, 9.1% for import samples, and 7% for all samples combined. Annual violation rates for this time period ranged from 0.9-3.8% for domestic samples and 4.0-12.6% for import samples. The majority of the violations for both domestic and import samples are due to “no tolerance” violations, which occur when there is no U.S. tolerance established for a specific pesticide/commodity pair. Targeting of samples with higher historic violation rates appears to be a major contributor to the increase in the overall import violation rate observed between FY 2009-2017. The difference between import and domestic violation rates is largest for grains, mainly due to import violations and differences in global tolerances for rice. Ginseng, sweet basil, capsicum spice, cilantro, and prickly pear are the top five violative commodities and are frequently identified in FDA’s annual reports as imports warranting special attention. Trends identified in the study could help FDA to plan future sampling more efficiently by targeting import commodities warranting special attention while maintaining coverage for commodities that are highly consumed, in order to fulfill FDA’s mission to protect public health.

Introduction

In the US, three federal agencies share responsibility for the oversight of pesticide chemical residues in or on food. EPA registers pesticides and sets tolerances for pesticide residues in food. FDA enforces EPA tolerances for domestic foods in interstate commerce and foods offered for import into the U.S., except for certain products regulated by the US Department of Agriculture. In its regulatory pesticide residue monitoring program, FDA selectively monitors a broad range of domestic and import commodities for pesticide residues and publishes an annual summary report. The annual report is a snapshot in time. We conducted an analysis of pesticide data from FY 2009 to 2017 and investigated trends in violations and violation rates.

Materials and Methods

We compiled data from 56,593 samples (13,718 domestic and 42,875 import) collected between FY 2009-2017 from the FDA pesticide regulatory monitoring program¹ and focused sampling assignments, and analyzed trends in violation types, violation rates, most frequently violative residues, and most frequently violative commodities. A “violative sample” is a sample containing one or more violative residues. “Violation rate” equals number of violative samples divided by total samples. A sample may have multiple violative residues, but is only counted once to determine violation rates.

Results and Discussion

Violation Type

- Violative residues can be divided into two categories: no tolerance violations and over tolerance violations. No tolerance means EPA has not established tolerances or exemptions for the pesticide/commodity pair. Over tolerance violation means that the level of pesticide residue has exceeded the EPA tolerance for that commodity.
- The majority of violations in both domestic and import samples are due to “no tolerance” violations (Figure 1).

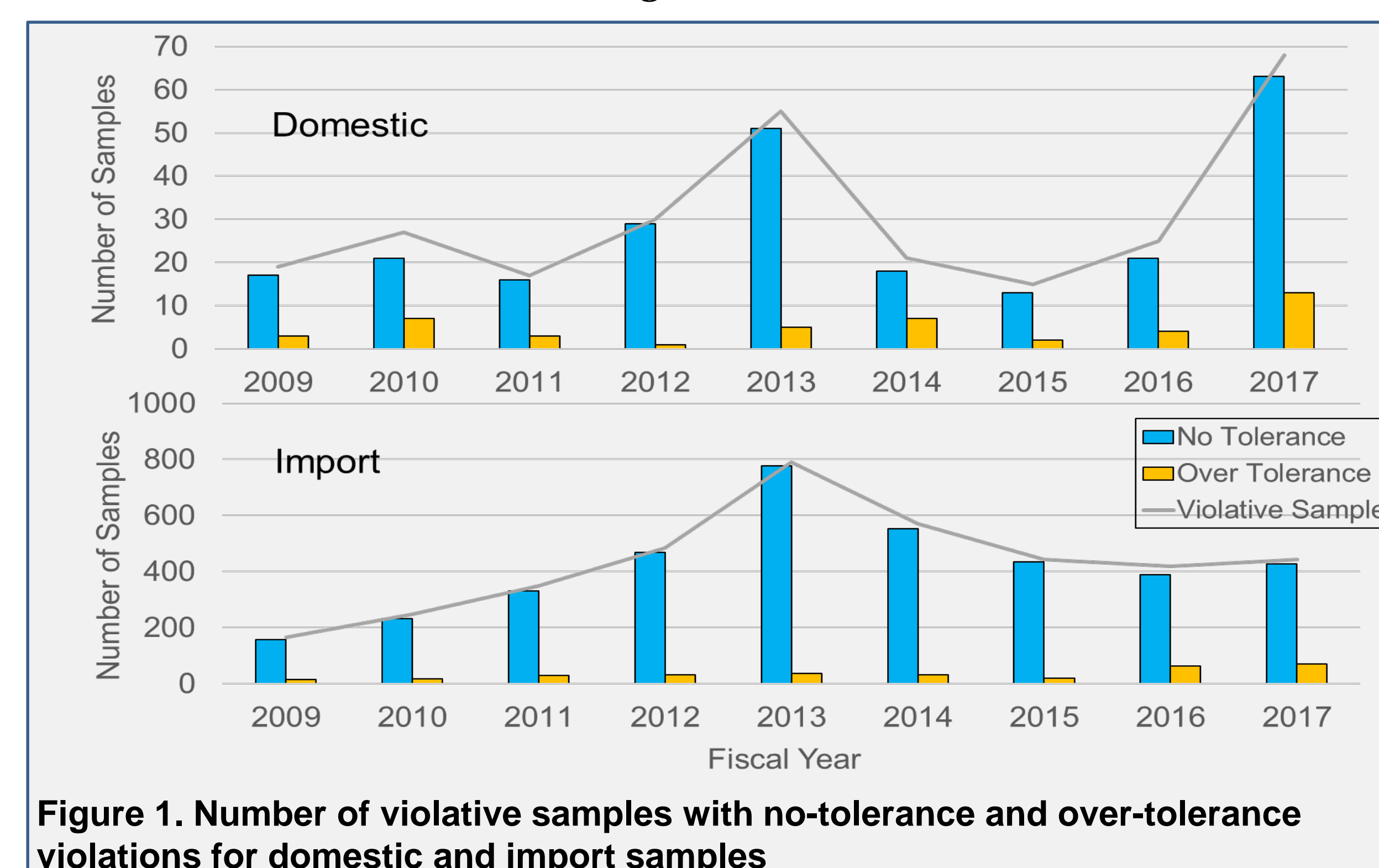


Figure 1. Number of violative samples with no-tolerance and over-tolerance violations for domestic and import samples

Violation Rate

- Figure 2 (lines, right axis) shows the annual violation rates from FY 2009-2017 for domestic and import samples. Yearly, the violation rate for import samples was 3-5 times higher than for domestic samples.
- The annual report identifies imported commodities that may warrant special attention based on an annual violation rate $\geq 10\%$, for commodities with ≥ 20 samples or ≥ 3 violations.
- The sum of the percentage of import samples collected for major commodities warranting special attention (left axis, columns) corresponds with the violation rate of import samples (right axis, line).

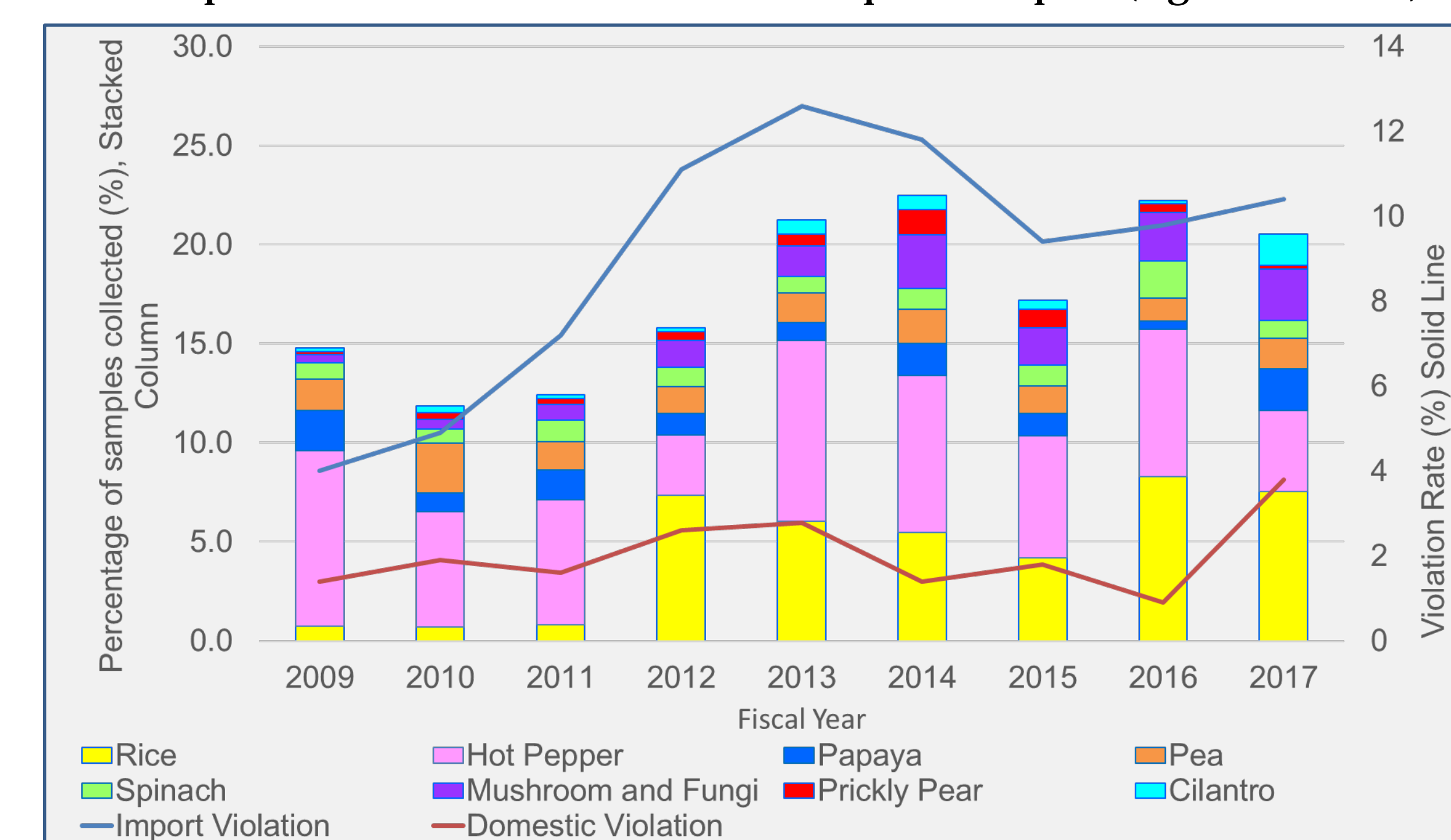


Figure 2. Annual violation rate for domestic and import samples [lines, right axis] and percentage of import samples for commodities warranting special attention [columns, left axis]

Violation Rate by Major Commodity Groups

- Figure 3 shows the violation rates by year and import status for four major commodity groups.
- The difference between import and domestic violation rates is largest for Grains, for which the violation rate increased sharply from 4.5% in FY 2011 to 21.9% in 2012.
- For “other commodities,” the high violation rates observed some years in imported samples are due to spices, botanicals, and tea as very few pesticide tolerances are established for these commodities.
- For domestic and imported samples combined, grains had the highest overall violation rate of 11.6%, followed by “other commodities” (10.6%), vegetables (7.5%), and fruits (6.2%).

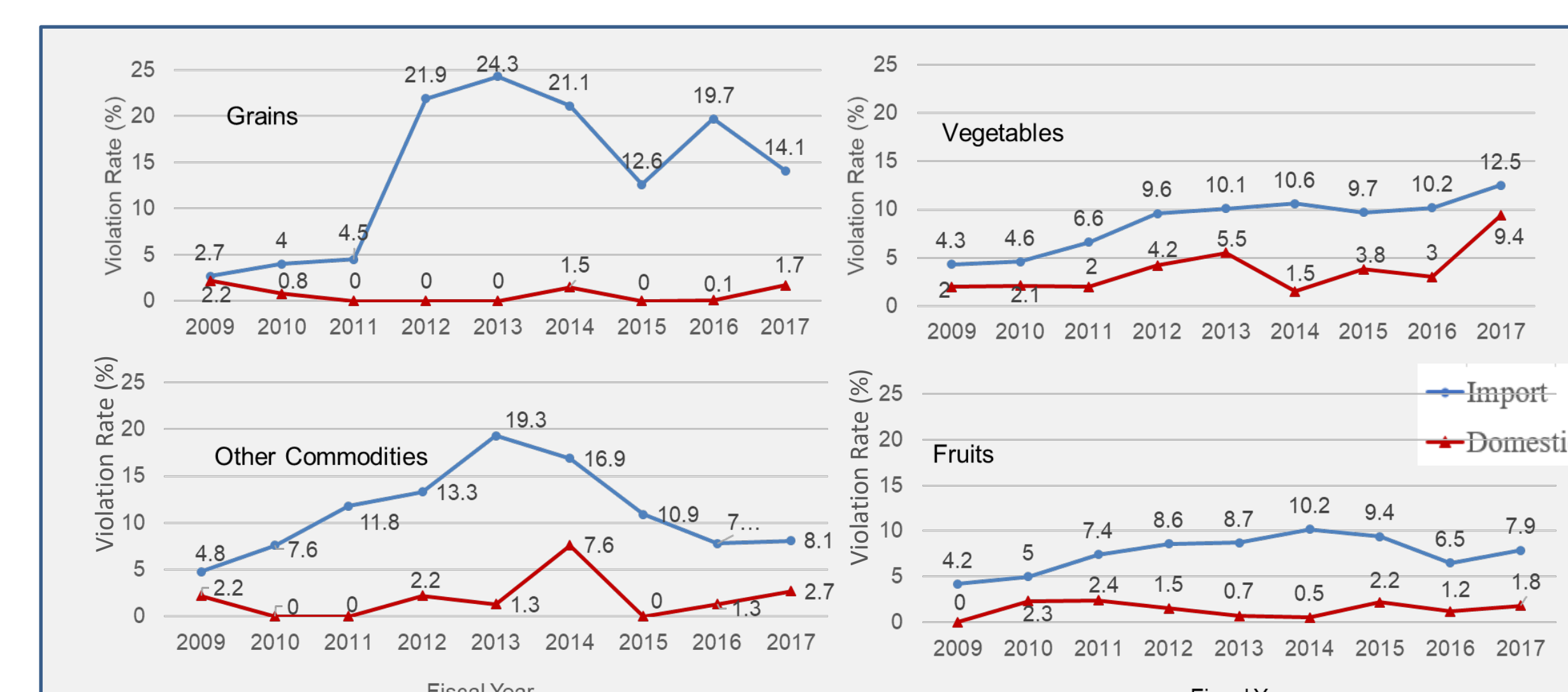


Figure 3. Violative samples by major commodities for domestic and import samples

Violation Rates in Rice

- High violation rates in grains may be linked to import violations and differences in global tolerances for rice. Table 1 lists the top 10 most frequently detected violative residues in rice, along with Maximum Residue Limits (MRL) established by Codex, the EU, and India.
- Table 1 highlights the inventory of pesticides that rice growers can use outside the US and provides an explanation for the high violation rate observed in imported rice. By FY 2019, the US had established import tolerances (an import tolerance is a tolerance that exists in the US for which there is no accompanying US registration) for three pesticides in Table 1, namely tricyclazole, buprofezin, and thiamethoxam.

Table 1. Top 10 most frequently detected violative residues in rice samples

Pesticide	Tolerance/MRL for rice (mg kg ⁻¹) (year established)			
	US	Codex ²	EU ³	India ⁴
Tricyclazole	3.0 (2014)	None	0.01*	0.02 (2011); 3 (2019)
Isoprothiolane	None	6.0, husked rice (2018) 1.5, polished rice (2018)	6 (2019) 5 (2014)	0.1 (2011)
Buprofezin	1.5 (2017)	None	0.01*	0.05 (2011)
Carbendazim	None	2.0, husked rice (2006)	0.01*	0.05, food grains (2019)
Tebuconazole	None	1.5 (2012)	1.5 (2018); 1 (2015)	1.5 (2019)
Chlorpyrifos	None	0.5 (2005)	0.5 (2018) 0.05* (2016)	0.01, milled food grains(2011) 0.05, food grains (2011) None (2019)
Pirimiphos methyl	None	7.0, cereal grains (2005)	0.5 (2016) 5 (2008)	0.5 (2011)
Triazophos	None	0.6, polished rice (2014)	0.02*	0.05 (2011) 0.6 (2019)
Methamidophos	None	0.6, husked rice (2012)	0.01*	1 (2019)
Thiamethoxam	6 (2019)	None	0.01*	0.02 (2011)

* Indicates lower limit of analytical determination for EU methods.

Top 10 Violative Commodities

- Table 2 lists the top 10 commodities with the highest violation rate from FY 2009-2017, along with years reported as imports warranting special attention. Prickly pear and rice were most frequently identified as warranting special attention (7 out of 9 years).
- Ginseng, sweet basil, capsicum spice, cilantro, and prickly pear are the top five violative commodities, likely because there are fewer pesticide tolerances for minor use crops or low consumption foods.
- Table 2 also listed countries that contributed $\geq 25\%$ of violations for each commodity; this metric may be driven by volume of imports.
- Both the volume of imports (column 4) and the violation rate per commodity/country (column 5) can affect overall violation rates and are important to consider when planning sampling.

Table 2. Top 10 violative commodities by violation rate

Commodity	Number of violative samples	Violation rate (%)	Country contributing $\geq 25\%$ of the violations (%) ^a	Violation rate of commodity/country of origin pair (%) ^b	Number of years flagged as warranting special attention
Ginseng	71	51.5	China (56.3)	58.0	5
Basil, sweet	50	50.0	Mexico (64.0)	60.4	3
Capsicum spice	115	46.6	India (65.2)	70.1	4
Cilantro	108	32.4	Mexico (56.5) US (36.1)	30.0 33.3	6
Prickly pear	67	30.5	Mexico (100.0)	30.5	7
Rice	531	25.6	India (60.5)	35.0	7
Wheat gluten	22	24.7	Poland (31.8) Germany (27.3)	50.0 33.3	3
Taro, Dasheen	30	23.1	Ecuador (46.7)	34.1	4
Pepper, hot, dried or paste	63	19.6	India (28.6)	78.3	2
Raisins	34	18.0	South Africa (26.5)	31.0	6

^a Number of violative samples from the country of origin divided by the total number of violative samples in the commodity.

^b Number of violative samples in the commodity/country pair divided by the total number of samples for the commodity/country pair.

Conclusion

- Out of 56,593 samples (13,718 domestic and 42,875 import) collected under FDA’s regulatory monitoring program from FY 2009-2017, the average violation rate was 2.0% for domestic samples, 9.1% for import samples, and 7% overall.
- Violation rates are higher in minor crops or low consumption commodities due to limited tolerances.
- Targeted sampling of one food type strongly affects changes in the overall violation rate from year to year. Targeting commodities that warrant special attention while maintaining coverage for commodities that are highly consumed helps fulfill FDA’s mission to protect public health.

References

- Pesticide Residue Monitoring Program Reports and Data
- Codex Pesticides Residues in Food Online Database
- EU Pesticides Database
- Food safety and standards (contaminants, toxins and residues) regulations