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Canada

2019

CIPARS

Canadian Integrated Program for Antimicrobial Resistance Surveillance

Pigs

CIPARS Canadian Integrated Program for Antimicrobial Resistance Surveillance

Programme intégré canadien de surveillance de la résistance aux antimicrobiens PICRA

To promote and protect the health of Canadians through leadership, partnership, innovation and action in public health, Public Health Agency of Canada

Working towards the preservation of effective antimicrobials for humans and animals, Canadian Integrated Program for Antimicrobial Resistance Surveillance

Également disponible en français sous le titre :

Programme intégré canadien de surveillance de la résistance aux antimicrobiens (PICRA) de 2019 : Porcs

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This publication can be made available in alternative formats upon request.

Publication date: April 2022

Cat.: HP2-4/2019E-5-PDF

ISBN: 978-0-660-41025-8

Pub.: 210452

Suggested Citation:

Government of Canada. Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) 2019: Pigs. Public Health Agency of Canada, Guelph, Ontario, 2022.

Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) 2019: Pigs

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Acknowledgements

Farm Swine Surveillance

We are grateful for the support of the Saskatchewan Ministry of Agriculture, as well as the sentinel veterinarians and the producers who participated in *Farm Surveillance* by providing data and enabling collection of samples for bacterial culture.

We would like to acknowledge the following organizations for their contribution to the CIPARS *Farm Swine Surveillance* component:

- Canadian Pork Council and Provincial Pork Boards
- CIPARS Farm Swine Advisory Committee

Abattoir Surveillance

We would like to thank the abattoir management and staff and the Canadian Food Inspection Agency's regional directors, inspection managers, and on-site staff, for their extensive voluntary participation in CIPARS *Abattoir Surveillance*.

Retail Meat Surveillance

We would like to extend our thanks to the following organizations for their participation in CIPARS *Retail Meat Surveillance*:

- Centre for Coastal Health
- Agriculture and Agri-Food Canada
- We also thank the participating health unit managers, public health inspectors, and environmental health officers

Chapter 1: Integrated Findings

The data presented in this section represents the integration of antimicrobial resistance, antimicrobial use, and animal health data across CIPARS Farm and Abattoir surveillance. CIPARS Retail sampling targets were not achieved in 2019 and therefore Retail results are not presented.

Key findings

Nationally, antimicrobial use remained stable in 2019 compared to 2018, antimicrobial resistance generally decreased and herd mortality was unchanged.

The proportion of isolates resistant to ≥1 antimicrobials classes was stable or increased slightly.

Nalidixic acid/ciprofloxacin-resistance was stable or increased slightly.

Resistance to ≥ 3 antimicrobial classes increased in *Salmonella* but decreased in *E. coli* and *Campylobacter.*

There was no meropenem resistance detected in *Salmonella* or *E. coli* isolated from grower-finisher pigs in Farm or Abattoir Surveillance.

Resistance to Category I antimicrobials was below 10% for Farm and Abattoir surveillance *E. coli* and *Salmonella* isolates.

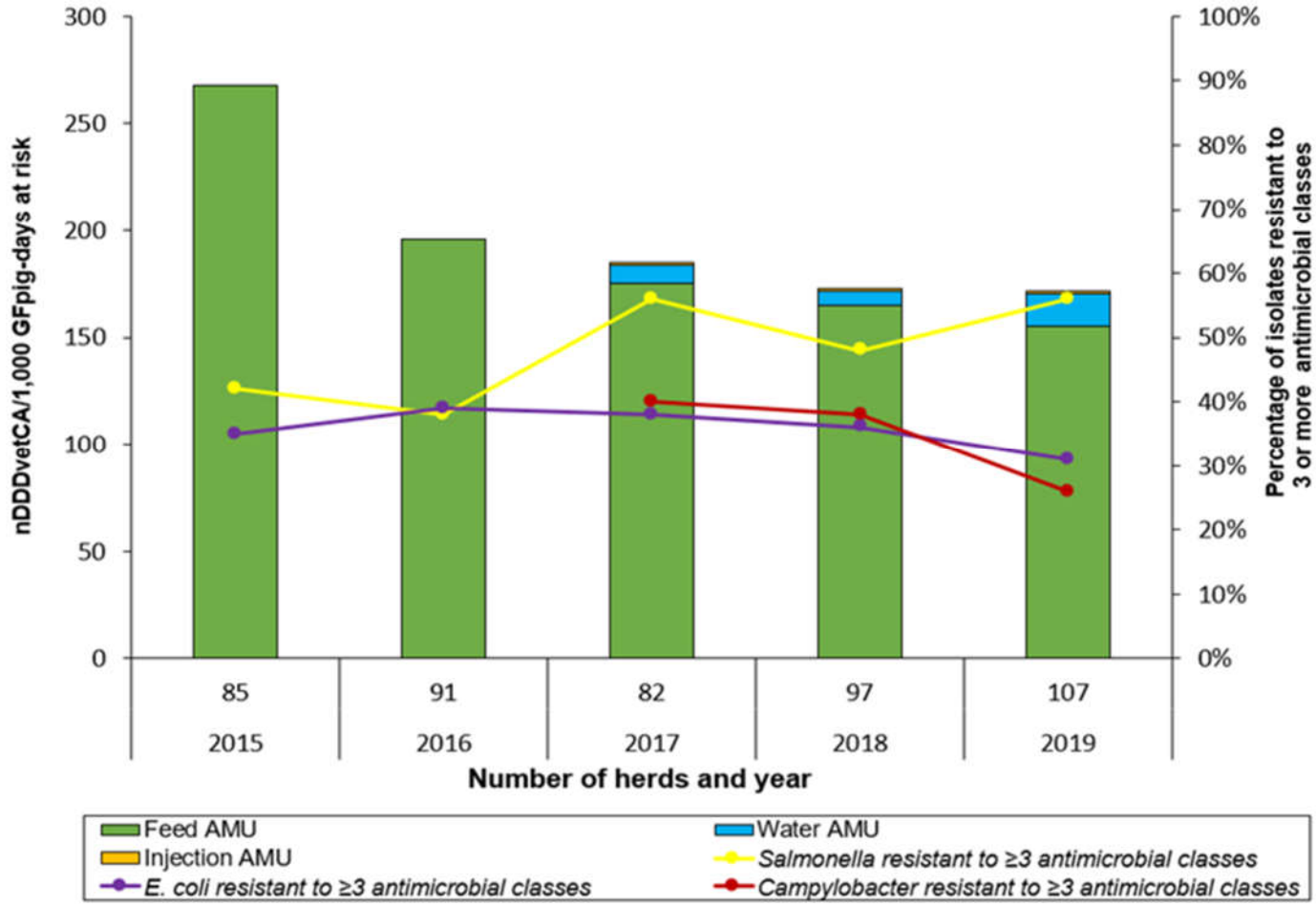
The most common resistance seen in *E. coli* and *Salmonella* from Farm and Abattoir was ampicillin, tetracycline, streptomycin, and sulfisoxazole.

Tetracycline and azithromycin were the most common resistance observed in *Campylobacter* isolates from Farm and Abattoir surveillance.

In both Farm and Abattoir surveillance, ciprofloxacin resistance continues to be the highest in *Campylobacter* isolates from Québec but is increasing in Ontario.

There was no resistance to gentamicin in *Campylobacter* isolates from Farm or Abattoir surveillance.

Figure 1.1 Integration of antimicrobial use and multiclass resistance in grower-finisher pigs, 2015 to 2019



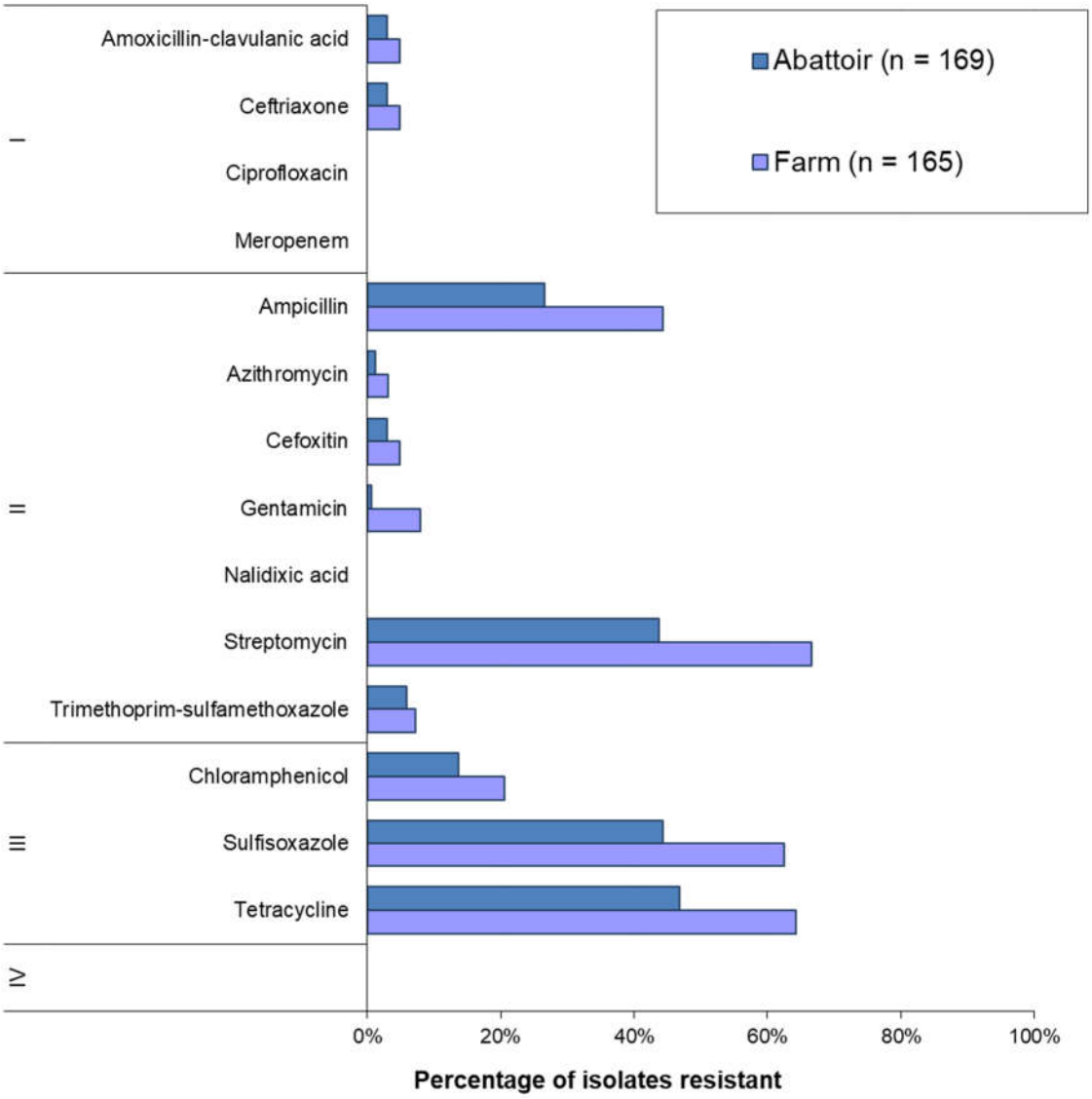
AMU: Antimicrobial use.
DDDvetCA = Canadian Defined Daily Doses for animals (average labelled dose) in milligrams per kilogram grower-finisher pig weight per day (mg_{drug}/kg_{animal}/day)
nDDDvetCA/1,000 GF pig-days at risk = Number of Canadian veterinary defined daily doses per 1000 grower-finisher pig-days at risk.
For detailed indicator descriptions, please refer to Table 3.1.
2019 was the first year of implementation of the regulatory changes in veterinary AMU in Canada.

Table 1.1 Temporal variations in resistance and grower-finisher herd mortality, 2017 to 2019

		2017	2018	2019	Comparing 2018 to 2019
Salmonella	Number of isolates	117	139	165	
	Ceftriaxone	5%	8%	6%	-2%
	Nalidixic acid/ciprofloxacin	0%/0%	0%/0%	0%/0%	0%
	Resistant to ≥1 classes	65%	65%	72%	+7%
E. coli	Number of isolates	484	585	628	
	Ceftriaxone	0%	2%	2%	0%
	Nalidixic acid/ciprofloxacin	<1%/0%	1%/<1%	1%/0%	0%
	Resistant to ≥1 classes	77%	78%	78%	0%
Campylobacter	Number of isolates	369	483	447	
	Ciprofloxacin	8%	11%	12%	+1%
	Resistant to ≥1 classes	78%	74%	78%	+4%
Herd health	Mortality	2.1%	2.3%	2.6%	<1%

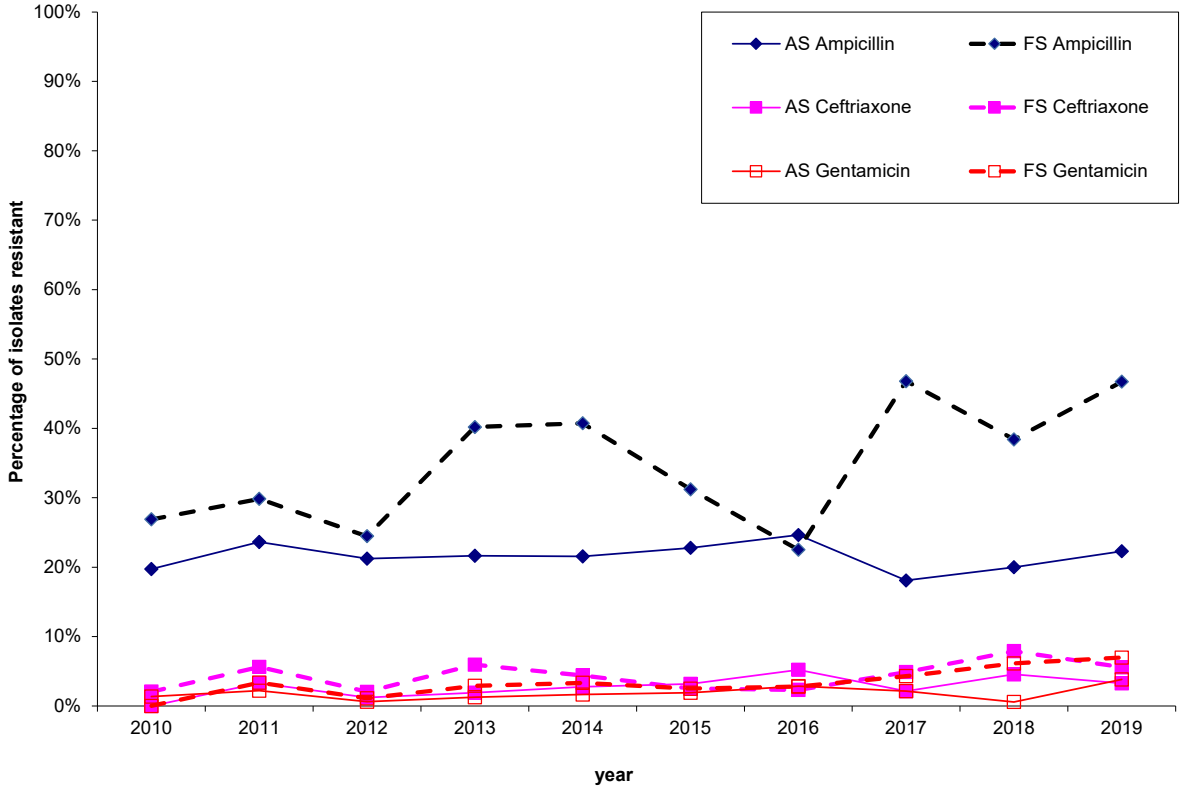
2019 was the first year of implementation of the regulatory changes in veterinary AMU in Canada.

Figure 1.2 Resistance of *Salmonella* isolates from farm pigs and pigs at abattoir, 2019



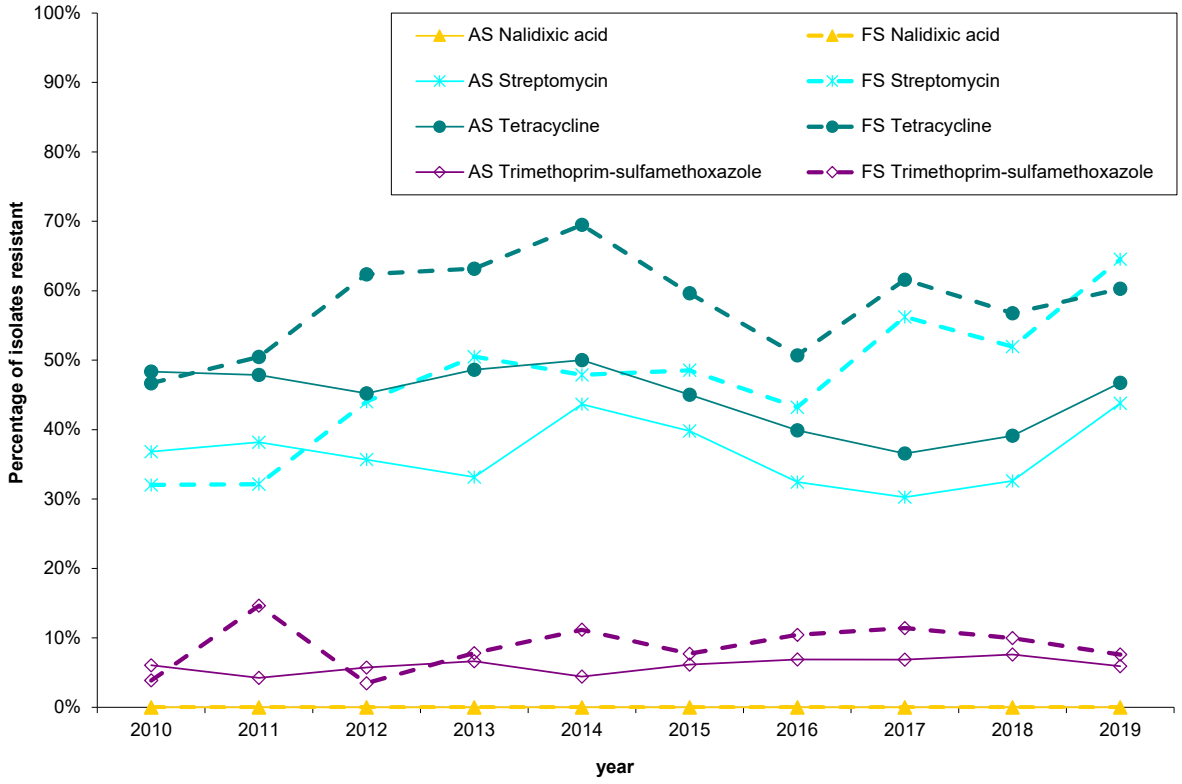
Categorization of antimicrobials based on their importance in human medicine

Figure 1.3 Temporal variations in resistance to selected antimicrobials in *Salmonella* from farm pigs and pigs at abattoir, 2010 to 2019



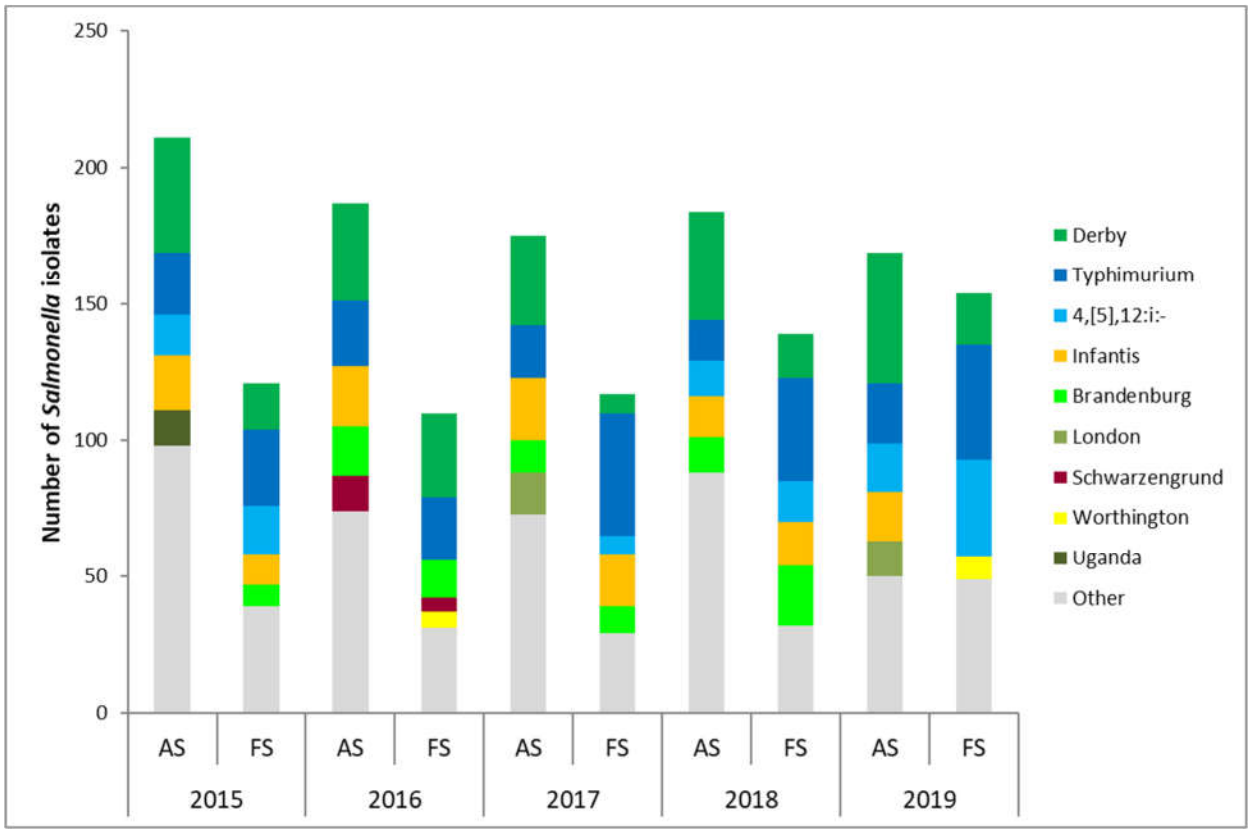
AS = Abattoir Surveillance.
FS = Farm Surveillance.

Figure 1.4 Temporal variations in resistance to selected antimicrobials in *Salmonella* from farm pigs and pigs at abattoir, 2010 to 2019



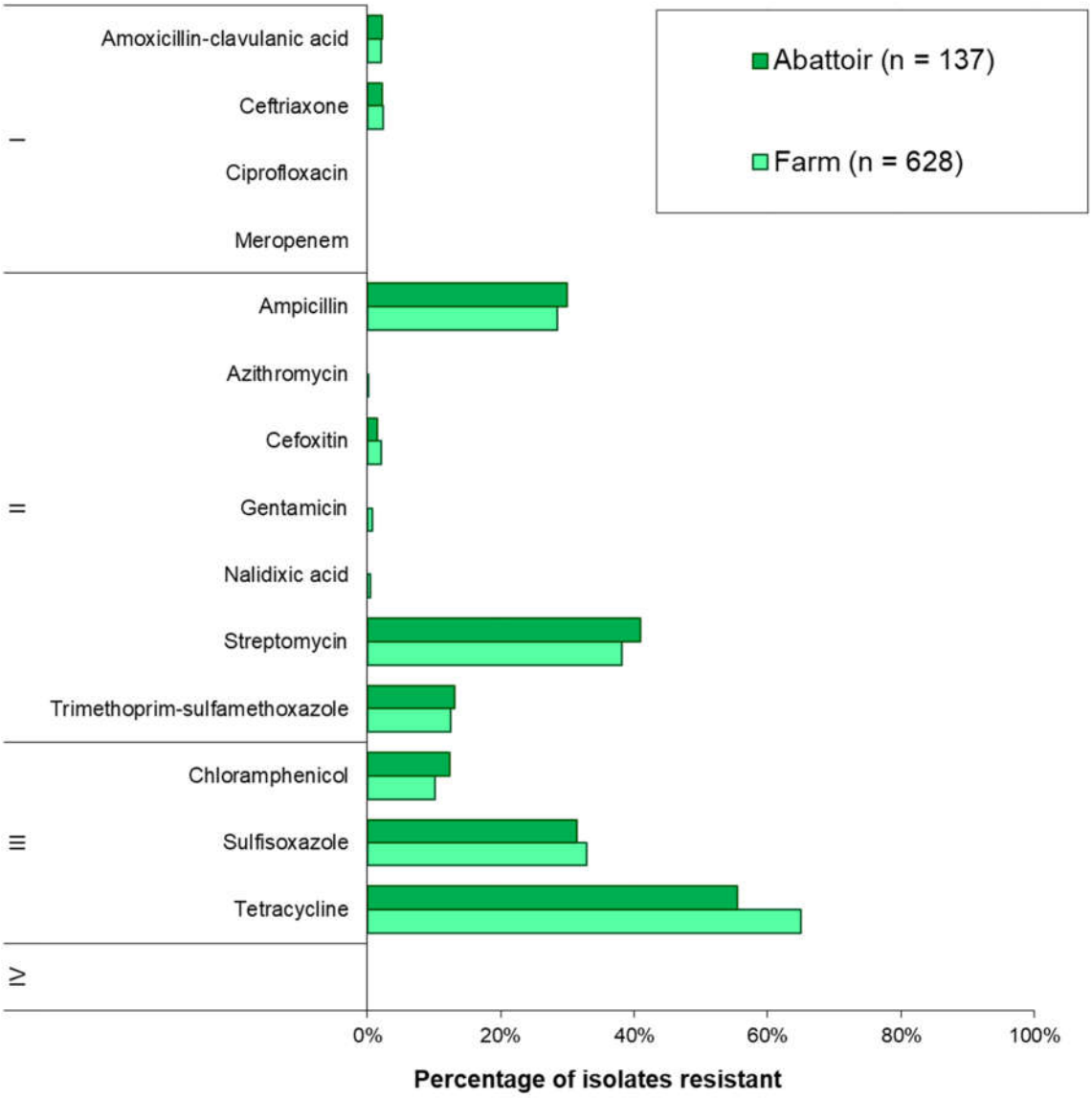
AS = Abattoir Surveillance.
FS = Farm Surveillance.

Figure 1.5 Temporal variations in top 5 most frequently identified *Salmonella* serovars from farm pigs and pigs at abattoir, 2015 to 2019



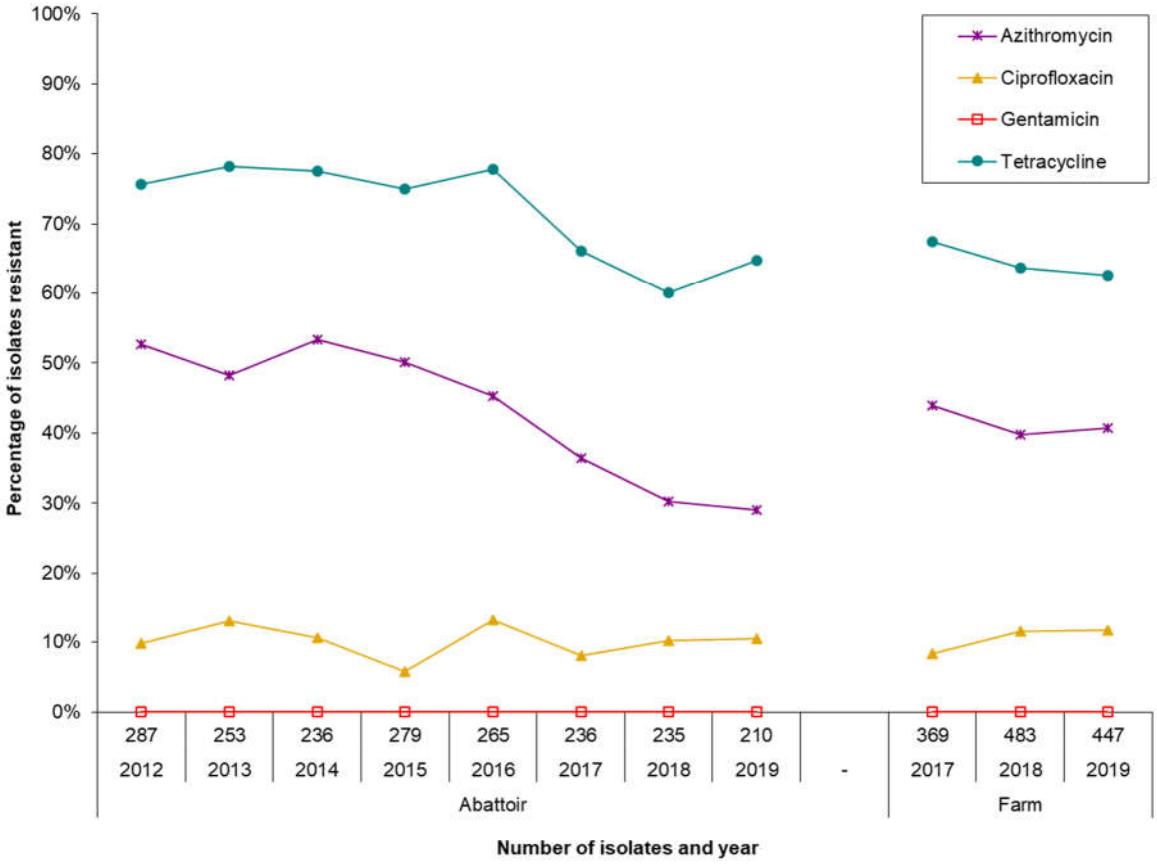
AS = Abattoir Surveillance.
FS = Farm Surveillance.

Figure 1.6 Resistance in *Escherichia coli* from farm pigs and pigs at abattoir, 2019



Categorization of antimicrobials based on their importance in human medicine

Figure 1.7 Temporal variations in resistance in *Campylobacter* from pigs at abattoir, 2012 to 2019 and from farm pigs, 2017 to 2019



Farm pigs: The percentage of isolates resistant is adjusted to account for multiple samples per herd.

Chapter 2: Animal health status and farm information

The data presented in this section pertains to pertinent farm-level animal health status and CIPARS sentinel farm information for swine. These data provide context to the antimicrobial use and antimicrobial resistance information presented in later chapters.

Key findings

Grower-finisher pigs

The proportion of herds with 7 or more diseases reported continued to increase in 2019 in Québec (2019: 75%, 2018: 73%, 2017: 70%, 2016: 54%, and 2015:48%) but slightly decreased in Ontario (2019: 78%, 2018: 81%, 2017:64%, 2016: 52%, and 2015: 25%). The proportion of herds with 7 or more diseases reported was substantially lower on the Prairies (2019: 32%, 2018: 37%, 2017: 23%, 2016: 35%, 2015: 21%).

In 2019 as in previous years, participating grower-finisher barns in Ontario and Québec were smaller than in the Prairies. As well, the number of pig farms within 2 km of CIPARS grower-finisher herds was higher in Ontario and Québec than in the Prairies.

Lawsonia, Hemophilus parasuis, *Streptococcus suis, E. coli* and Porcine coronavirus associated disease (PCVAD) continue to be very commonly reported in all 3 regions.

The proportion of herds reporting Erysipelas in Québec in 2019 (96%) continued to increase compared to previous years (2018: 89%, 2017: 80%, 2016: 63%, 2013: 28%). A general increasing trend was also observed in Ontario (2019: 77%, 2018: 77%, 2017: 71%, 2016: 71%) but not on the Prairies.

Salmonella was more commonly reported in Ontario (67%) and Québec (54%) than the Prairies (11%).

Swine Influenza continues to be more commonly reported in Québec (82%) and Ontario (85%) than the Prairies (43%).

There was 1 herd on the Prairies reported with PED in 2019.

Antimicrobials have been commonly reported in grower-finisher herds in all 3 regions (Prairies, Ontario, and Québec) for the control or treatment of *Streptococcus suis, Lawsonia,* and *Hemophilus parasuis*. The proportion of herds in Québec reporting the use of antimicrobials for the treatment or control of *Streptococcus suis* had decreased substantially between 2013 (41%) and 2018 (23%) but increased to 39% in 2019.

Antimicrobials reported for the control or treatment of *Mycoplasma* remained uncommon in the Prairies (4%), substantially decreased in Ontario (2019: 13%, 2018: 26%, 2015: 36%) and although there was in increase in Québec between 2018 (9%) and 2019 (25%), there has been a decreasing trend since 2015 (52%).

In Québec, 11% of herds used antimicrobials for the treatment or control of swine influenza which is a decrease compared to 2018 (32%). There was also a decrease in this reported

use in the Prairies (2019: 0%, 2018: 9%). There was no reported use of antimicrobials for the treatment or control of swine influenza in Ontario from 2015 to 2019.

Nurseries

In 2019, the use of antimicrobials to treat or control *Salmonella* in Québec nurseries supplying CIPARS grower-finisher herds decreased to zero and the decrease in the use of antimicrobials to treat or control *Mycoplasma* remained relatively stable (2019: 23%, 2018: 20%).

The use of antimicrobials to treat or control *Streptococcus suis, E. coli and Hemophilus parasuis* in Ontario nurseries supplying CIPARS grower-finisher herds decreased from 2018 (2019:72%,59%, 48%, 2018:85%, 64%, 54%) but was substantially higher than in Québec (2019: 52%, 46%, 15%) and the Prairies (2019: 47%, 20%, 20%).

In 2019 the proportion of herds reporting the use of antimicrobials to treat or control swine influenza in these Québec nurseries decreased (2019: 12%, 2018:20%) but was substantially higher than in Ontario (0%) and the Prairies (2%).

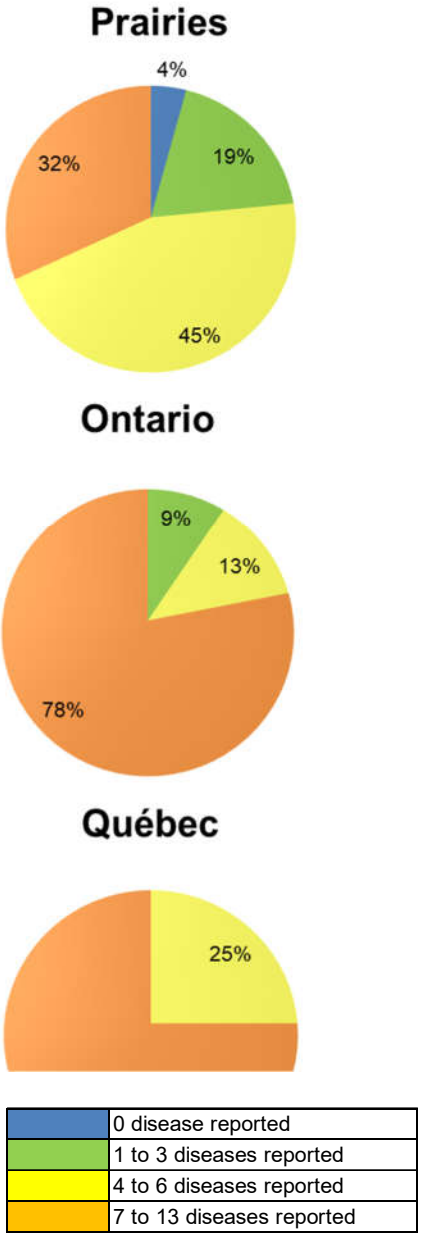
In Ontario, 14% of herds reported the use of antimicrobials to treat or control PCVAD in these nurseries. There were no herds in Québec or the Prairies that reported this use.

Sow herds

In 2019 there was a slight decrease in the reported use of antimicrobials for Erysipelas in Ontario sow herds supplying CIPARS grower-finisher herds (2019: 61%, 2018: 69%, 2013: 14%). This is still substantially higher than in the other 2 regions over the last 5 years (2019: Québec: 12%, Prairies: 4%).

The reported use of antimicrobials for the treatment or control of bacterial diseases was generally higher in these sow herds in Ontario and Québec than in the Prairies.

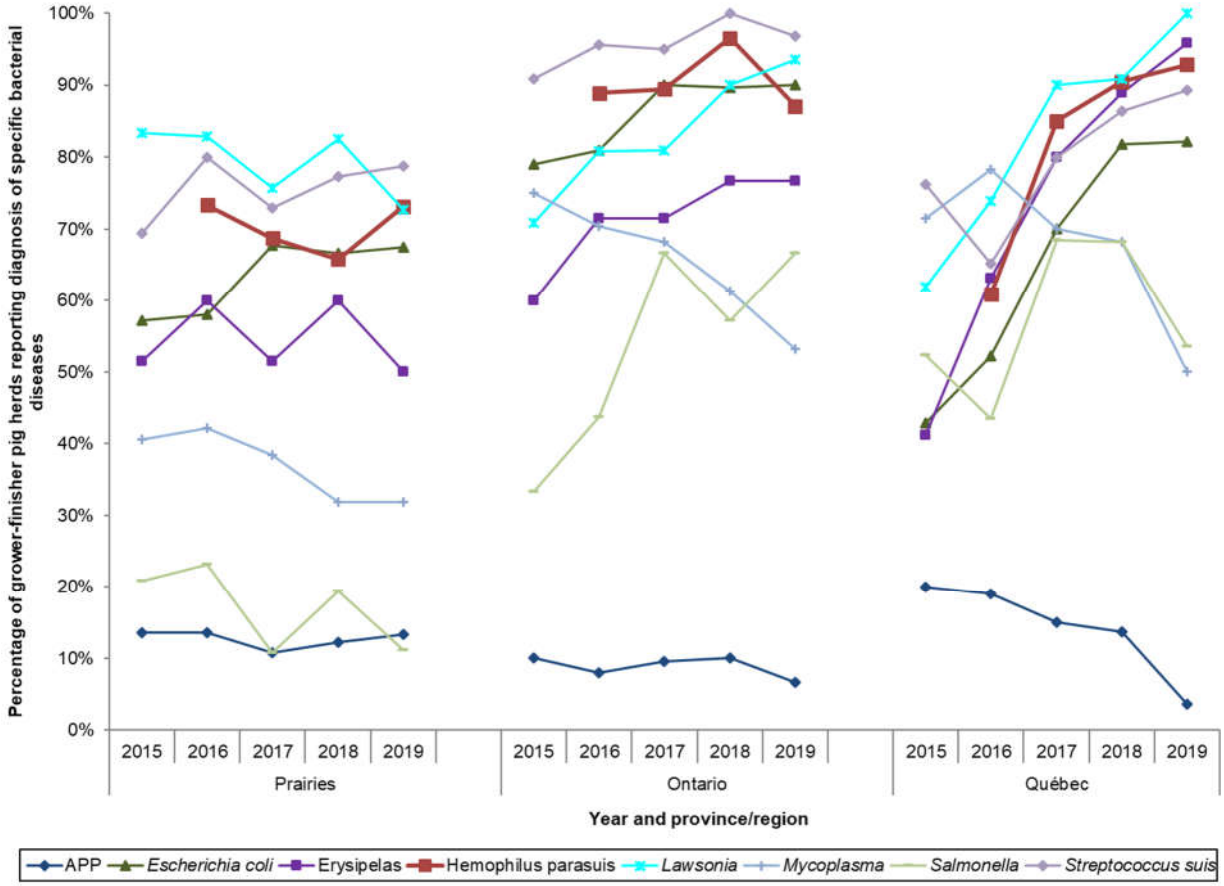
Figure 2.1 Number of infectious diseases reported by grower-finisher pig herds (n = 107) by province/region, 2019



Number of diseases is tabulated based on the 13 diseases listed on the questionnaire.
All farms in Ontario and Québec reported at least 1 disease on the questionnaire.
Health status was considered to be positive if the questionnaire response was "confirmed positive" or "likely positive". Health status was considered to be negative if the questionnaire response was "confirmed negative" or "likely negative".
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 2.2 Reported health status for diseases of grower-finisher pig herds, by province/region, 2015 to 2019

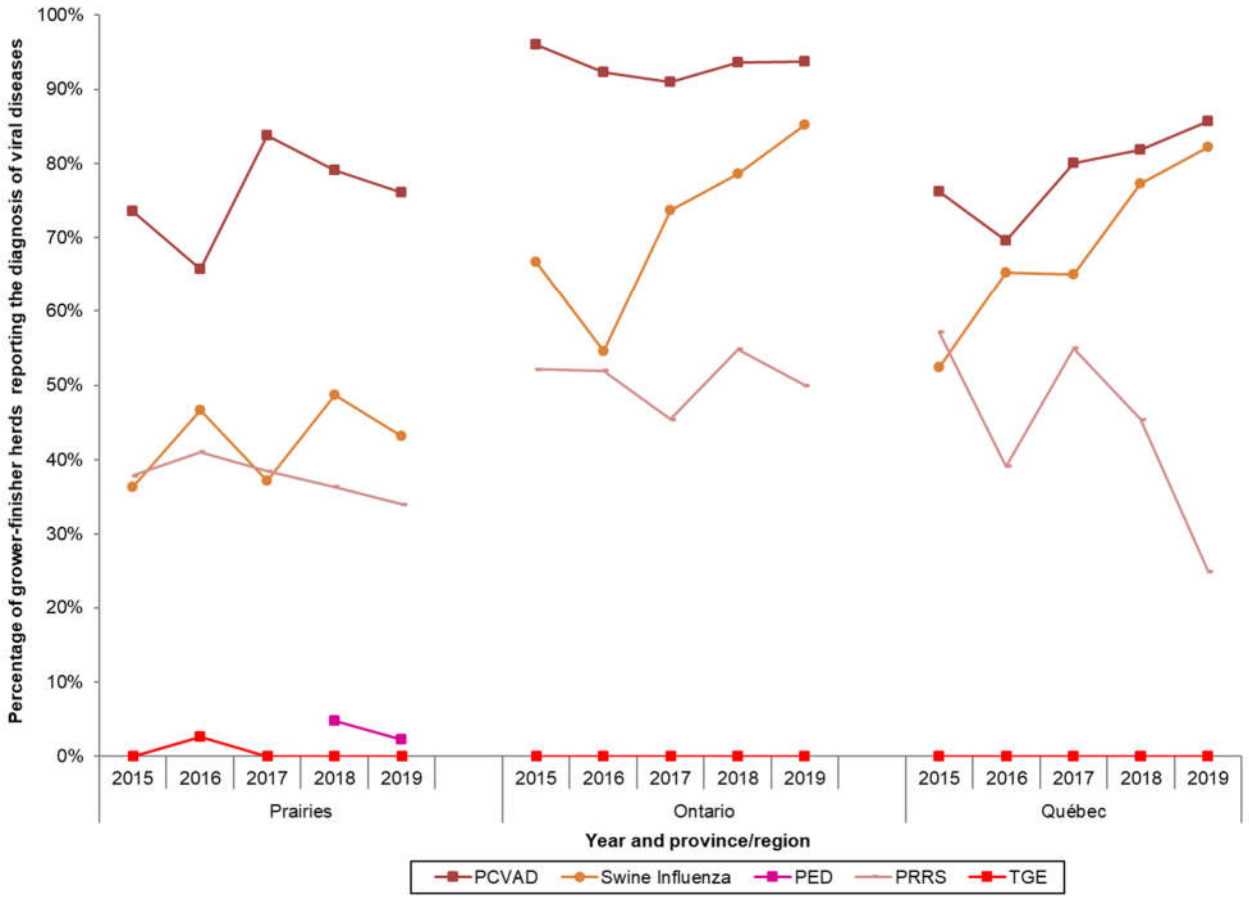
a) Bacterial diseases



Province/region	Prairies					Ontario					Québec				
Year	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Disease/bacteria															
APP	14%	14%	11%	12%	13%	10%	8%	10%	10%	7%	20%	19%	15%	14%	4%
Escherichia coli	57%	58%	68%	67%	68%	79%	81%	90%	90%	90%	43%	52%	70%	82%	82%
Erysipelas	51%	60%	51%	60%	50%	60%	71%	71%	77%	77%	41%	63%	80%	89%	96%
Hemophilus parasuis		73%	69%	66%	73%		89%	89%	97%	87%		61%	85%	90%	93%
Lawsonia	83%	83%	76%	83%	73%	71%	81%	81%	90%	94%	62%	74%	90%	91%	100%
Mycoplasma	41%	42%	38%	32%	32%	75%	70%	68%	61%	53%	71%	78%	70%	68%	50%
Salmonella	21%	23%	11%	19%	11%	33%	44%	67%	57%	67%	52%	43%	68%	68%	54%
Streptococcus suis	69%	80%	73%	77%	79%	91%	96%	95%	100%	97%	76%	65%	80%	86%	89%

APP = *Actinobacillus pleuropneumoniae*.
Hemophilus parasuis was added to the questionnaire in 2016.
Health status was considered to be positive if the questionnaire response was "confirmed positive" or "likely positive". Health status was considered to be negative if the questionnaire response was "confirmed negative" or "likely negative".
Health status of nurseries and sow herds supplying CIPARS grower-finisher pig herds is available upon request.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

b) Viral diseases

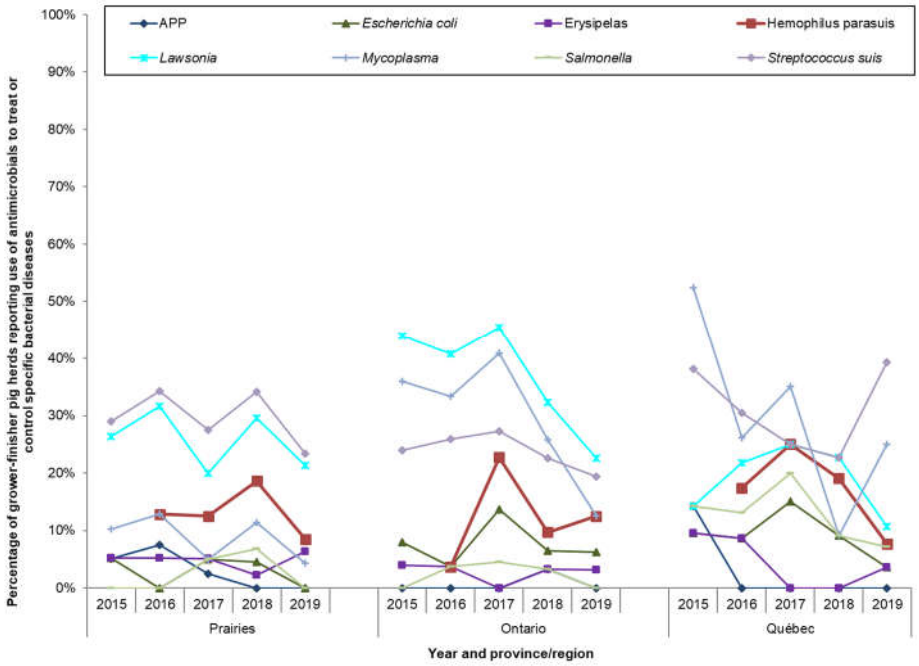


Province/region	Prairies					Ontario					Québec				
Year	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Disease/virus															
PCVAD	74%	66%	84%	79%	76%	96%	92%	91%	94%	94%	76%	70%	80%	82%	86%
Swine Influenza	36%	47%	37%	49%	43%	67%	55%	74%	79%	85%	52%	65%	65%	77%	82%
PED		0%	0%	5%	2%		0%	0%	0%	0%		0%	0%	0%	0%
PRRS	38%	41%	38%	36%	34%	52%	52%	45%	55%	50%	57%	39%	55%	45%	25%
TGE	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

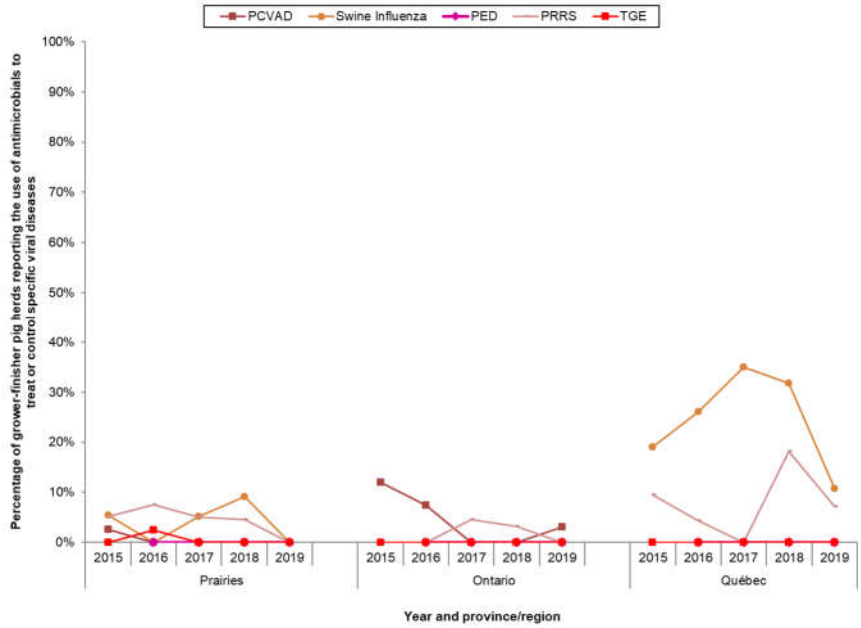
PCVAD = Porcine Circovirus Associated Disease.
TGE = Transmissible Gastroenteritis.
PED = Porcine Epidemic Diarrhea. PED was added to the questionnaire in 2016.
PRRS = Porcine Reproductive and Respiratory Syndrome.
Health status was considered to be positive if the questionnaire response was "confirmed positive" or "likely positive". Health status was considered to be negative if the questionnaire response was "confirmed negative" or "likely negative".
Health status of nurseries and sow herds supplying CIPARS grower-finisher herds is available upon request.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 2.3 Reported antimicrobial use for specific diseases in grower-finisher pig herds by province/region, 2015 to 2019

a) Bacterial diseases



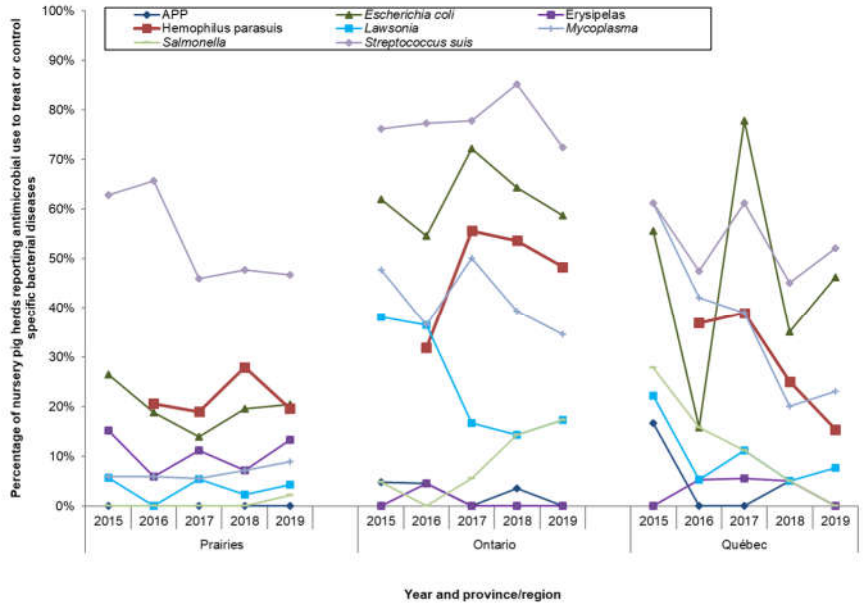
b) Viral diseases



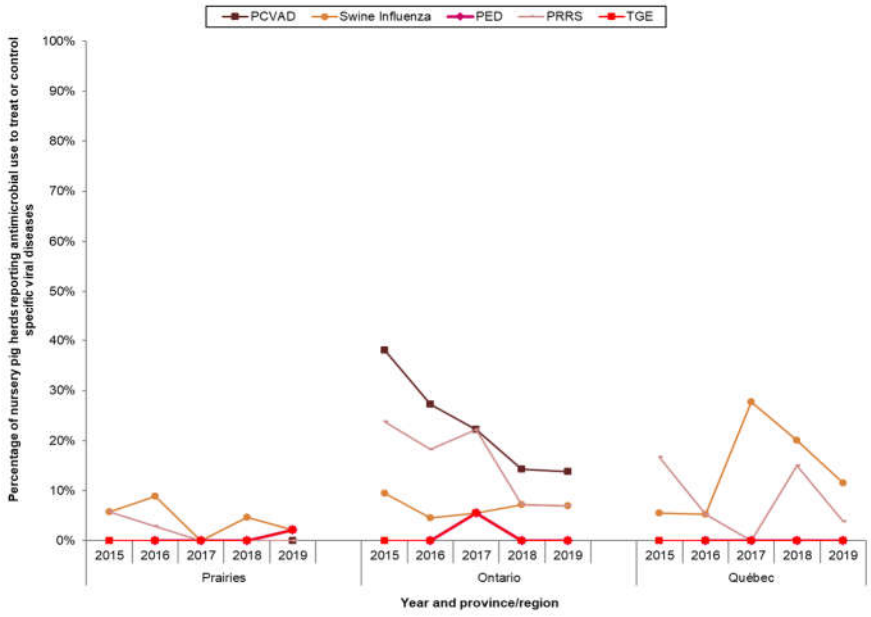
APP = *Actinobacillus pleuropneumoniae.*
PCVAD = Porcine Circovirus Associated Disease.
PRRS = Porcine Reproductive and Respiratory Syndrome.
PED = Porcine Epidemic Diarrhea.
TGE = Transmissible Gastroenteritis.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 2.4 Reported antimicrobial use for specific diseases in nurseries supplying grower-finisher herds, by province/region, 2015 to 2019

a) Bacterial diseases



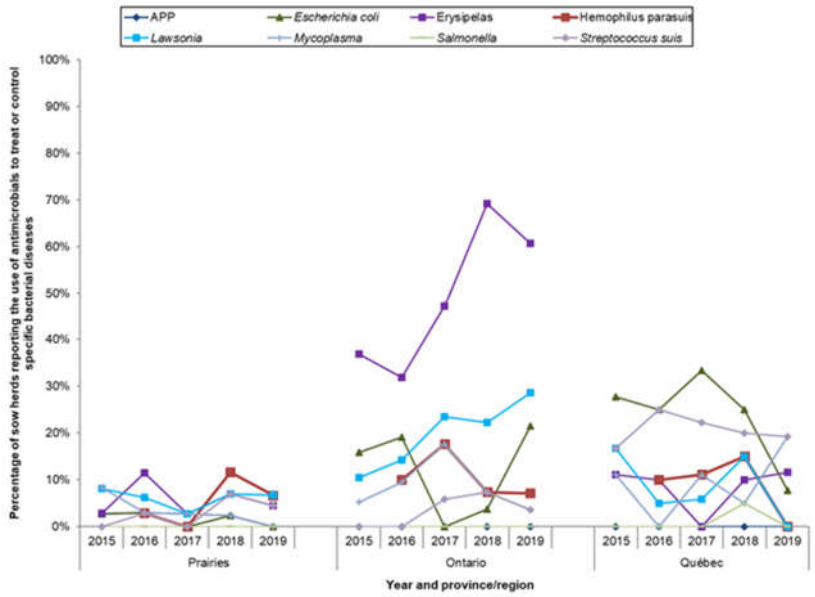
b) Viral diseases



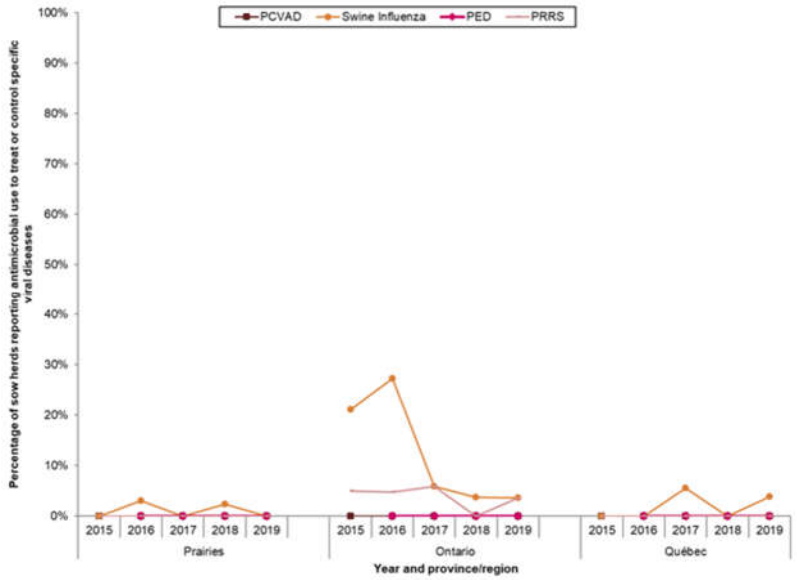
APP = *Actinobacillus pleuropneumoniae.*
PCVAD = Porcine Circovirus Associated Disease.
PRRS = Porcine Reproductive and Respiratory Syndrome.
PED = Porcine Epidemic Diarrhea.
TGE = Transmissible gastroenteritis.
Not all questionnaires were completed for all diseases listed.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 2.5 Reported antimicrobial use for specific diseases in sow herds supplying grower-finisher pig herds, by province/region, 2015 to 2019

a) Bacterial diseases



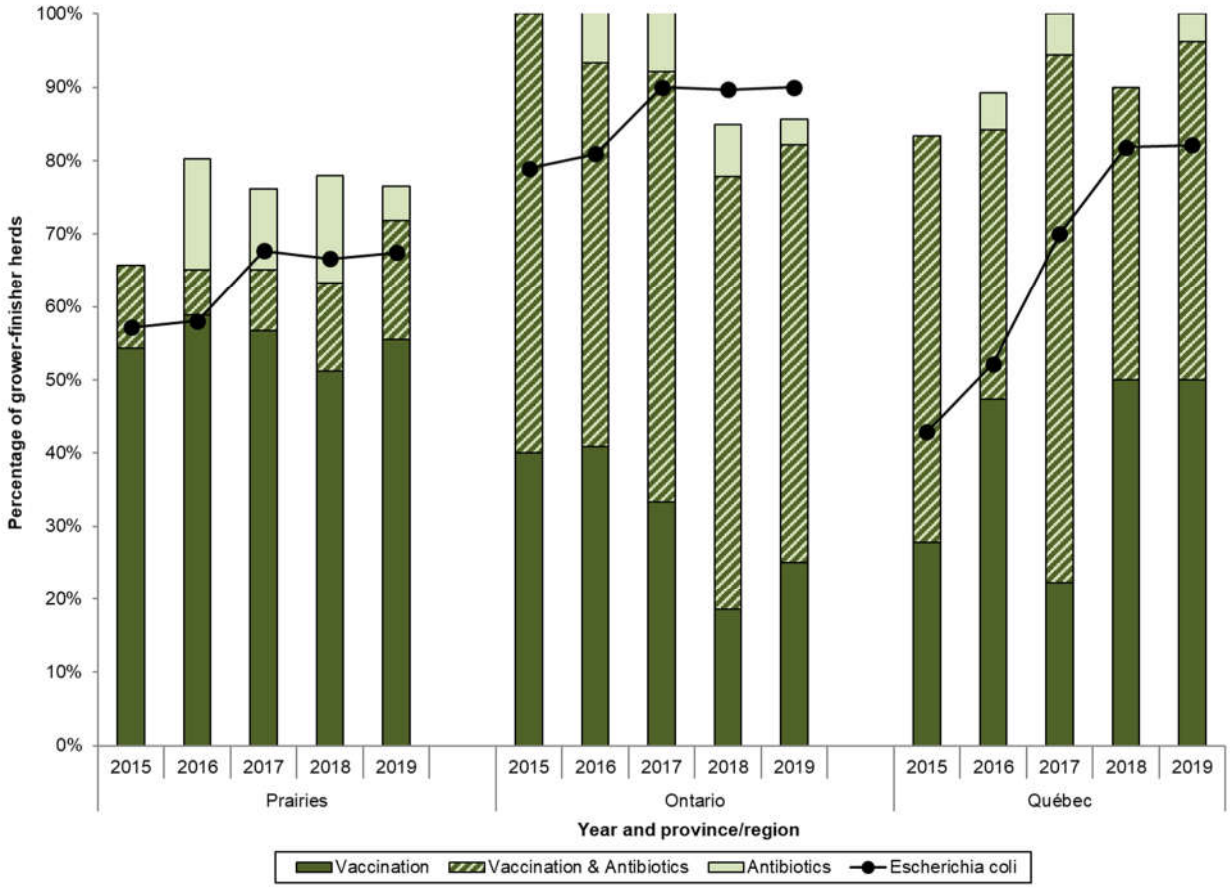
b) Viral diseases



APP = *Actinobacillus pleuropneumoniae.* PCVAD = Porcine Circovirus Associated Disease.
PED = Porcine Epidemic Diarrhea.
PRRS = Porcine Reproductive and Respiratory Syndrome.
Transmissible Gastroenteritis (TGE) was not included in the sow herd survey.
Not all questionnaires were completed for all diseases listed.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

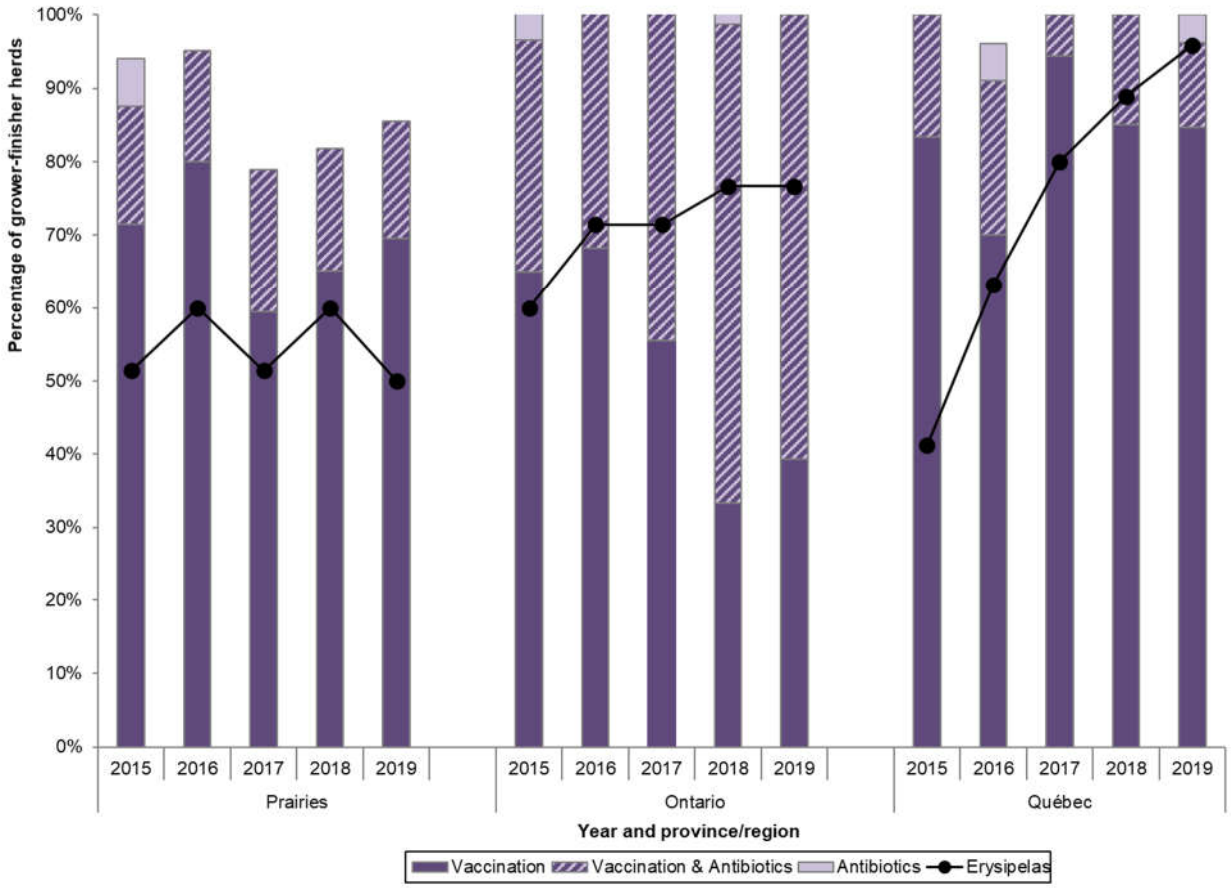
Figure 2.6 Reported health status of selected diseases of grower-finisher pig herds and the use of vaccines and antibiotics for their control, by province/region, 2015 to 2019

a) *Escherichia coli*



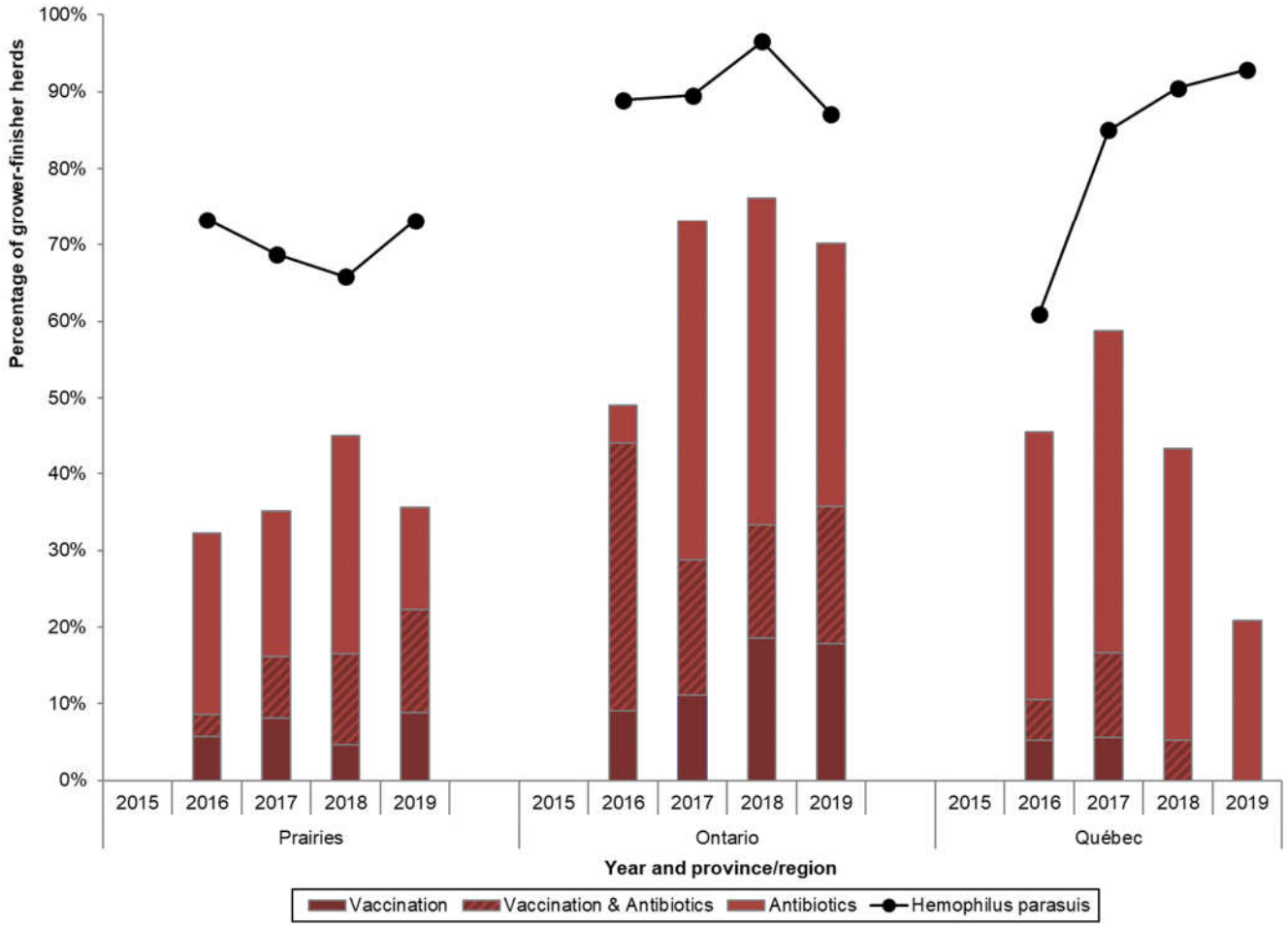
Health status of the finisher herd was considered to be positive if the questionnaire response was "confirmed positive" or "likely positive". Health status was considered to be negative if the questionnaire response was "confirmed negative" or "likely negative".
Vaccination and antibiotic use status was considered to be positive if the questionnaire response was positive for sow herds, nurseries or finisher herds.
Health status of nurseries and sow herds supplying CIPARS grower-finisher pig herds is available upon request.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

b) Erysipelas



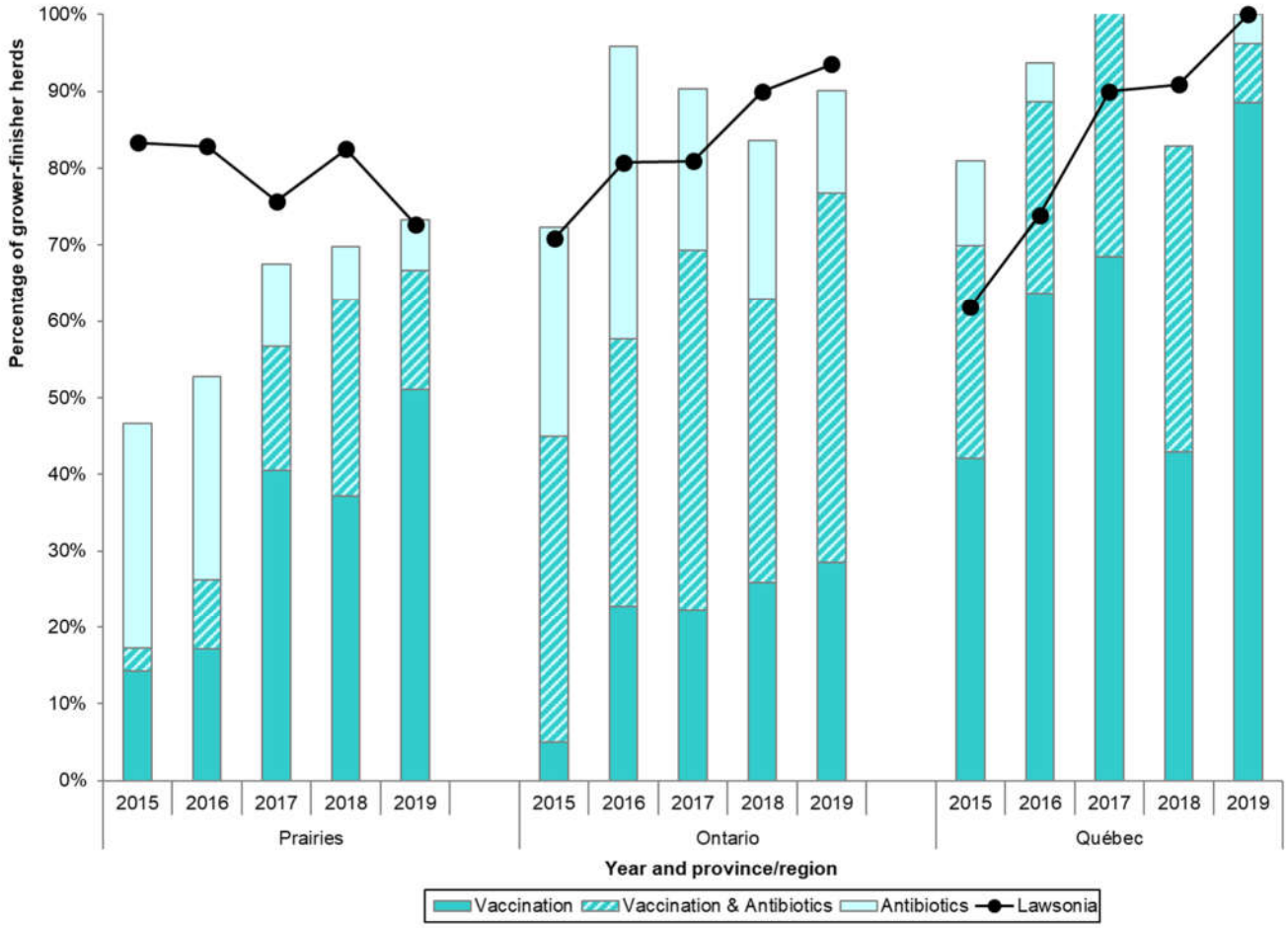
Health status of the finisher herd was considered to be positive if the questionnaire response was "confirmed positive" or "likely positive". Health status was considered to be negative if the questionnaire response was "confirmed negative" or "likely negative".
Vaccination and antibiotic use status was considered to be positive if the questionnaire response was positive for sow herds, nurseries or finisher herds.
Health status of nurseries and sow herds supplying CIPARS grower-finisher pig herds is available upon request.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

c) *Hemophilus parasuis*



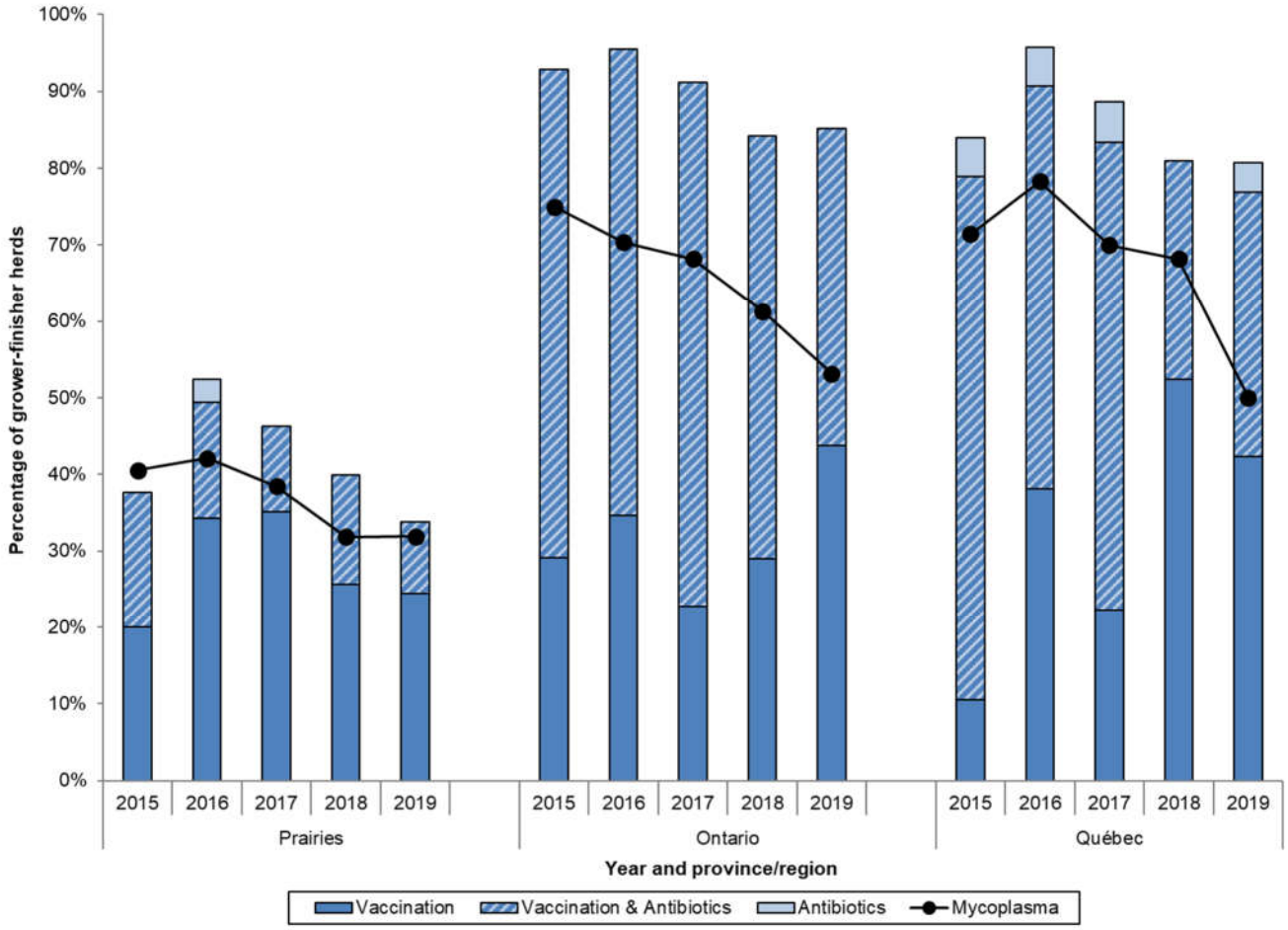
Health status of the finisher herd was considered to be positive if the questionnaire response was "confirmed positive" or "likely positive". Health status was considered to be negative if the questionnaire response was "confirmed negative" or "likely negative".
Vaccination and antibiotic use status was considered to be positive if the questionnaire response was positive for sow herds, nurseries or finisher herds.
Health status of nurseries and sow herds supplying CIPARS grower-finisher pig herds is available upon request.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

d) *Lawsonia*



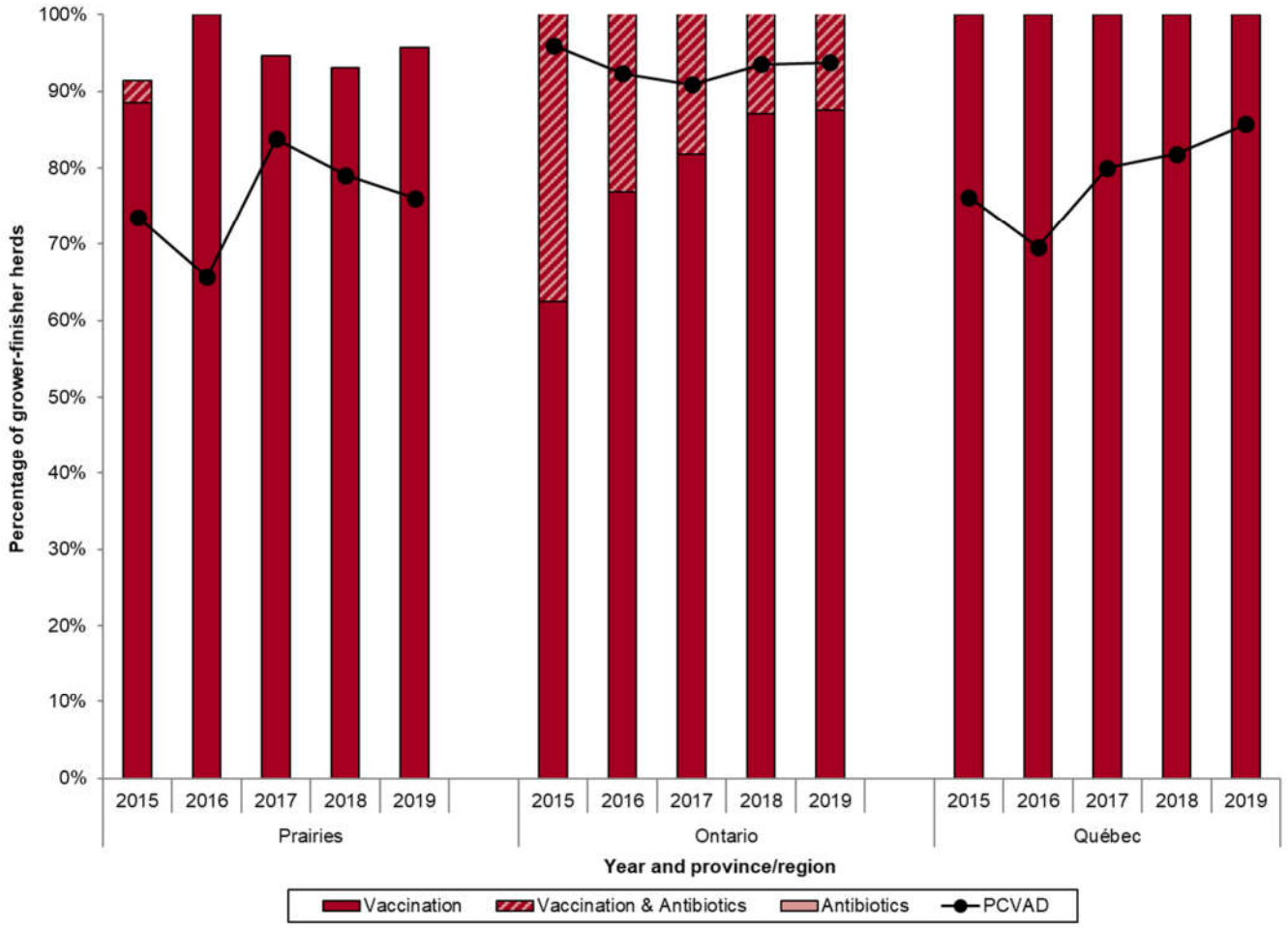
Health status of the finisher herd was considered to be positive if the questionnaire response was "confirmed positive" or "likely positive". Health status was considered to be negative if the questionnaire response was "confirmed negative" or "likely negative".
Vaccination and antibiotic use status was considered to be positive if the questionnaire response was positive for sow herds, nurseries or finisher herds.
Health status of nurseries and sow herds supplying CIPARS grower-finisher pig herds is available upon request.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

e) *Mycoplasma*



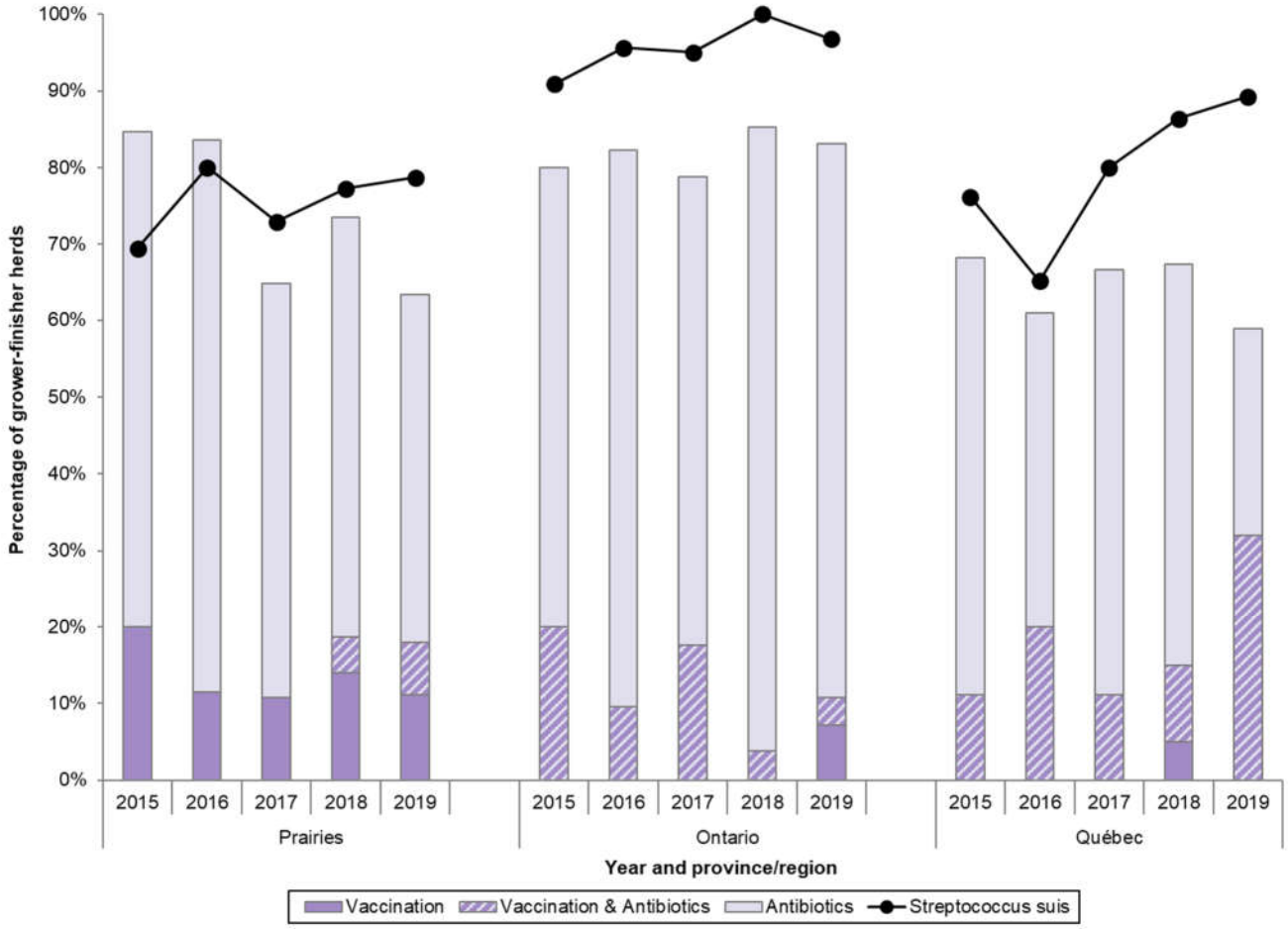
Health status of the finisher herd was considered to be positive if the questionnaire response was "confirmed positive" or "likely positive". Health status was considered to be negative if the questionnaire response was "confirmed negative" or "likely negative".
Vaccination and antibiotic use status was considered to be positive if the questionnaire response was positive for sow herds, nurseries or finisher herds.
Health status of nurseries and sow herds supplying CIPARS grower-finisher pig herds is available upon request.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

f) Porcine Circovirus Associated Disease



PCVAD = Porcine Circovirus Associated Disease.
Health status of the finisher herd was considered to be positive if the questionnaire response was "confirmed positive" or "likely positive". Health status was considered to be negative if the questionnaire response was "confirmed negative" or "likely negative".
Vaccination and antibiotic use status was considered to be positive if the questionnaire response was positive for sow herds, nurseries or finisher herds.
Health status of nurseries and sow herds supplying CIPARS grower-finisher pig herds is available upon request.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

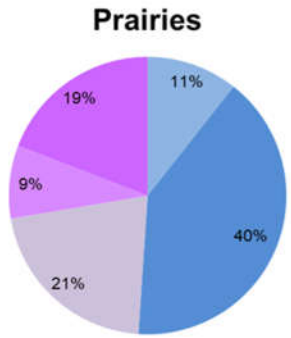
g) *Streptococcus suis*

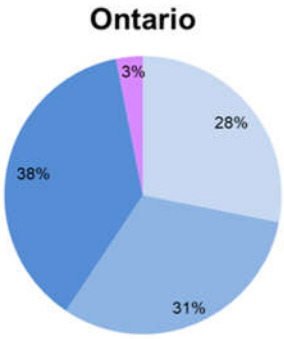


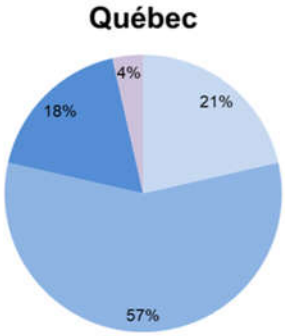
Health status of the finisher herd was considered to be positive if the questionnaire response was "confirmed positive" or "likely positive". Health status was considered to be negative if the questionnaire response was "confirmed negative" or "likely negative".
Vaccination and antibiotic use status was considered to be positive if the questionnaire response was positive for sow herds, nurseries or finisher herds.
Health status of nurseries and sow herds supplying CIPARS grower-finisher pig herds is available upon request.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 2.7 Demographics of grower-finisher pig herds by province/region (n = 107), 2019

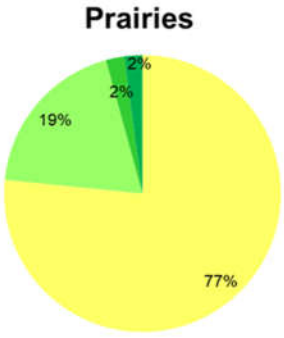
a) Barn capacity

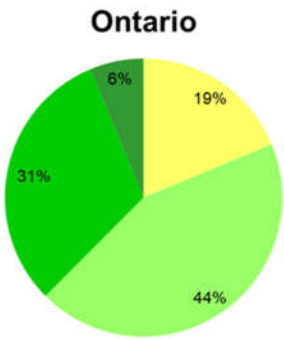


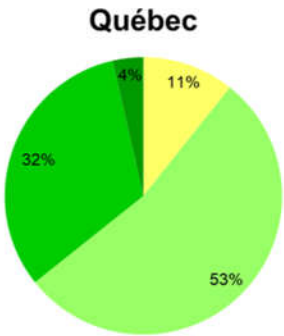




b) Number of swine farms within 2 km







	<1000 pigs
	1000 to 1999 pigs
	2000 to 2999 pigs
	3000 to 3999 pigs
	4000 to 4999 pigs
	>5000 pigs

	0 swine farms
	1 to 3 swine farms
	4 to 6 swine farms
	7 to 10 swine farms
	>10 swine farms

Capacity indicates the maximum number of pigs that the barn is designed to house.
Participating herds may have additional barns that were not sampled for the CIPARS program therefore this barn capacity is not necessarily equivalent to grower-finisher herd size.

Chapter 3: Antimicrobial use

How to read this chapter

This chapter highlights the most notable antimicrobial use (AMU) findings in grower-finisher pigs. Data are presented as antimicrobial active ingredient (summary table and frequency figures by route of administration) and antimicrobial class (quantitative AMU indicators).

Terms and definitions that apply to this chapter

- **Metric:** also known as technical unit of measurement[1]; 3 different AMU metrics are used throughout this chapter including 1) frequency of use (counts of herds), 2) milligrams of antimicrobials consumed by the herds and, 3) number (n) of defined daily doses in animals (DDDvet) using Canadian (CA) standards (nDDDvetCA).

- **Indicator:** is defined as "a metric quantifying use of antimicrobials, usually expressed in relation to a denominator representing the population (at risk)"[2,3].

- **Dose:** is the recommended or veterinarian-prescribed milligrams of active ingredient administered per kilogram of the animal treated; dose information is indicated in the product label and are available from 2 Canadian references[4,5] or expert opinion[6].

- **Defined Daily Dose in animals (DDDvet) using Canadian (CA) standards (DDDvetCA):** the DDDvetCA standard is the average of all unique treatment and prevention label doses in milligrams per kg animal per day (unit: mg/kg per day). These are assigned by species. The DDDvetCA standards are listed in the Appendix. These were developed using an approach similar to ESVAC's DDDvet assignment with some

[1] Collineau L, Belloc C, Stärk KD, Hémonic A, Postma M, Dewulf J, and Chauvin C. 2017. Guidance on the Selection of Appropriate Indicators for Quantification of Antimicrobial Use in Humans and Animals. Zoonoses Public Health, 64: 165-184.

[2] Collineau L, Belloc C, Stärk KD, Hémonic A, Postma M, Dewulf J, and Chauvin C. 2017. Guidance on the Selection of Appropriate Indicators for Quantification of Antimicrobial Use in Humans and Animals. Zoonoses Public Health, 64: 165-184.

[3] AACTING Consortium. Guidelines for collection, analysis and reporting of farm-level antimicrobial use, in the scope of antimicrobial stewardship. VERSION 1_2018-03-21. Available at: http://www.aacting.org/guidelines/. Accessed March 26, 2018.

[4] Compendium of Veterinary Products. Available at: https://bam.cvpservice.com/. Accessed March 26, 2018.

[5] Compendium of Medicating Ingredients Brochure. Available: http://www.inspection.gc.ca/animals/feeds/medicating-ingredients/eng/1300212600464/1320602461227. Accessed March 26, 2018.

[6] Canadian Association of Poultry Veterinarians. CgFARAD. Available at: https://www.capv-acva.ca/cgfarad. Accessed March 26, 2018

exceptions[7]. Details of the development of the standardscan be found in CIPARS Design and Methods 2018[8].

- **Number of Defined Daily Doses in animals using Canadian standards (nDDDvetCA):** is the total milligrams consumed by the flock/herd adjusted by the DDDvetCA standard. This metric is used in the dose-based indicator presented in this report, the nDDDvetCA/1,000 animal-days at risk.

- **Population correction unit (PCU):** also known as animal biomass, is the total of all animals in the surveyed flock/herd (minus half of the mortality rate at the time of sampling) adjusted by the ESVAC standard body weight (e.g., 1 kg for broilers, 6.5 kg for turkeys, and 65 kg for grower-finisher pigs). For the national distribution data, this pertains to the number of livestock and/or slaughtered animals in each species/production stage adjusted by the ESVAC and Canadian standard body weight.

- **Animal-days at risk:** also known as "standard-animals at risk"[9], is a denominator that accounts for the inter-species variations in live animal biomass and duration of the grow-out or observation period[10]. The "animal" component was calculated as above (i.e., total animals in the surveyed flock/herd minus half the mortality rate at the time of sampling multiplied by the ESVAC standard body weight) adjusted by the average days at risk or lifespan of the animal (e.g., broiler chickens = 34 days, grower-finisher pigs = 114 days, turkeys = 90 days). The average days at risk vary from year to year due to changes in production practices and other factors (e.g., diseases, genetics).

[7] ESVAC. Principles on assignment of defined daily dose for animals (DDDvet) and defined course dose for animals (DCDvet). Available at: http://www.ema.europa.eu/docs/en_GB/document_library/Scientific_guideline/2015/06/WC500188890.pdf.

[8] CIPARS 2018: Design and Methods. Available at: https://www.canada.ca/en/public-health/services/surveillance/canadian-integrated-program-antimicrobial-resistance-surveillance-cipars/cipars-reports/2018-annual-report-design-methods.html.

[9] DANMAP. DANMAP 2016. Use of antimicrobial agents and occurrence of antimicrobial resistance in bacteria from food animals, food and humans in Denmark. Available at: https://www.danmap.org/~/media/Projekt%20sites/Danmap/DANMAP%20reports/DANMAP%20%202015/DANMAP%202015.ashx. Accessed March 2018.

[10] DANMAP. DANMAP 2016. Use of antimicrobial agents and occurrence of antimicrobial resistance in bacteria from food animals, food and humans in Denmark. Available at: https://www.danmap.org/~/media/Projekt%20sites/Danmap/DANMAP%20reports/DANMAP%20%202015/DANMAP%202015.ashx. Accessed March 2018.

Table 3.1 Antimicrobial technical units of measurement and indicators

Indicator	Numerator	Denominator
Frequency of use	Number of herds exposed	Total herds sampled
$Percentage\ of\ herds\ exposed/treated = \frac{Number\ of\ herds\ exposed}{total\ herds\ sampled}\ x\ 100$		
Frequency of medicated rations	Number of medicated (or unmedicated rations)	Total number of rations
$Percentage\ of\ rations\ medicated = \frac{Number\ of\ rations\ medicated}{total\ rations\ fed}\ x\ 100$		
milligrams/population correction unit (mg/PCU)	Total quantity of antimicrobials used by the surveyed animals for one grow-out period in mg	Population correction unit or biomass: total population minus half of the mortality rate, adjusted by the standard weight of pig
$mg/PCU = \frac{Feed\ (mg) + Water\ (mg) + Injection\ (mg)}{PCU\ (total\ animals\ x\ standard\ weight\ in\ kg)}\ x\ 100$		
Number of Canadian defined daily doses per 1,000 pig-days at risk (nDDDvetCA/1,000 pig-days at risk)	Total quantity of antimicrobials used by the surveyed animals for one grow-out period in mg adjusted by the Canadian defined daily dose standards (mg/DDDvetCA$_{mg/kg/day}$)	Animal time-at-risk: Total number of animals minus half of the mortality rate, multiplied by the standard weight of pig and the average days at risk
$nDDDvetCA/1{,}000\ pig-days\ at\ risk = \frac{Total\ milligrams/DDDvetCA_{mg/kg/day}}{Total\ animals\ x\ standard\ weight\ in\ kg\ x\ average\ days\ at\ risk}\ x\ 1{,}000$		

For more details consult the CIPARS 2018: Design and Methods[11].

[11] Available at: https://www.canada.ca/en/public-health/services/surveillance/canadian-integrated-program-antimicrobial-resistance-surveillance-cipars/cipars-reports/2018-annual-report-design-methods.html.

Key findings

The majority of antimicrobial exposure in grower-finisher swine was through feed (90%) followed by water (9%) and administrations by injection (< 1%), on a quantitative basis (DDDvetCA/1000 pig-days).

Antimicrobial use frequency (Number of herds)

Feed

Trends in the frequency of antimicrobial use in feed are decreasing with significant decreases in the use of chlortetracycline and tylosin, over the period 2010 to 2019. Over the same period, the number of herds reporting no antimicrobial use in feed increased significantly to over 40% of herds.

The percentage of pigs exposed to medicated feed was generally 100%.

A notable finding was a general decrease in the number of rations medicated across all herds nationally, with Québec showing the steepest decline from 75% in 2015 down to 35% of rations in 2019.

The frequency of salinomycin was stable at 21%, and was used primarily in Québec.

The frequency of narasin use was also stable at 9% since its emergence in 2014.

Water

The reporting frequency of no antimicrobial use in water was stable at approximately 80% of herds nationally.

In Québec, the significant increase in the reporting of no antimicrobial use in water was due in large part to significant decreases in penicillin and trimethoprim-sulfadiazine use since 2014. Over the same period, an increasing frequency in the number of herds reporting the use of tylvalosin in the Prairie region and Québec was noted.

When used, the percentage of pigs exposed to medicated water was also generally 100%.

Injection

The increasing trend towards no antimicrobial use by injection has stabilized since 2017 at approximately 50% of herds. This trend was mirrored by significant decreases in the frequency of penicillin and ceftiofur injections.

There was a significant increase in the frequency of the administration of florfenicol by injection from 6% of herds in 2010 to 15% in 2019.

Regionally there were many significant differences in the administration of antimicrobials by injection. In Québec, there was a significant decrease in the use of ceftiofur with increases in the use of penicillin and florfenicol by injection. The reporting of no antimicrobial use by injection was significantly higher in Prairie (55%) and Ontario herds (69%) compared to Québec (29%).

Over 2017 to 2019, when antimicrobials were administered by injection, the median exposure was 2% of pigs, with a maximum of 30%.

Antimicrobial use quantity (Weight and dose based indicators)

Feed

Compared to 2015 the percentage change in the number of defined daily doses (DDDvetCA/1000 pig-days at risk) administered through feed was in the range of -28% to -48% nationally, indicating decreasing trends in the quantity of antimicrobial use in feed.

The main quantity of antimicrobials administered in feed were from the use of the tylosin (76 DDDvetCA/1000 pig-days), lincomycin (24 DDDvetCA/1000 pig-days) and chlortetracycline (35 DDDvetCA/1000 pig-days).

The quantity of tylosin (macrolide) increased from 47 DDDvetCA/1000 pig-days in 2018, due mainly to increases in the amounts used in Ontario and Prairie herds.

Québec continued to see decreasing trends in the quantities of antimicrobial use in feed with notable decreases in the amounts of lincomycin and tylosin use.

Water

The quantity of antimicrobial use in water increased from 6.8 DDDvetCA/1000 pig-days in 2018 to 15.3 in 2019. This was due to a doubling in the amounts of tylvalosin, penicillin and trimethoprim-sulfadiazine, and increased tetracycline use in 2019 compared to 2017 and 2018.

Prairie herds used the greatest quantity of tylvalosin and tetracycline in water at 6.8 and 6.1 DDDvetCA/1000 pig-days, respectively.

Québec herds were the only users of trimethoprim-sulfadiazine in water reporting an increased amount in 2019 of 6.6 DDDvetCA/1000 pig-days.

Relative to the quantities reported for feed, antimicrobial use in water was moderately low overall.

Injection

The quantities of antimicrobial use by injection were fractional with an overall amount of 0.94 DDDvetCA/1000 pig days.

The only Category I antimicrobial use in grower-finisher pigs was ceftiofur, which decreased to 0.5 DDDvetCA/1000 pig-days in 2019, due in part to new legislation in 2019 in Québec limiting the use of Category I antimicrobials.

Québec herds reported the use of higher quantities of antimicrobial by injection (0.99 DDDvetCA/1000 pig-days) relative to Prairie (0.44 DDDvetCA/1000 pig-days) and Ontario (0.71 DDDvetCA/1000 pig-days) herds, primarily due to the increased use of penicillin and florfenicol in 2019.

Reasons for Antimicrobial Use

Legislative changes in December 2018 moved all medically important antimicrobials (MIAs) to prescription-only status, removed growth promotion claims from MIA drug labels, and stated that the use of MIAs in food-producing animals should only be for the treatment or prevention of diseases. With this, the proportion of use ascribed to preventative use has increased from 50% of the overall quantity in feed in 2015 to 74% of the aggregated quantity in 2019.

The proportion of the total amount, aggregated over all 3 routes of administration, reported for treatment purposes was 13% in 2019.

There was a small amount of growth promotant use reported by Prairie and Québec herds in 2019.

Summary of antimicrobials used in grower-finisher pigs

Table 3.2 Frequency and quantity of antimicrobial use (in feed, water, and by injection) in grower-finisher pigs, 2019

Route of administration	Antimicrobial	Herds n (%) Total = 107	Rations or treatments n (%) *Total = 466	Days exposed[a] Median (min. ; max.)	Percent of herd exposed Median (min. ; max.)	Weight (kg) at exposure Median[b] (min. ; max.)[c]	Level of drug Median (min. ; max.)	Quantity of antimicrobial active ingredient[e] mg/PCU	 nDDDvetCA / 1,000 GF pig-days at risk
Feed							g/tonne		
	Lincomycin	20 (19)	35 (28)	21 (3 ; 63)	100 (50 ; 100)	70 (25 ; 130)	44 (40 ; 220)	14	24
	Lincomycin-spectinomycin	0 (0)	(0)	0 (0 ; 0)	0 (0 ; 0)	0 (0 ; 0)	0 (0 ; 0)	0	0
	Penicillin-chlortetracycline-sulfamethazine	2 (2)	2 (2)	20.5 (6 ; 35)	100 (100 ; 100)	41 (23 ; 59)			
	Penicillin						55 (55 ; 55)	1	6
	Chlortetracycline						110 (110 ; 110)	2	1
II	Sulfamethazine						110 (110 ; 110)	2	3
	Penicillin	1 (1)	1 (1)	14 (14 ; 14)	100 (100 ; 100)	35 (30 ; 40)	99 (99 ; 99)	0	0
	Tilmicosin	0 (0)	(0)	0 (0 ; 0)	0 (0 ; 0)	0 (0 ; 0)	0 (0 ; 0)	0	0
	Tylosin	14 (13)	29 (24)	24.5 (3 ; 49)	100 (100 ; 100)	70 (23 ; 135)	44 (22 ; 390)	23	64
	Tylvalosin	5 (5)	9 (7)	21 (14 ; 28)	100 (100 ; 100)	55 (18 ; 135)	43 (43 ; 111)	3	13
	Virginiamycin	1 (1)	3 (2)	21 (21 ; 70)	100 (100 ; 100)	45 (27 ; 122)	11 (11 ; 11)	1	1
	Bacitracin	0 (0)	(0)	0 (0 ; 0)	0 (0 ; 0)	0 (0 ; 0)	0 (0 ; 0)	0	0
	Chlortetracycline	14 (13)	21 (17)	17.5 (3 ; 49)	100 (50 ; 100)	38 (18 ; 94)	330 (100 ; 1210)	38	31
III	Oxytetracycline	1 (1)	1 (1)	9.1 (9.1 ; 9.1)	100 (100 ; 100)	38 (25 ; 51)	440 (440 ; 440)	2	4
	Spectinomycin	0 (0)	(0)	0 (0 ; 0)	0 (0 ; 0)	0 (0 ; 0)	0 (0 ; 0)	0	0
	Sulfamethazine	0 (0)	(0)	0 (0 ; 0)	0 (0 ; 0)	0 (0 ; 0)	0 (0 ; 0)	0	0
IV	Bambermycin	1 (1)	4 (3)	31.5 (21 ; 42)	100 (100 ; 100)	68 (25 ; 135)	2 (2 ; 2)	0.1	9.1
UC	Tiamulin	6 (6)	14 (11)	21 (14 ; 35)	100 (100 ; 100)	46 (25 ; 90)	31 (22 ; 39)	6	9
AMU in feed		**62 (58)**	**123 (26)**	**21 (3 ; 70)**	**100 (50 ; 100)**	**53 (18 ; 135)**		**89**	**164**
No antimicrobial use in feed		45 (42)	231 (50)	28 (11 ; 98)	100 (50 ; 100)	78 (16 ; 140)		0	0
Ionophores									
IV	Narasin	10 (9)	37 (8)	28 (14 ; 126)	100 (50 ; 100)	75 (20 ; 136)	15 (11 ; 150)	11	
	Salinomycin	22 (21)	75 (16)	32 (10 ; 70)	100 (50 ; 100)	72 (20 ; 145)	25 (25 ; 60)	23	
Total		**32 (30)**	**112 (24)**	**28 (10 ; 126)**	**100 (50 ; 100)**	**72 (20 ; 145)**		**34**	
Water							mg/kg body weight/day		
	Amoxicillin	5 (5)	6 (17)	5 (4 ; 5)	100 (64 ; 100)	44 (28 ; 80)	17 (14 ; 23)	4	2
	Lincomycin	2 (2)	2 (6)	5 (5 ; 5)	100 (100 ; 100)	43 (30 ; 55)	7 (4 ; 10)	0.2	0.4
II	Penicillin	7 (7)	7 (19)	5 (5 ; 10)	100 (100 ; 100)	35 (26 ; 91)	18 (3 ; 54)	3	2
	Trimethoprim-sulfadiazine	3 (3)	5 (14)	5 (5 ; 6)	100 (100 ; 100)	34 (24 ; 35)	20 (17 ; 42)	4	2
	Tylvalosin	8 (7)	10 (28)	7 (3 ; 14)	100 (24 ; 100)	51 (35 ; 85)	5 (1 ; 15)	3	5
III	Tetracycline	5 (5)	5 (14)	5 (5 ; 7)	100 (64 ; 100)	35 (35 ; 45)	23 (15 ; 31)	4	4
UC	Tiamulin	1 (1)	1 (3)	5 (5 ; 5)	50 (50 ; 50)	50 (50 ; 50)		0.02	0.04
AMU in water		**23 (21)**	**36 (100)**	**5 (3 ; 14)**	**100 (24 ; 100)**	**37 (24 ; 91)**		**19**	**15**
No antimicrobial use in water		84 (79)							
Injection							mg/kg body weight/day		
I	Ceftiofur	12 (11)	17 (12)	1 (1 ; 3)	1 (0.1 ; 4.5)	59 (22 ; 115)	3 (2 ; 5)	0.017	0.057
	Ampicillin	6 (6)	6 (4)	3 (2 ; 3)	1.5 (1 ; 2)	69 (26 ; 100)	5.9 (5.9 ; 8)	0.010	0.015
	Lincomycin	14 (13)	20 (14)	3 (1 ; 4)	1.3 (0.1 ; 20)	55 (27 ; 110)	10 (3.8 ; 10.7)	0.175	0.153
II	Penicillin	30 (28)	44 (31)	3 (1 ; 10)	1.8 (0.1 ; 5)	42 (25 ; 70)	20 (2 ; 60)	0.222	0.390
	Trimethoprim-sulfadoxine	8 (7)	8 (6)	3 (2 ; 3)	2 (0.2 ; 5)	48 (25 ; 82)	15 (15 ; 15)	0.067	0.077
	Tulathromycin	14 (13)	14 (10)	1 (1 ; 2)	1.2 (0.2 ; 10)	46 (25 ; 75)	2.5 (2.5 ; 2.6)	0.010	0.125
	Tylosin	2 (2)	2 (1)	2.5 (2 ; 3)	5 (5 ; 5)	58 (55 ; 60)	11 (10 ; 12)	0.107	0.015
III	Florfenicol	16 (15)	18 (13)	2 (1 ; 3)	3.3 (0.3 ; 11)	48 (25 ; 85)	15 (11 ; 18.5)	0.023	0.124
	Oxytetracycline	2 (2)	2 (1)	1.5 (1 ; 2)	5 (5 ; 5)	36 (32.5 ; 40)	20 (20 ; 20)	0.017	0.035
UC	Tiamulin	1 (1)	1 (1)	1 (1 ; 1)	10 (10 ; 10)	60 (60 ; 60)	12 (12 ; 12)	0.652	0.013
AMU by injection		**49 (46)**	**140 (100)**	**2 (1 ; 10)**	**2 (0.1 ; 20)**	**49 (22 ; 115)**	**12 (2 ; 60)**	**0.643**	**1.004**
No antimicrobial use by injection		56 (52)							

See notes on following page.

Table 3.2 Frequency and quantity of antimicrobial use (in feed, water, and by injection) in grower-finisher pigs, 2019 (continued)

Roman numerals I to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
Grey shaded cells = no data or calculations/values are not applicable for grower-finisher pigs.
mg/PCU = milligrams/population correction unit.
UC = tiamulin is a medically important but uncategorized (UC) antimicrobial.
DDDvetCA = Canadian Defined Daily Doses for animals (average labelled dose) in milligrams per kilogram grower-finisher pig weight per day (mg_{drug}/kg_{animal}/day); please refer to Appendix: Supplemental data of the CIPARS 2018: Design and Methods, Table A. 2 for the list of standards.
nDDDvetCA/1,000 GF pig-days at risk = number of DDDvetCA/1,000 grower-finisher pig-days at risk.
For detailed indicator descriptions, please refer to Table 3.1.
[a] Ration days exposed = for rations medicated with the specific antimicrobial and do not reflect the full grow-out period.
[b] Median weight (kg) at exposure = the median of all average weights of pigs exposed to a ration containing a specific antimicrobial [(Ration Start Weight + Ration End Weight)/2].
[c] Minimum (min.) and maximum (max.) pig weight at exposure = the lowest start weight and the highest end weight reported for all rations containing the specific antimicrobial, respectively.
[d] Level of drug is in grams/tonne of feed.
[e] Quantitative antimicrobial consumption estimates were calculated using reported ration days fed and predicted feed intake[12], adjusted for herd average daily gain; only rations medicated with the specific antimicrobial were included in this analysis; the final mg/PCU and nDDDvetCA/1,000 GF pig-days at risk exclude coccidiostats and pyrimethamine. Bambermycin was included only in the mg/PCU.

[12] National Research Council. 2012. Nutrient Requirements of Swine, Eleventh Edition. Washington, DC: National Academy Press.

Table 3.3 Quantitative summary of antimicrobial use, by all routes of administration, in grower-finisher pigs by province/region, 2015 to 2019

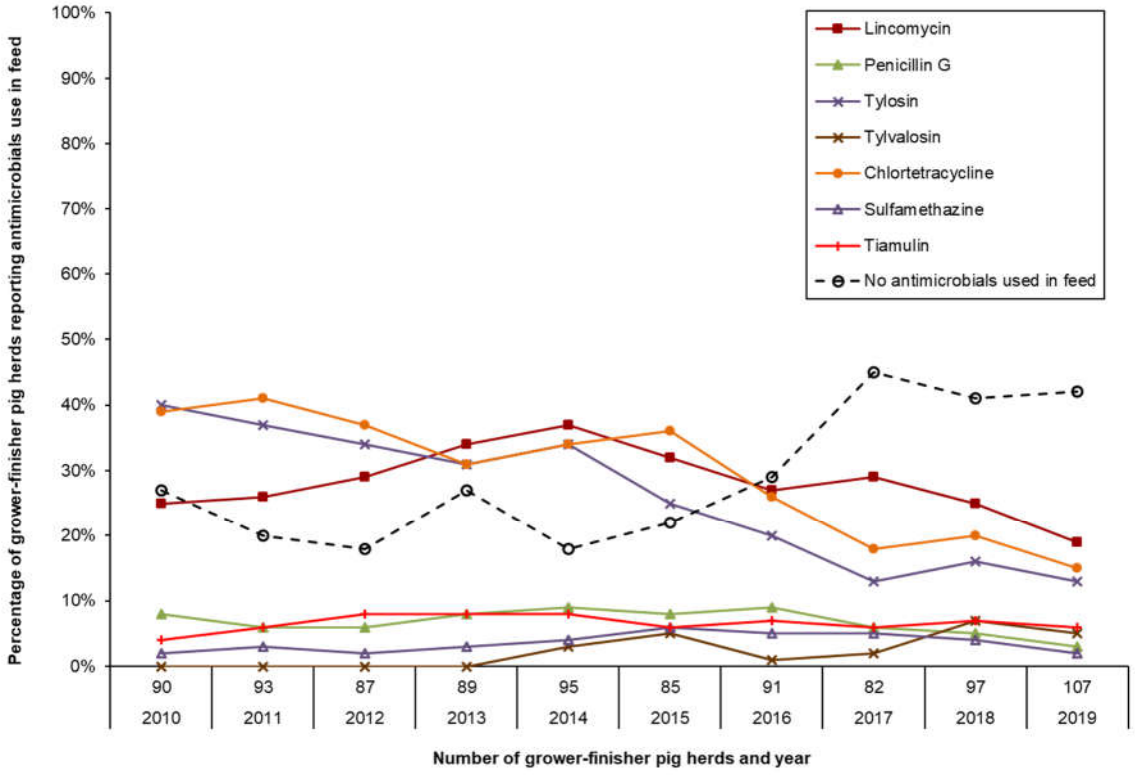
Province/ region	Year	Number of herds	Average weight at exposure Median (min ; max)			Average grow-finish period	Active ingredient[a]	Grower-finisher pig weights[b]	mg/PCU		nDDDvetCA / 1,000 GF pig-days at risk	
		n (%)	Feed	Water	Injection	(Days)	(mg)	(kg)	Total	% change[c]	Total	% change[c]
Prairies	2015	39 (46)	70 (25 ; 121)			111	854,877,885	5,493,810	156		268	
	2016	40 (44)	69 (28 ; 136)			112	548,609,650	5,438,142	101	-35	217	-19
	2017	40 (49)	68 (23 ; 215)	30 (21 ; 65)	44 (20 ; 100)	111	597,016,065	5,359,508	111	10	185	-15
	2018	44 (45)	68 (28 ; 194)	43 (25 ; 110)	50 (25 ; 95)	112	782,080,276	5,523,828	142	27	199	7
	2019	47 (44)	70 (23 ; 125)	42 (35 ; 91)	53 (22 ; 110)	109	695,079,105	6,022,995	115	-18	198	-1
Ontario	2015	25 (29)	70 (27 ; 125)			114	454,971,382	2,306,070	197		325	
	2016	27 (30)	63 (28 ; 125)			114	298,836,760	2,422,905	123	-37	200	-39
	2017	22 (27)	70 (30 ; 125)	80 (80 ; 80)	45 (30 ; 150)	110	199,105,199	1,333,670	149	21	263	32
	2018	31 (32)	70 (30 ; 135)	35 (29 ; 50)	40 (30 ; 85)	112	248,788,752	2,152,361	116	-23	202	-23
	2019	32 (30)	71 (28 ; 165)	45 (28 ; 60)	50 (35 ; 75)	113	260,074,927	2,480,335	105	-9	205	1
Québec	2015	21 (25)	58 (22 ; 119)			115	393,836,556	1,864,200	211		268	
	2016	24 (26)	59 (25 ; 120)			117	262,132,293	1,744,568	150	-29	164	-39
	2017	20 (24)	63 (30 ; 123)	35 (25 ; 100)	43 (18 ; 120)	125	187,547,603	1,809,600	104	-31	148	-10
	2018	22 (23)	61 (30 ; 120)	45 (32 ; 80)	42 (25 ; 105)	121	204,453,093	2,052,375	100	-4	141	-5
	2019	28 (26)	58 (22 ; 120)	34 (24 ; 85)	47 (25 ; 115)	127	241,399,765	2,538,153	95	-5	95	-33
National[d]	2015	85 (18)	67 (22 ; 125)			113	1,703,685,823	9,664,080	176		281	
	2016	91 (20)	67 (25 ; 136)			114	1,109,578,703	9,605,614	116	-34	202	-28
	2017	82 (18)	68 (23 ; 215)	35 (21 ; 100)	45 (18 ; 150)	114	983,668,866	8,502,778	116	0	188	-7
	2018	97 (21)	68 (28 ; 194)	45 (25 ; 110)	45 (25 ; 105)	114	1,235,322,120	9,728,564	127	10	186	-1
	2019	107 (23)	68 (22 ; 165)	37 (24 ; 91)	49 (22 ; 115)	115	1,196,553,796	11,041,483	108	-15	172	-8

This analysis excludes the use of ionophore coccidiostats in feed.
mg/PCU = milligrams/population correction unit.
nDDDvetCA/1,000 GF pig-days at risk = Number of Canadian veterinary defined daily doses per 1,000 grower-finisher pig-days at risk.
For detailed indicator descriptions, please refer to Table 3.1.
The Prairies is a region and includes the provinces of Alberta, Saskatchewan, and Manitoba.
[a] Quantitative data were not available for water and injection in 2015-2016; quantitative data for these years are only for AMU in feed.
[b] Population correction unit (PCU) or biomass, European weight (total herd population x ESVAC standard pig weight of 65 kilograms).
[c] Percent change = [(current surveillance year – previous surveillance year)/previous surveillance year] x 100.
[d] Includes only the provinces/regions surveyed and includes only the quantity of ionophores used in feed, excluding other antimicrobials.

Antimicrobial use in feed

Frequency (Count based measures)

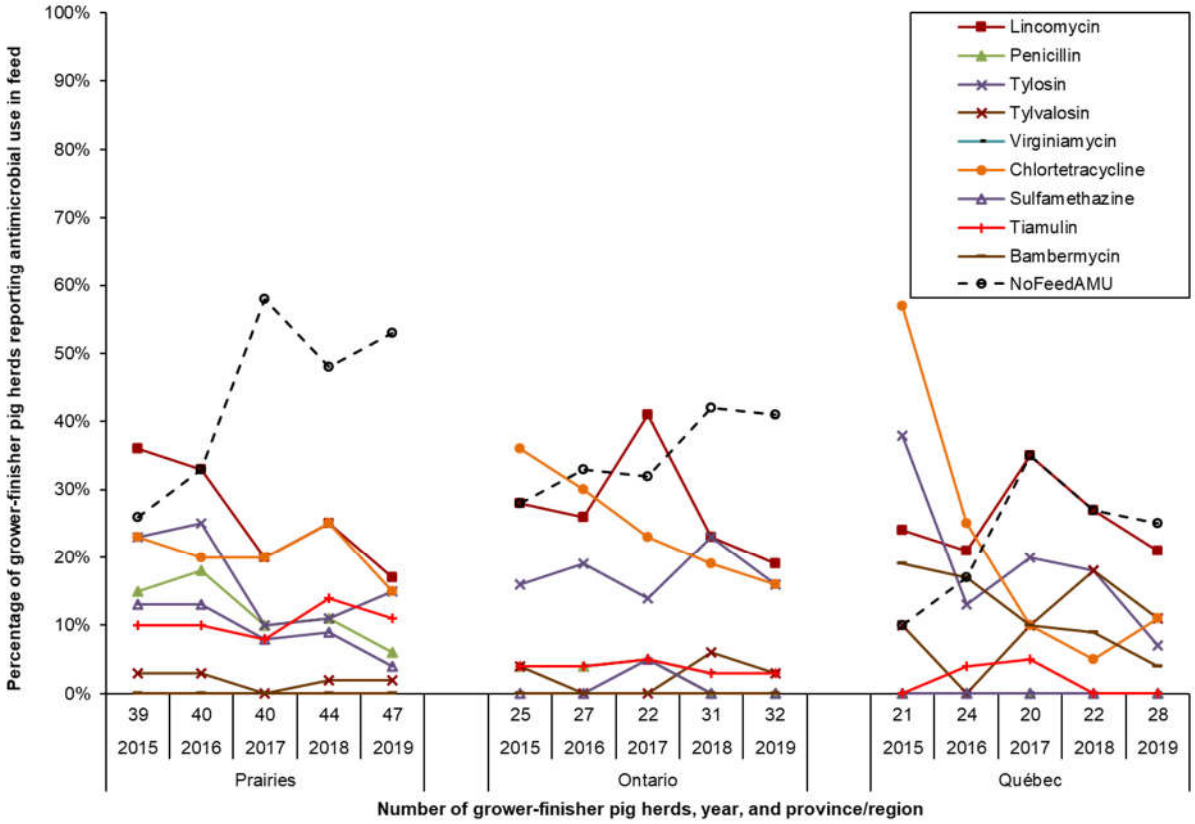
Figure 3.1 Percentage of grower-finisher pig herds reporting antimicrobial use in feed, 2010 to 2019



Year		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of herds		90	93	87	89	95	85	91	82	97	107
Antimicrobial											
II	Lincomycin	**25%**	26%	29%	34%	37%	32%	27%	29%	**25%**	**19%**
	Penicillin G	**8%**	6%	6%	8%	9%	8%	9%	6%	**5%**	**3%**
	Tylosin	**40%**	37%	34%	31%	34%	25%	20%	13%	**16%**	**13%**
	Tylvalosin	**0%**	0%	0%	0%	3%	5%	1%	2%	**7%**	**5%**
III	Chlortetracycline	**39%**	41%	37%	31%	34%	36%	26%	18%	**20%**	**15%**
	Sulfamethazine	**2%**	3%	2%	3%	4%	6%	5%	5%	**4%**	**2%**
UC	Tiamulin	**4%**	6%	8%	8%	8%	6%	7%	6%	**7%**	**6%**
	No antimicrobials used in feed	**27%**	20%	18%	27%	18%	22%	29%	45%	**41%**	**42%**

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = tiamulin is a medically important but uncategorized (UC) antimicrobial.
Only antimicrobials used by 5% of herds or more in a given year within any province/region are depicted in this figure. Antimicrobial use in feed reported by fewer than 5% of herds included Category II: tilmicosin, virginiamycin; Category III: bacitracin, neomycin, oxytetracycline, spectinomycin; Category IV: bambermycin.
"For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial in the first and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial."
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 3.2. Percentage of grower-finisher pig herds reporting antimicrobial use in feed, by province/region, 2015 to 2019



Province/region		Prairies					Ontario					Québec				
Year		2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Number of herds		39	40	40	44	47	25	27	22	31	32	21	24	20	22	28
Antimicrobial																
II	Lincomycin	**36%**	33%	20%	**25%**	**17%**	**28%**	26%	41%	**23%**	**19%**	**24%**	21%	35%	**27%**	**21%**
	Penicillin	**15%**	18%	10%	**11%**	**6%**	**4%**	4%	5%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**
	Tylosin	**23%**	25%	10%	**11%**	**15%**	**16%**	19%	14%	**23%**	**16%**	**38%**	13%	20%	**18%**	**7%**
	Tylvalosin	**3%**	3%	0%	**2%**	**2%**	**4%**	0%	0%	**6%**	**3%**	**10%**	0%	10%	**18%**	**11%**
	Virginiamycin	**0%**	0%	0%	**0%**	**0%**	**4%**	4%	5%	**3%**	**3%**	**0%**	0%	0%	**0%**	**0%**
III	Chlortetracycline	**23%**	20%	20%	**25%**	**15%**	**36%**	30%	23%	**19%**	**16%**	**57%**	25%	10%	**5%**	**11%**
	Sulfamethazine	**13%**	13%	8%	**9%**	**4%**	**0%**	0%	5%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**
IV	Bambermycin	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**	**19%**	17%	10%	**9%**	**4%**
UC	Tiamulin	**10%**	10%	8%	**14%**	**11%**	**4%**	4%	5%	**3%**	**3%**	**0%**	4%	5%	**0%**	**0%**
	No antimicrobials used in feed	**26%**	33%	58%	**48%**	**53%**	**28%**	33%	32%	**42%**	**41%**	**10%**	17%	35%	**27%**	**25%**

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = tiamulin is a medically important but uncategorized (UC) antimicrobial.
Only antimicrobials used by 5% of herds or more in a given year within any province/region are depicted in this figure. Antimicrobial use in feed reported by fewer than 5% of herds included Category II: tilmicosin, tylvalosin and virginiamycin; Category III: bacitracin, neomycin, oxytetracycline, and spectinomycin.
For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial during the previous 5 years and previous surveillance year (grey areas). The presence of blue areas indicates significant temporal differences within province/region ($P \leq 0.05$) for a given antimicrobial. The presence of red areas indicates significant provincial/regional differences ($P \leq 0.05$) for a given antimicrobial within the current year. The presence of purple areas (2019 surveillance year; Québec-referent province) indicates significant temporal and provincial/regional differences ($P \leq 0.05$) for a given antimicrobial.
The Prairies is a region and includes the provinces of Alberta, Saskatchewan, and Manitoba.

Quantity (Weight based measures)

Figure 3.3 Quantity of antimicrobial use in feed, excluding ionophores, adjusted for population and pig weight (mg/PCU), 2019

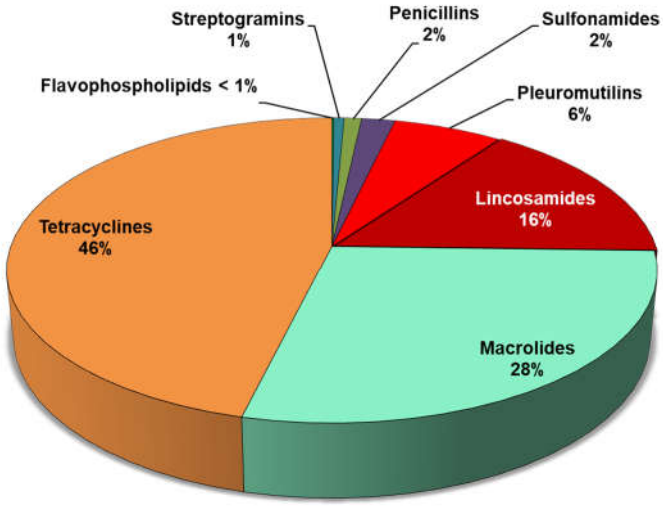


Figure 3.4 Quantity of antimicrobial use in feed, including ionophores, adjusted for population and pig weight (mg/PCU), 2019

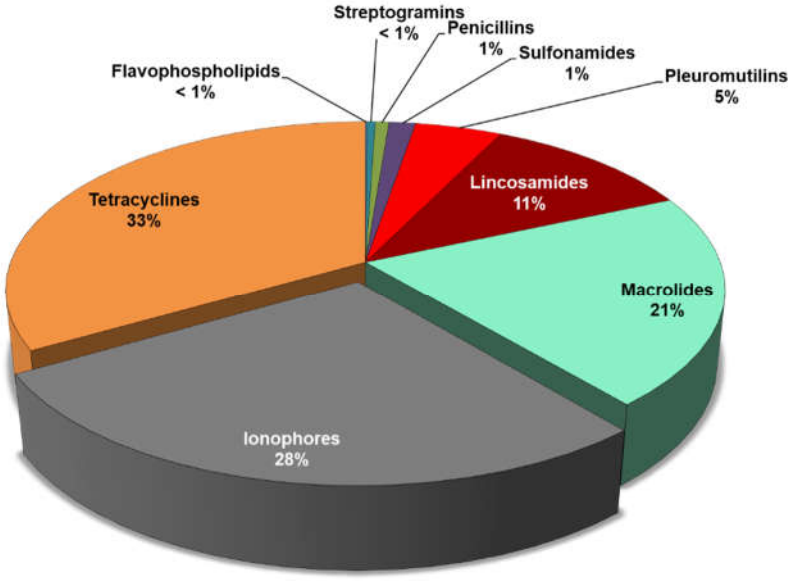
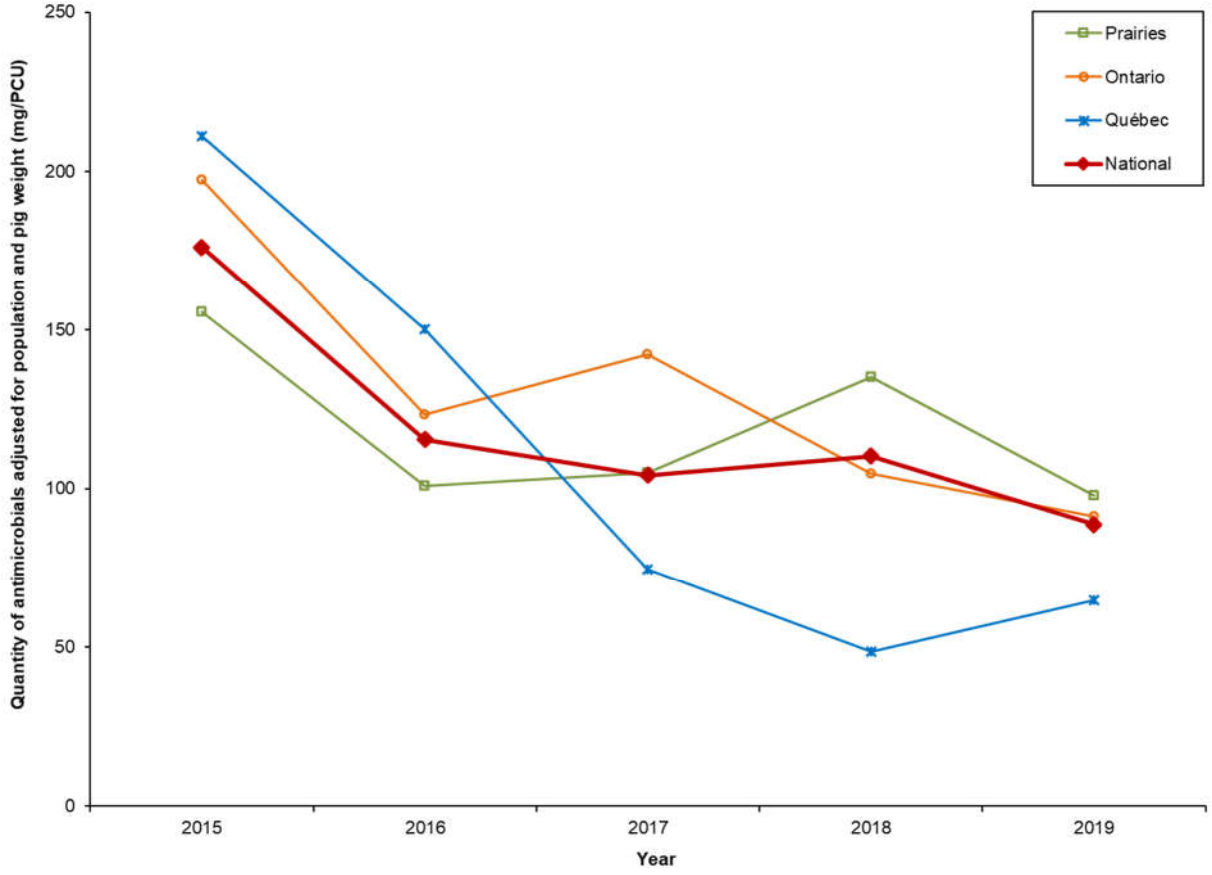


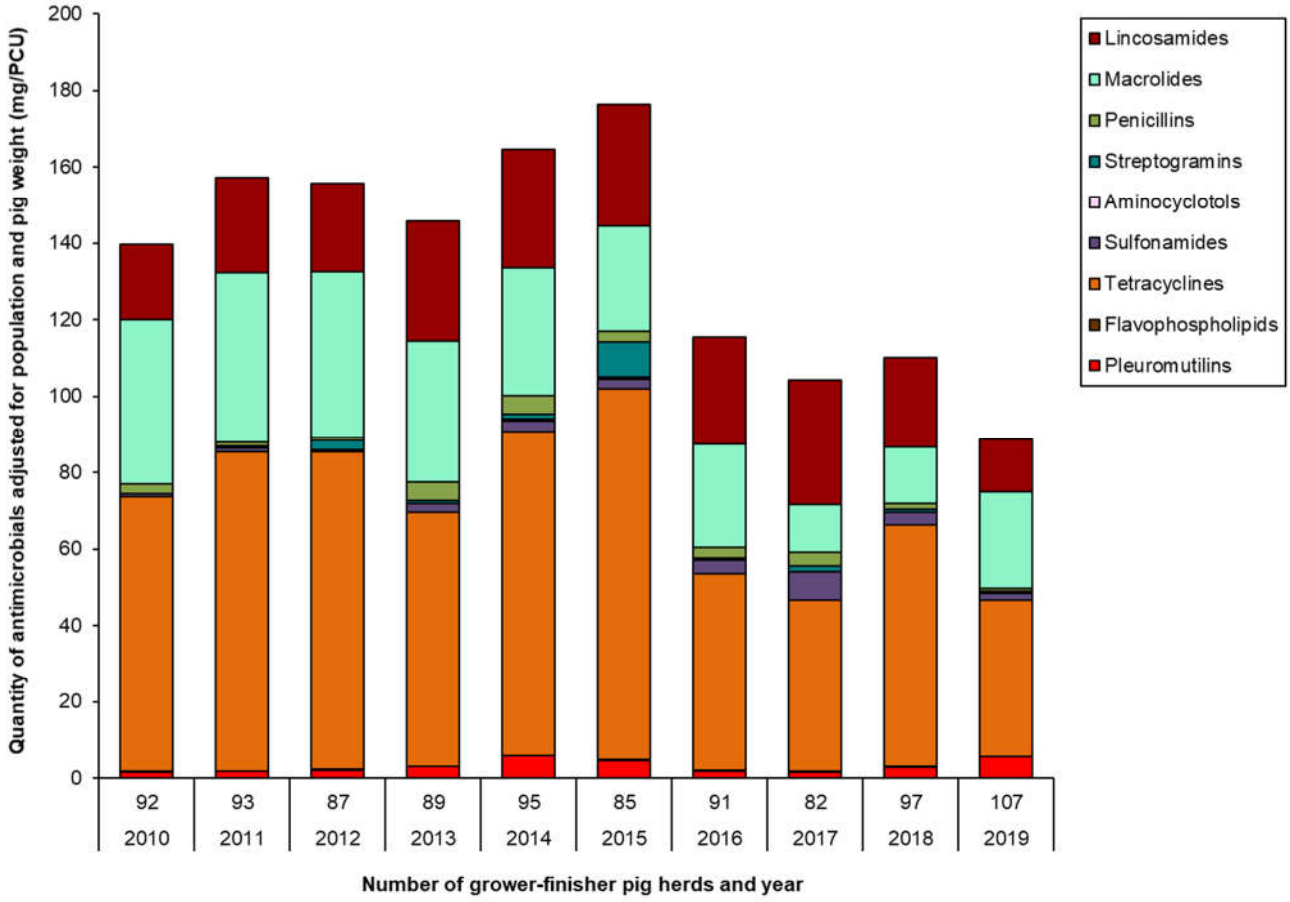
Figure 3.5 Quantity of antimicrobial use in feed adjusted for population and pig weight (mg/PCU), by province/region, 2015 to 2019



Year Province/region	2015	2016	2017	2018	2019
Prairies	156	101	105	135	98
Ontario	197	123	142	105	91
Québec	211	150	75	48	65
National	**176**	**116**	**104**	**110**	**89**

Excluded from this analysis were antimicrobials used for growth promotion and have doses lower than preventive and treatment dosage: bambermycin, narasin, and salinomycin.
mg/PCU = milligrams/population correction unit.
For detailed indicator description, please refer to Table 3.1.
The Prairies is a region and includes the provinces of Alberta, Saskatchewan, and Manitoba.

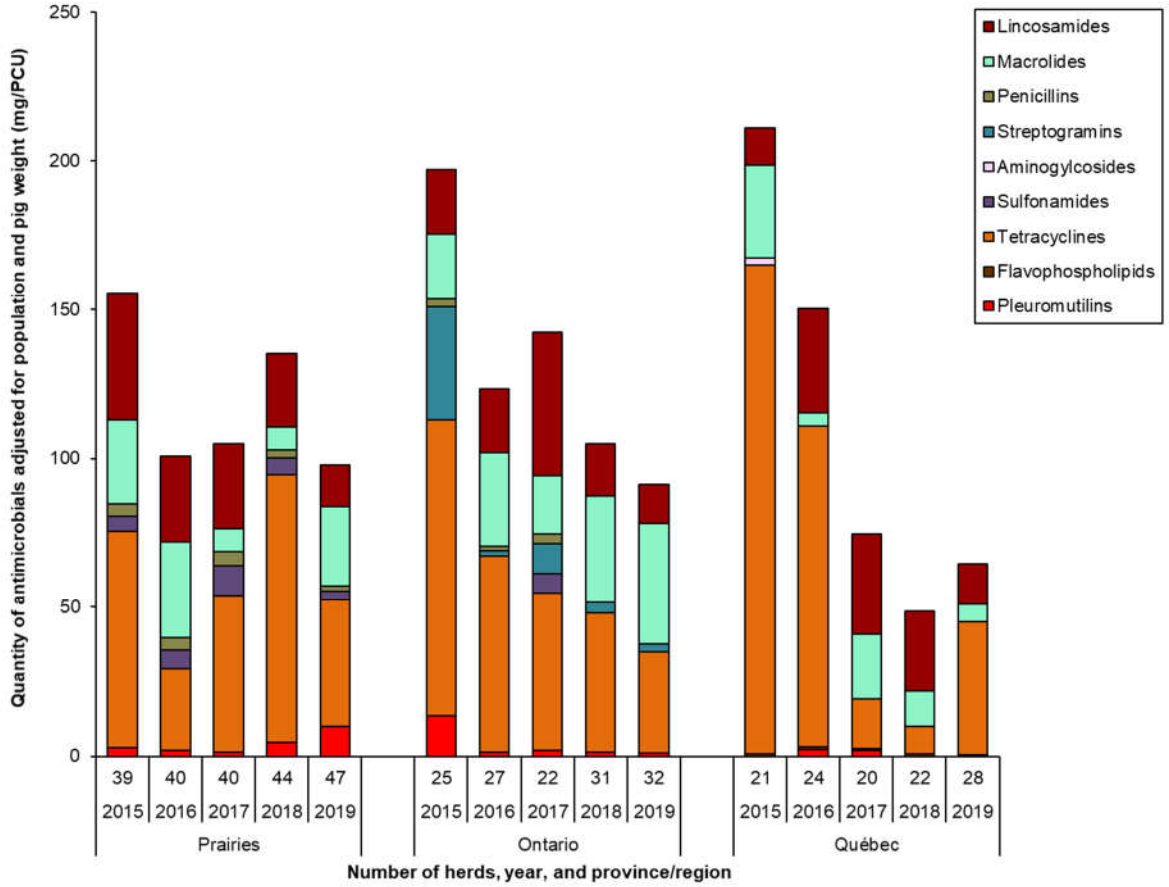
Figure 3.6 Quantity of antimicrobials used in feed adjusted for population and pig weight (mg/PCU), 2010 to 2019



Year		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of herds		92	93	87	89	95	85	91	82	97	107
Antimicrobial class											
II	Lincosamides	19.8	25.1	23.2	31.3	31.1	31.9	28.1	32.6	23.5	13.7
	Macrolides	43.0	44.2	43.3	36.8	33.2	27.3	27.0	12.5	14.8	25.2
	Penicillins	2.4	1.2	0.8	4.9	4.9	3.0	2.9	3.7	1.6	0.9
	Streptogramins	< 0.1	0.1	2.6	0.8	1.3	9.0	0.4	1.6	0.7	0.5
III	Aminocyclitols	< 0.1	0.4	0.0	0.0	0.6	0.5	0.0	0.0	0.0	0.0
	Bacitracins	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sulfonamides	0.8	0.9	0.5	2.3	2.7	2.7	3.5	7.3	3.2	1.7
	Tetracyclines	71.9	83.5	83.1	66.3	84.7	97.0	51.6	44.9	63.3	41.0
IV	Flavophospholipids	0.1	< 0.1	0.1	0.0	< 0.1	0.1	0.2	0.2	0.2	0.1
UC	Pleuromutilins	1.6	1.8	2.1	3.2	6.0	4.8	1.9	1.5	2.9	5.6
Total		**140.6**	**157.2**	**155.7**	**145.6**	**164.6**	**176.3**	**115.5**	**104.3**	**110.2**	**88.8**

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = pleuromutilins are medically important but uncategorized (UC).
mg/PCU = milligrams /population correction unit.
For detailed indicator description, please refer to Table 3.1.

Figure 3.7 Quantity of antimicrobials used in feed, adjusted for population and pig weight (mg/PCU), by province/region, 2015 to 2019

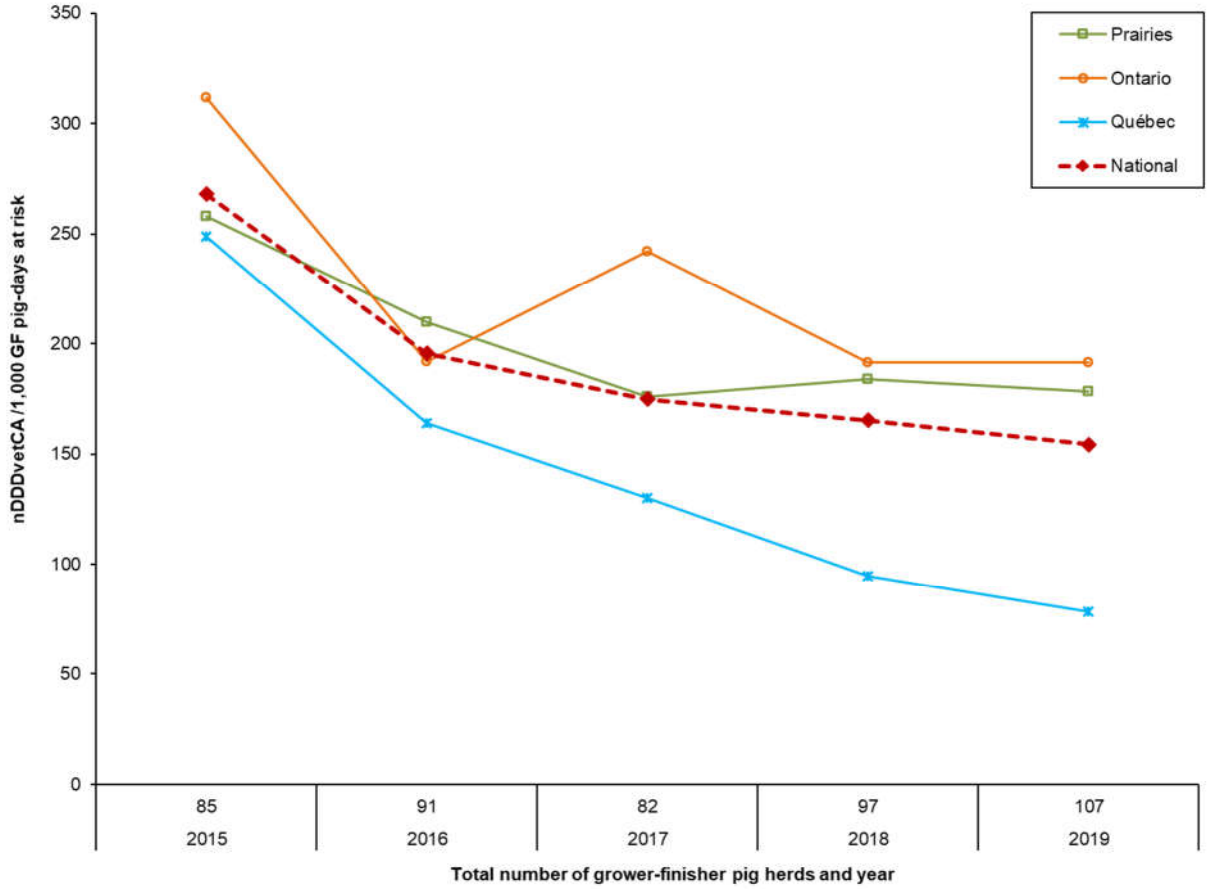


Province/region		Prairies					Ontario					Québec				
Year		2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Number of herds		39	40	40	44	47	25	27	22	31	32	21	24	20	22	28
Antimicrobial class																
II	Lincosamides	43	29	28	25	14	22	21	48	17	13	13	35	34	27	14
II	Macrolides	28	32	8	8	27	22	31	20	36	41	31	5	22	12	6
II	Penicillins	4	4	5	3	2	3	2	3	0	0	0	0	0	0	0
II	Streptogramins	0	0	0	0	0	38	2	10	3	2	0	0	0	0	0
III	Aminoglycosides	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
III	Sulfonamides	5	6	10	6	3	0	0	7	0	0	0	0	0	0	0
III	Tetracyclines	73	27	53	90	42	100	66	53	47	34	165	108	17	9	45
IV	Flavophospholipids	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0
UC	Pleuromutilins	3	2	1	5	10	13	1	2	1	1	0	2	2	0	0
Total		**156**	**101**	**105**	**135**	**98**	**197**	**123**	**142**	**105**	**91**	**211**	**150**	**75**	**48**	**65**

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = pleuromutilins are medically important but uncategorized (UC).
mg/PCU = milligrams/population correction unit.
For detailed indicator description, please refer to Table 3.1.
The Prairies is a region and includes the provinces of Alberta, Saskatchewan, and Manitoba.

Quantity (Dose based measures)

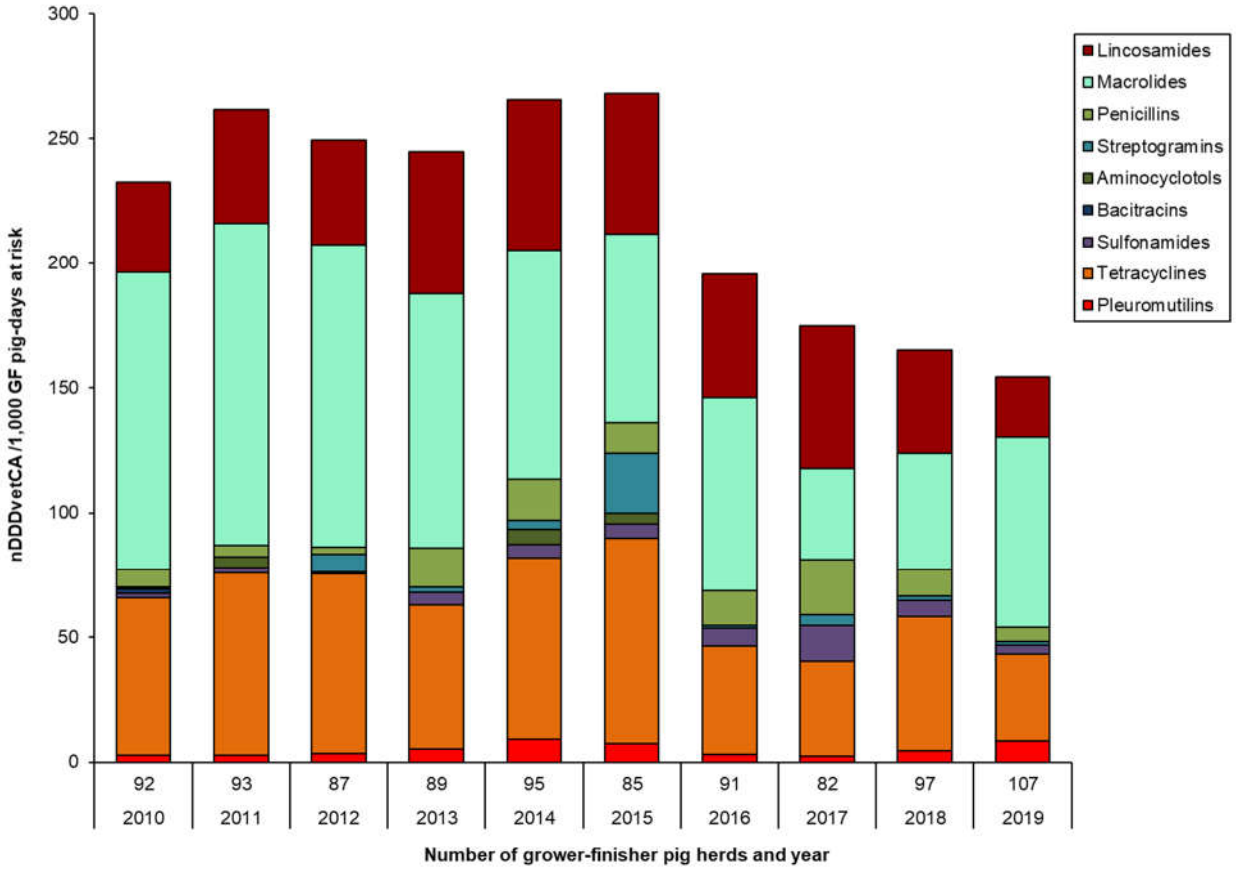
Figure 3.8 Number of Canadian Defined Daily Doses for animals per 1,000 grower-finisher pig-days at risk (nDDDvetCA/1,000 GF pig-days at risk) for antimicrobials administered in feed, by province/region, 2015 to 2019



Year Number of herds	2015 85	2016 91	2017 82	2018 97	2019 107
Province/region					
Prairies	258	210	176	184	178
Ontario	312	192	242	191	192
Québec	249	164	130	94	78
National	**268**	**196**	**175**	**165**	**154**

Excluded from this analysis were the ionophores, narasin, and salinomycin.
DDDvetCA = Canadian Defined Daily Doses for animals (average labelled dose) in milligrams per kilogram grower-finisher pig weight per day (mg_{drug}/kg_{animal}/day); please refer to Appendix: Supplemental data of the CIPARS 2018: Design and Methods, Table A.2 for the list of standards.
For detailed indicator descriptions, please refer to Table 3.1.
The Prairies is a region and includes the provinces of Alberta, Saskatchewan, and Manitoba.

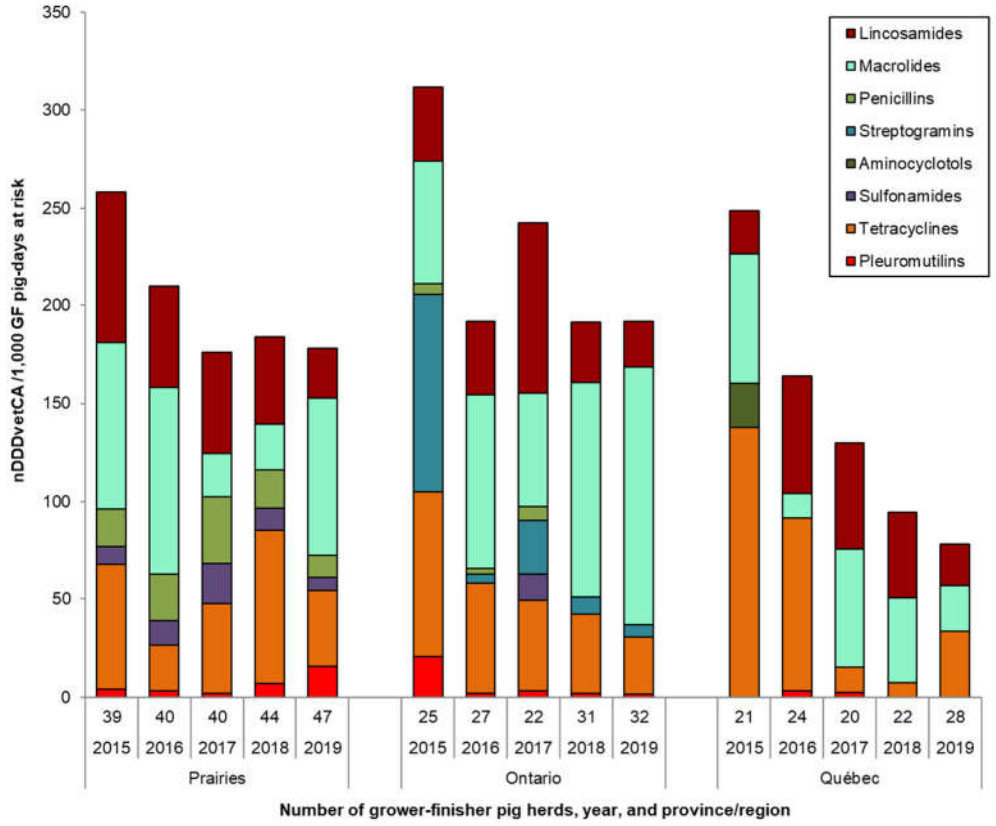
Figure 3.9 Number of Canadian Defined Daily Doses for animals per 1,000 grower-finisher pig-days at risk (nDDDvetCA/1,000 GF pig-days at risk) for antimicrobials administered in feed, 2010 to 2019



Year		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of herds		92	93	87	89	95	85	91	82	97	107
Antimicrobial class											
II	Lincosamides	36	46	42	57	60	56	49	57	41	24
	Macrolides	119	129	121	102	92	76	78	36	47	76
	Penicillins	7	5	3	16	16	12	14	22	11	6
	Streptogramins	0	0	7	2	4	24	1	4	2	1
III	Aminocyclitols	1	4	0	0	6	4	0	0	0	0
	Bacitracins	2	0	0	0	0	0	0	0	0	0
	Sulfonamides	2	2	1	5	5	6	7	15	6	3
	Tetracyclines	63	73	72	58	73	83	44	38	54	35
UC	Pleuromutilins	3	3	3	5	9	7	3	2	4	9

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = pleuromutilins are medically important but uncategorized (UC).
DDDvetCA = Canadian Defined Daily Doses for animals (average label dose) in milligrams per kilogram grower-finisher pig weight (mg_{drug}/kg_{animal}/day); please refer to Appendix: Supplemental data of the CIPARS 2018: Design and Methods, Table A. 2 for the list of standards.
For detailed indicator description, please refer to Table 3.1.

Figure 3.10 Number of Canadian Defined Daily Doses for animals per 1,000 grower-finisher pig-days at risk (nDDDvetCA/1,000 GF pig-days at risk) for antimicrobials administered in feed, by province/region, 2015 to 2019



Province/region		Prairies					Ontario					Québec				
Year		2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Number of herds		39	40	40	44	47	25	27	22	31	32	21	24	20	22	28
Antimicrobial class																
II	Lincosamides	77	52	51	44	26	38	38	87	31	23	22	60	54	44	22
II	Macrolides	85	95	22	24	80	63	89	58	109	132	67	13	61	43	23
II	Penicillins	19	24	35	19	11	5	3	7	0	0	0	0	0	0	0
II	Streptogramins	0	0	0	0	0	100	4	28	9	6	0	0	0	0	0
III	Aminocyclotols	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0
III	Sulfonamides	10	12	20	11	7	0	0	13	0	0	0	0	0	0	0
III	Tetracyclines	63	23	46	78	38	85	56	46	40	29	138	89	13	7	34
UC	Pleuromutilins	4	3	2	7	16	21	2	3	2	2	0	3	3	0	0

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = pleuromutilins are medically important but uncategorized (UC).
DDDvetCA = Canadian Defined Daily Doses for animals (average label dose) in milligrams per kilogram grower-finisher pig weight (mg_{drug}/kg_{animal}/day); please refer to Appendix: Supplemental data of the CIPARS 2018: Design and Methods, Table A. 2 for the list of standards.
For detailed indicator description, please refer to Table 3.1.
The Prairies is a region and includes the provinces of Alberta, Saskatchewan, and Manitoba.

Antimicrobial use in feed - Ionophores

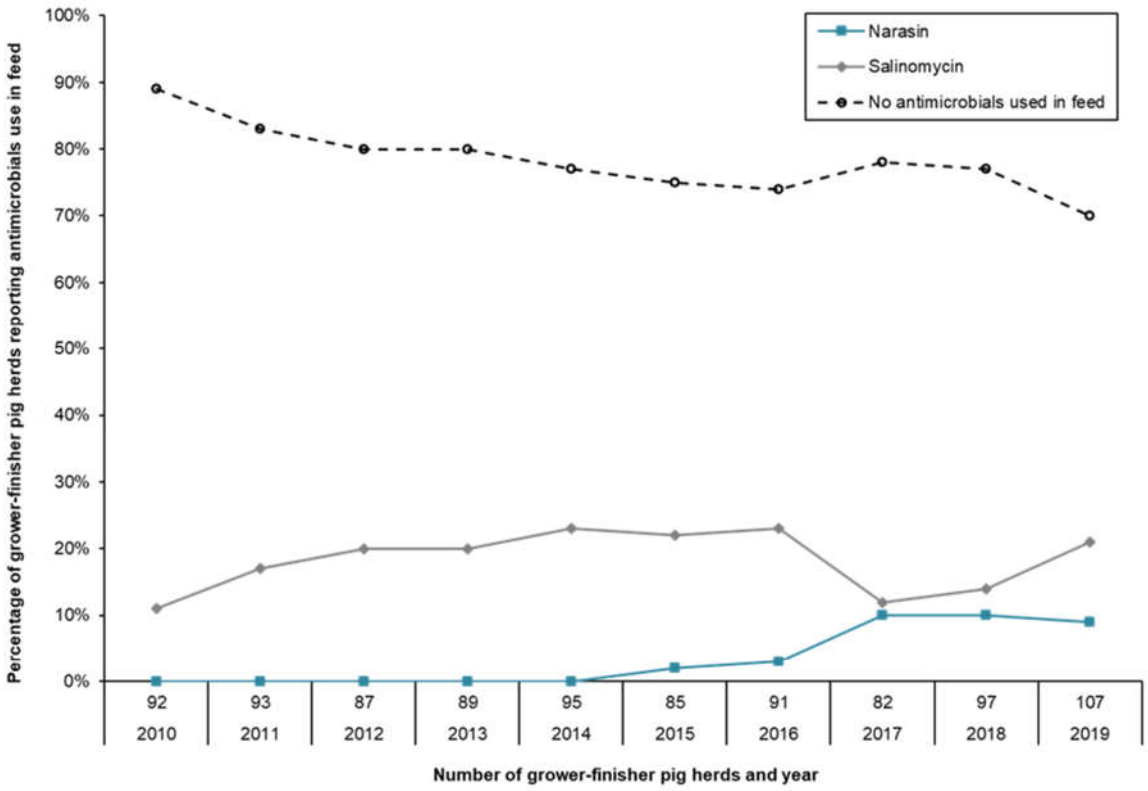
Table 3.4 Frequency and quantity of ionophore coccidiostat use in feed in grower-finisher pigs, 2019

Route of administration	Antimicrobial	Herds n (%) Total = 107	Rations n (%) *Total n = 466	Ration days exposed[a] median (min. ; max.)	Percent of herd exposed median (min. ; max.)	Weight at exposure median[b] (min. ; max.)[c]	Level of drug g/tonne[d] median (min. ; max.)	Quantity of antimicrobial active ingredient[e] (mg/PCU)
Feed								
IV	Narasin	10 (9)	37 (8)	28 (14, 126)	100 (50, 100)	75 (20, 136)	15 (11, 150)	11
	Salinomycin	22 (21)	75 (16)	32 (10, 70)	100 (50, 100)	72 (20, 145)	25, (25, 60)	23
All ionophore use		**32 (30)**	**112 (24)**	**28 (10, 126)**	**100 (50, 100)**	**72 (20, 145)**	**25 (11, 150)**	**34**

Roman numeral IV indicates the category of importance to human medicine as outlined by the Veterinary Drugs Directorate.
mg/PCU = milligrams/population correction unit.
For detailed indicator descriptions, please refer to Table 3.1.
[a] Ration days exposed = for rations medicated with the specific antimicrobial and do not reflect the full grow-out period.
[b] Median weight (kg) at exposure = the median of all average weights of pigs exposed to a ration containing a specific antimicrobial [(Ration Start Weight + Ration End Weight)/2].
[c] Minimum (min.) and maximum (max.) pig weight at exposure = the lowest start weight and the highest end weight reported for all rations containing the specific antimicrobial, respectively.
[d] Level of drug is in grams/tonne of feed.
[e] Quantitative antimicrobial consumption estimates were calculated using reported ration days fed and predicted feed intake[13], adjusted for herd average daily gain; only rations medicated with the specific antimicrobial were included in this analysis

[13] National Research Council. 2012. Nutrient Requirements of Swine, Eleventh Edition. Washington, DC: National Academy Press.

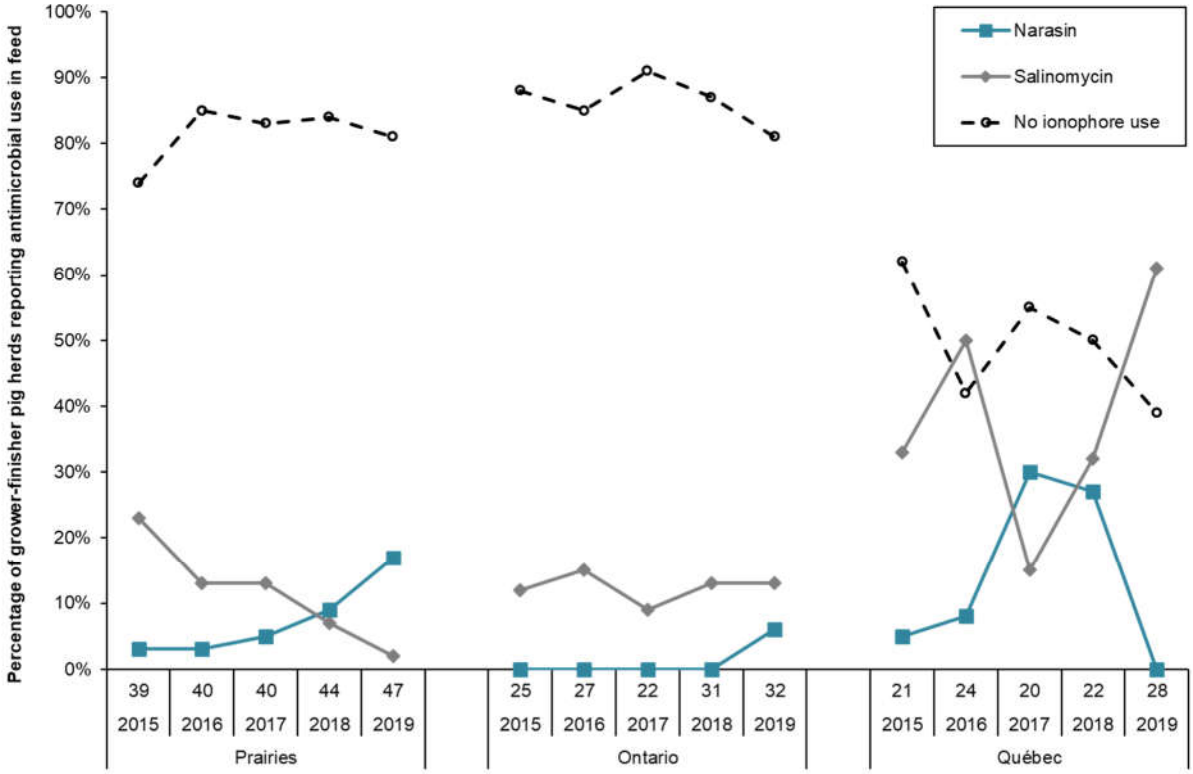
Figure 3.11 Percentage of grower-finisher pig herds reporting ionophore coccidiostat use in feed, 2010 to 2019



Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of herds	92	93	87	89	95	85	91	82	97	107
Antimicrobial										
IV Narasin	**0%**	0%	0%	0%	0%	2%	3%	10%	**10%**	**9%**
IV Salinomycin	**11%**	17%	20%	20%	23%	22%	23%	12%	**14%**	**21%**
No antimicrobials used in feed	**89%**	83%	80%	80%	77%	75%	74%	78%	**77%**	**70%**

Roman numeral IV indicates the category of importance to human medicine as outlined by the Veterinary Drugs Directorate.
For the temporal analyses, the proportion (%) of herds using a specific ionophore in the current year has been compared to the proportion (%) of flocks using the same ionophore during the previous 10 years and the previous surveillance year (grey areas). The presence of blue areas indicates significant temporal differences ($P \leq 0.05$) for a given ionophore.

Figure 3.12 Percentage of grower-finisher pig herds reporting ionophore coccidiostat use in feed, by province/region, 2015 to 2019



Number of grower-finisher pig herds, year, and province/region

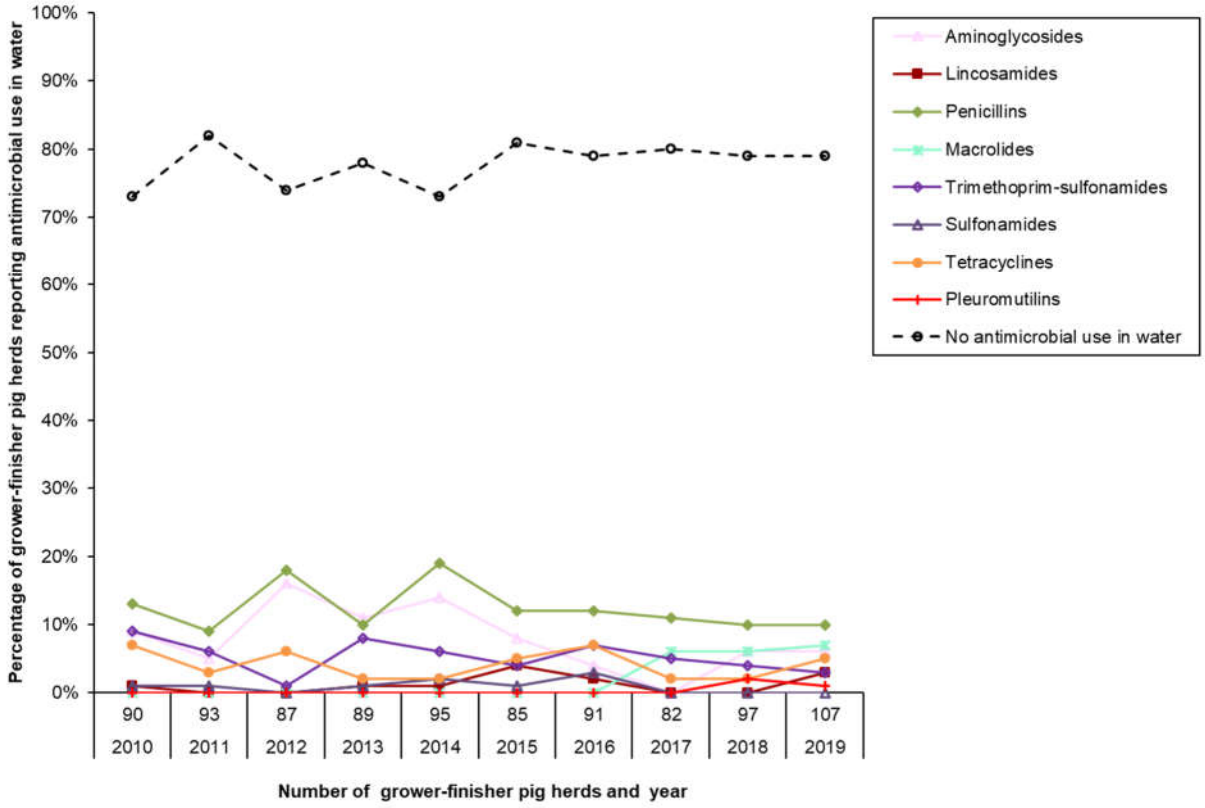
Province/region		Prairies					Ontario					Québec				
Year		2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Number of herds		39	40	40	44	47	25	27	22	31	32	21	24	20	22	28
Coccidiostat																
IV	Narasin	**3%**	3%	5%	**9%**	**17%**	**0%**	0%	0%	**0%**	**6%**	**5%**	8%	30%	**27%**	**0%**
	Salinomycin	**23%**	13%	13%	**7%**	**2%**	**12%**	15%	9%	**13%**	**13%**	**33%**	50%	15%	**32%**	**61%**
	No ionophore use in feed	**74%**	85%	83%	**84%**	**81%**	**88%**	85%	91%	**87%**	**81%**	**62%**	42%	55%	**50%**	**39%**

Roman numeral IV indicates the category of importance to human medicine as outlined by the Veterinary Drugs Directorate.
For the temporal analyses within province/region, the proportion (%) of herds using a specific ionophore in the current year has been compared to the proportion (%) of herds using the same ionophore during the previous 5 years and the previous surveillance year (grey areas). The presence of blue areas indicates significant temporal differences within province/region ($P \leq 0.05$) for a given ionophore. The presence of red areas indicates significant provincial/regional differences ($P \leq 0.05$) for a given ionophore within the current year (Québec-referent province). The presence of purple areas (2019 surveillance year; Québec-referent province) indicates significant temporal and provincial/regional differences ($P \leq 0.05$) for a given ionophore.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Antimicrobial use in water

Frequency (Count based measures)

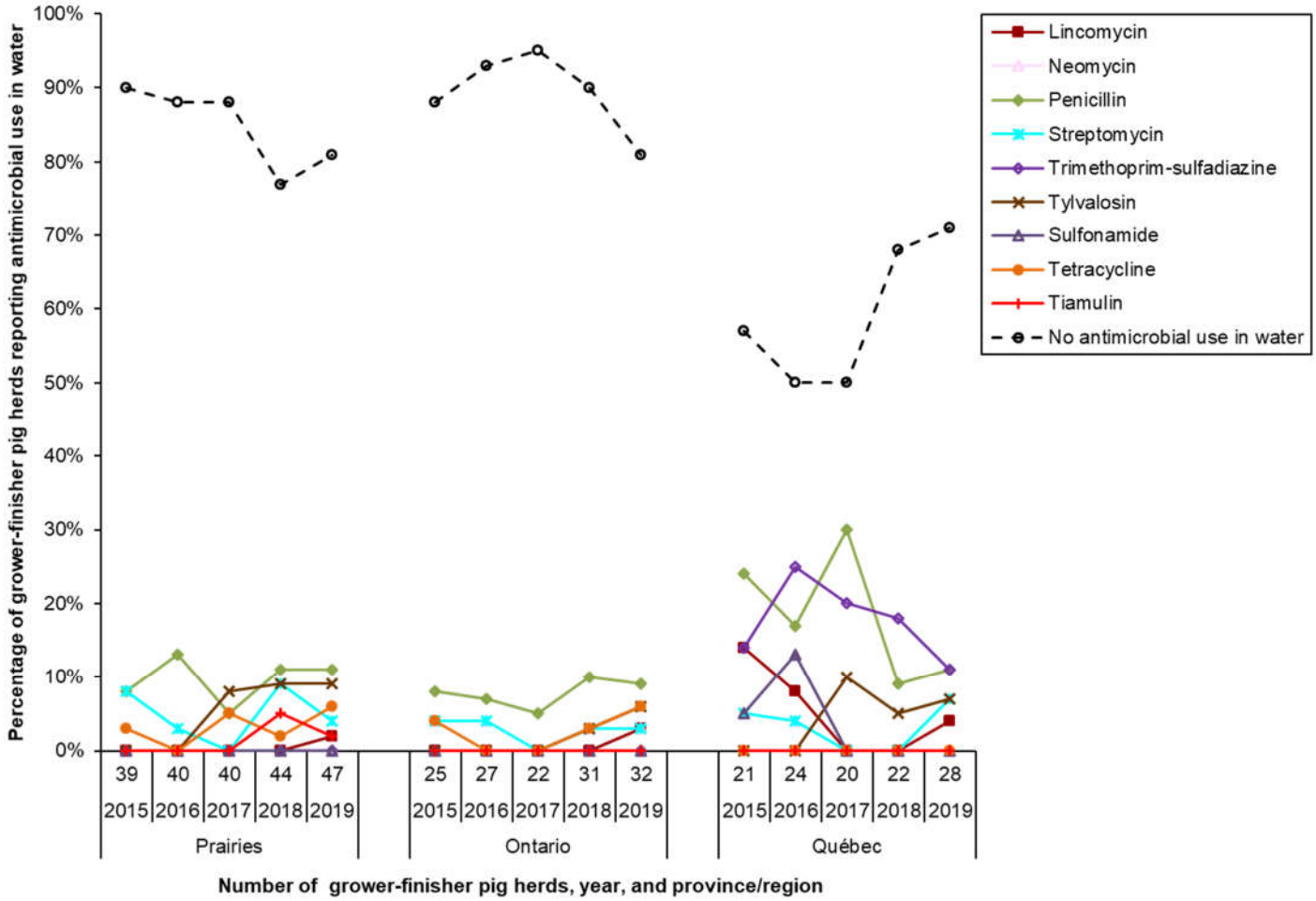
Figure 3.13 Percentage of pig herds reporting antimicrobial use in water, 2010 to 2019



Year		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of herds		90	93	87	89	95	85	91	82	97	107
Antimicrobial											
II	Aminoglycosides	**9%**	5%	16%	11%	14%	8%	4%	0%	**6%**	**6%**
	Lincosamides	**1%**	0%	0%	1%	1%	4%	2%	0%	**0%**	**3%**
	Penicillins	**13%**	9%	18%	10%	19%	12%	12%	11%	**10%**	**10%**
	Macrolides	**0%**	0%	0%	0%	0%	0%	0%	6%	**6%**	**7%**
	Trimethoprim-sulfonamides	**9%**	6%	1%	8%	6%	4%	7%	5%	**4%**	**3%**
III	Sulfonamides	**1%**	1%	0%	1%	2%	1%	3%	0%	**0%**	**0%**
	Tetracyclines	**7%**	3%	6%	2%	2%	5%	7%	2%	**2%**	**5%**
UC	Pleuromutilins	**0%**	0%	0%	0%	0%	0%	0%	0%	**2%**	**1%**
	No antimicrobial use in water	**73%**	82%	74%	78%	73%	81%	79%	80%	**79%**	**79%**

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = pleuromutilins are medically important but uncategorized (UC).
Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure. Antimicrobial use in water reported by fewer than 5% of herds included neomycin (Category II) and spectinomycin. (Category III).
There were no significant temporal or regional differences noted in 2019.

Figure 3.14. Percentage of pig herds reporting antimicrobial use in water, by province/region, 2015 to 2019

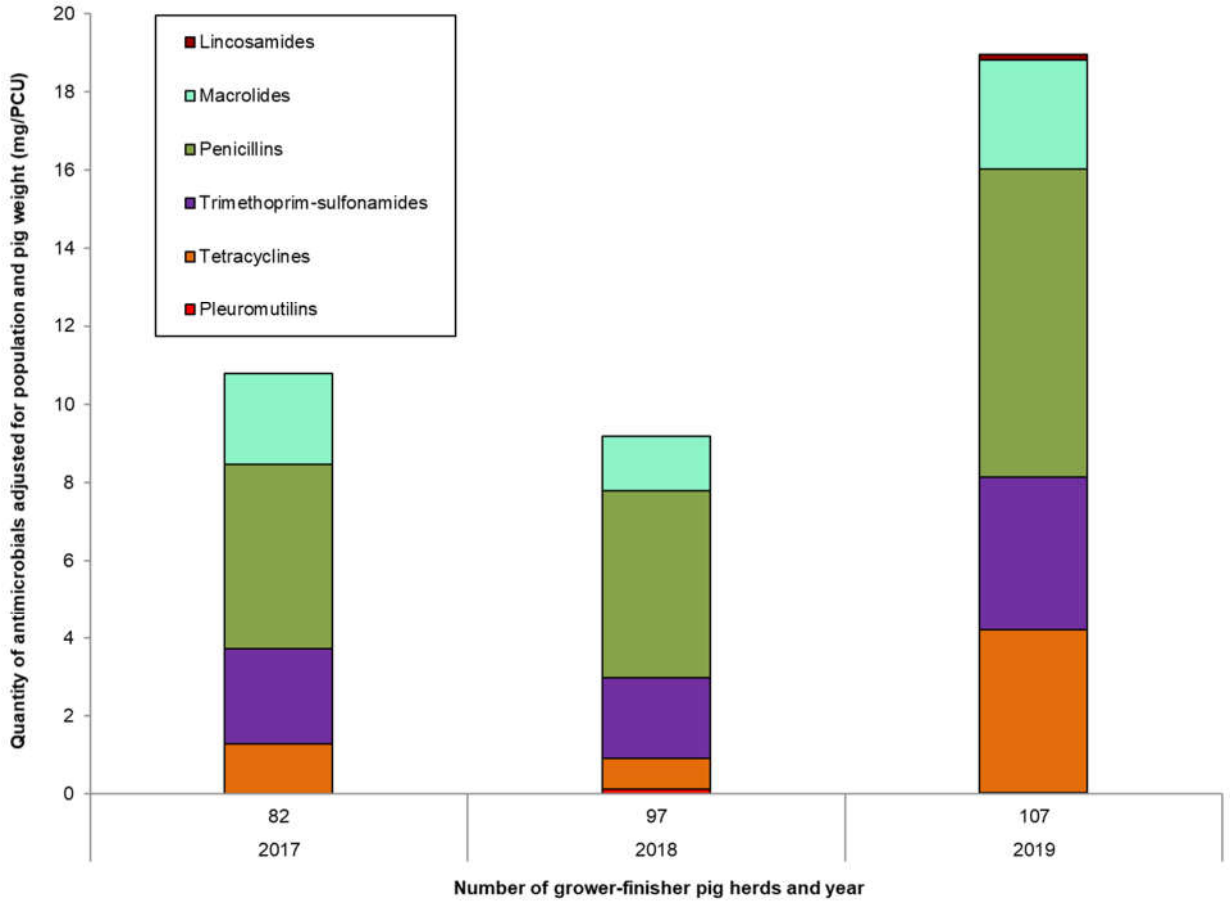


Province/region		Prairies					Ontario					Québec				
Year		2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Number of herds		39	40	40	44	47	25	27	22	31	32	21	24	20	22	28
Antimicrobial																
II	Lincomycin	**0%**	0%	0%	**0%**	**2%**	**0%**	0%	0%	**0%**	**3%**	**14%**	8%	0%	**0%**	**4%**
	Neomycin	**0%**	0%	0%	**0%**	**0%**	**4%**	4%	0%	**3%**	**3%**	**5%**	4%	0%	**0%**	**0%**
	Penicillin	**8%**	13%	5%	**11%**	**11%**	**8%**	7%	5%	**10%**	**9%**	**24%**	17%	30%	**9%**	**11%**
	Streptomycin	**8%**	3%	0%	**9%**	**4%**	**4%**	4%	0%	**3%**	**3%**	**5%**	4%	0%	**0%**	**7%**
	Trimethoprim-sulfadiazine	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**	**14%**	25%	20%	**18%**	**11%**
	Tylvalosin	**0%**	0%	8%	**9%**	**9%**	**0%**	0%	0%	**3%**	**6%**	**0%**	0%	10%	**5%**	**7%**
III	Sulfonamide	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**	**5%**	13%	0%	**0%**	**0%**
	Tetracycline	**3%**	0%	5%	**2%**	**6%**	**4%**	0%	0%	**3%**	**6%**	**0%**	0%	0%	**0%**	**0%**
UC	Tiamulin	**0%**	0%	0%	**5%**	**2%**	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**
	No antimicrobial use in water	**90%**	88%	88%	**77%**	**81%**	**88%**	93%	95%	**90%**	**81%**	**57%**	50%	50%	**68%**	**71%**

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = tiamulin is a medically important but uncategorized (UC) antimicrobial.
Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure. Antimicrobial use in water reported by fewer than 5% of herds included neomycin (Category II) and spectinomycin (Category III).
There were no significant temporal or regional differences noted in 2019.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Quantity (Weight based measures)

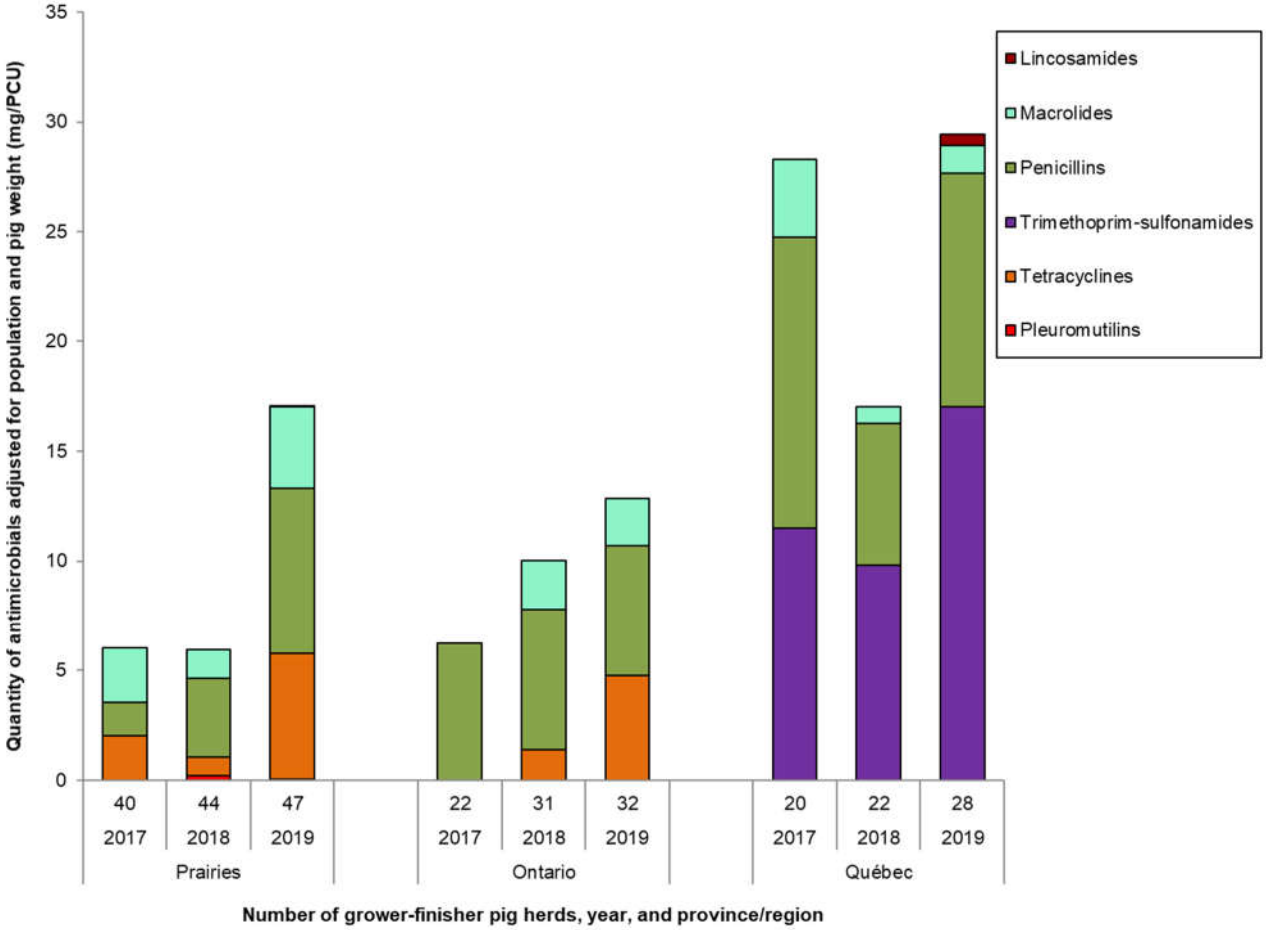
Figure 3.15 Quantity of antimicrobials administered in water adjusted for population and pig weight (mg/PCU), 2017 to 2019



Year		2017	2018	2019
Number of herds		82	97	107
Antimicrobial class				
II	Lincosamides	0.0	0.0	0.2
	Macrolides	2.3	1.4	2.8
	Penicillins	4.7	4.8	7.9
	Trimethoprim-sulfonamides	2.4	2.1	3.9
III	Tetracyclines	1.3	0.8	4.2
UC	Pleuromutilins	0.0	0.1	0.0
Total		**10.8**	**9.2**	**19.0**

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = pleuromutilins are medically important but uncategorized (UC).
mg/PCU = milligrams /population correction unit.
For detailed indicator descriptions, please refer to Table 3.1.

Figure 3.16 Quantity of antimicrobials administered in water adjusted for population and pig weight (mg/PCU), by province/region, 2017 to 2019

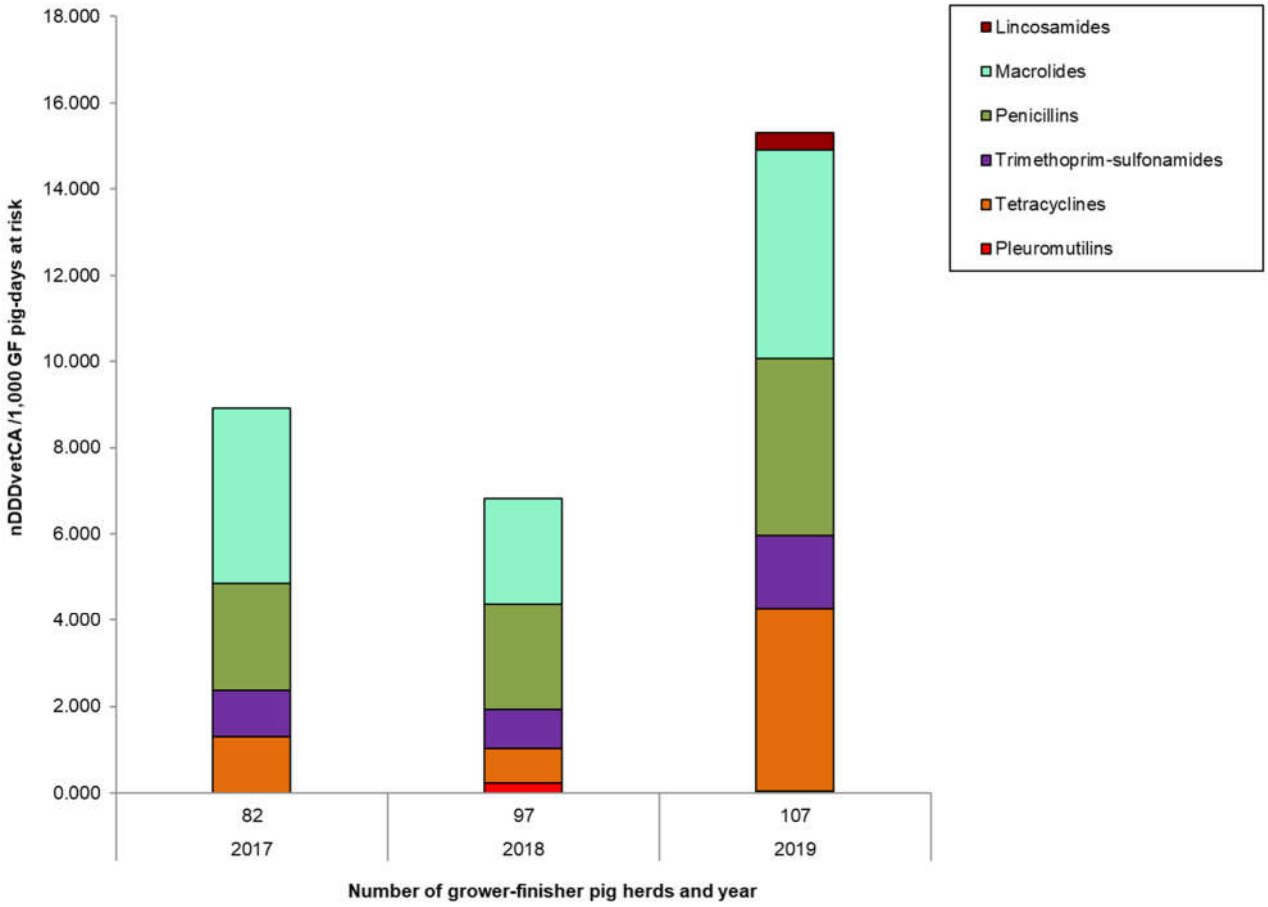


Province/region		Prairies			Ontario			Québec		
Year		2017	2018	2019	2017	2018	2019	2017	2018	2019
Number of herds		40	44	47	22	31	32	20	22	28
Antimicrobial class										
II	Lincosamides	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.5
II	Macrolides	2.5	1.3	3.7	0.0	2.2	2.1	3.5	0.8	1.3
II	Penicillins	1.5	3.6	7.5	6.2	6.4	5.9	13.3	6.4	10.6
II	Trimethoprim-sulfonamides	0.0	0.0	0.0	0.0	0.0	0.0	11.5	9.8	17.0
III	Tetracyclines	2.0	0.8	5.7	0.0	1.4	4.7	0.0	0.0	0.0
UC	Pleuromutilins	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total		**6.0**	**5.9**	**17.1**	**6.2**	**10.0**	**12.8**	**28.3**	**17.0**	**29.4**

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = pleuromutilins are medically important but uncategorized (UC).
mg/PCU = milligrams /population correction unit.
For detailed indicator descriptions, please refer to Table 3.1.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Quantity (Dose based measures)

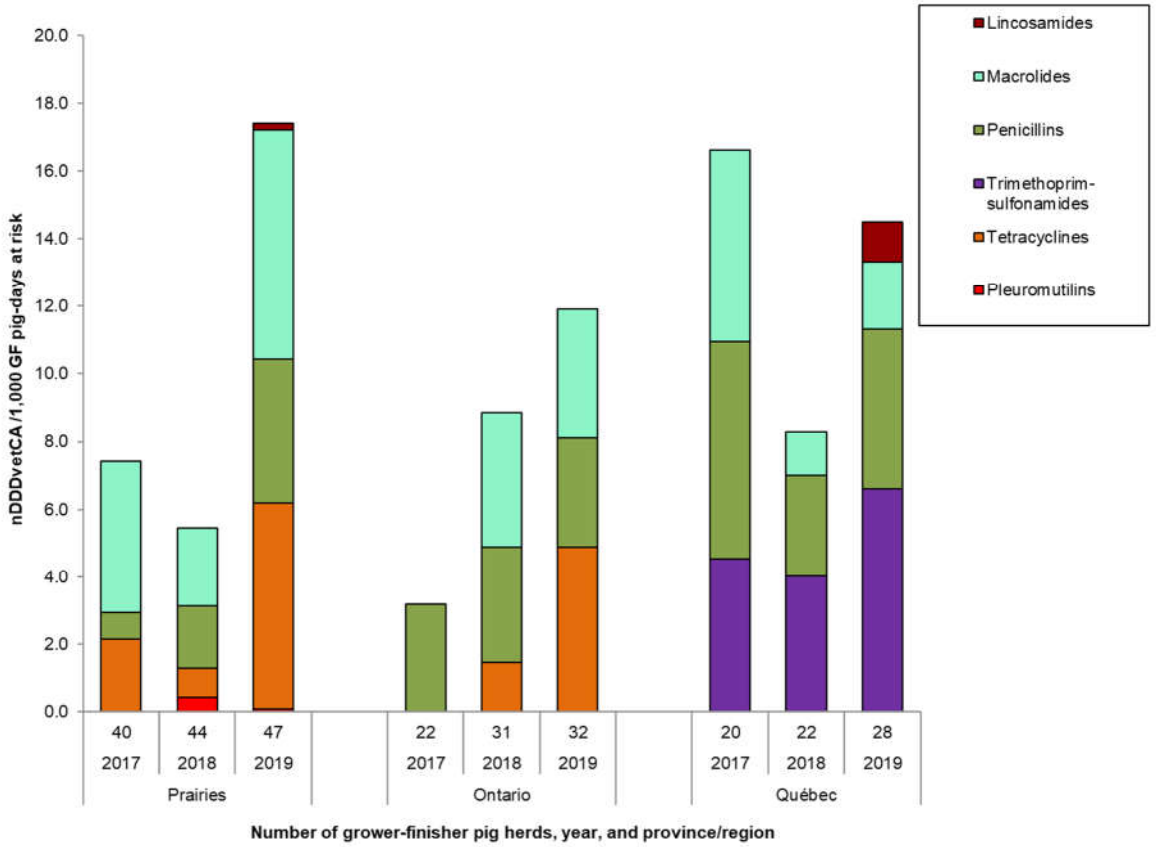
Figure 3.17 Number of Canadian Defined Daily Doses for animals per 1,000 grower-finisher pig-days at risk (nDDDvetCA/1,000 GF pig-days at risk) administered in water, 2017 to 2019



Year Number of herds		2017 82	2018 97	2019 107
Antimicrobial class				
II	Lincosamides	0.0	0.0	0.4
	Macrolides	4.1	2.5	4.9
	Penicillins	2.5	2.4	4.1
	Trimethoprim-sulfonamides	1.1	0.9	1.7
III	Tetracyclines	1.3	0.8	4.2
UC	Pleuromutilins	0.0	0.2	0.0
Overall		**8.9**	**6.8**	**15.3**

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = Pleuromutilins are medically important but uncategorized.
DDDvetCA = Canadian Defined Daily Doses for animals (average labelled dose) in milligrams per kilogram grower-finisher pig weight per day (mg_{drug}/kg_{animal}/day); please refer to Appendix: Supplemental data of the CIPARS 2018: Design and Methods, Table A. 2 for the list of standards available at: https://www.canada.ca/en/public-health/services/surveillance/canadian-integrated-program-antimicrobial-resistance-surveillance-cipars/cipars-reports/2018-annual-report-design-methods.html.
For detailed indicator description, please refer to Table 3.1.

Figure 3.18 Number of Canadian Defined Daily Doses for animals per 1,000 grower-finisher pig-days at risk (nDDDvetCA/1,000 GF pig-days at risk) for antimicrobials administered in water, by province/region, 2017 to 2019



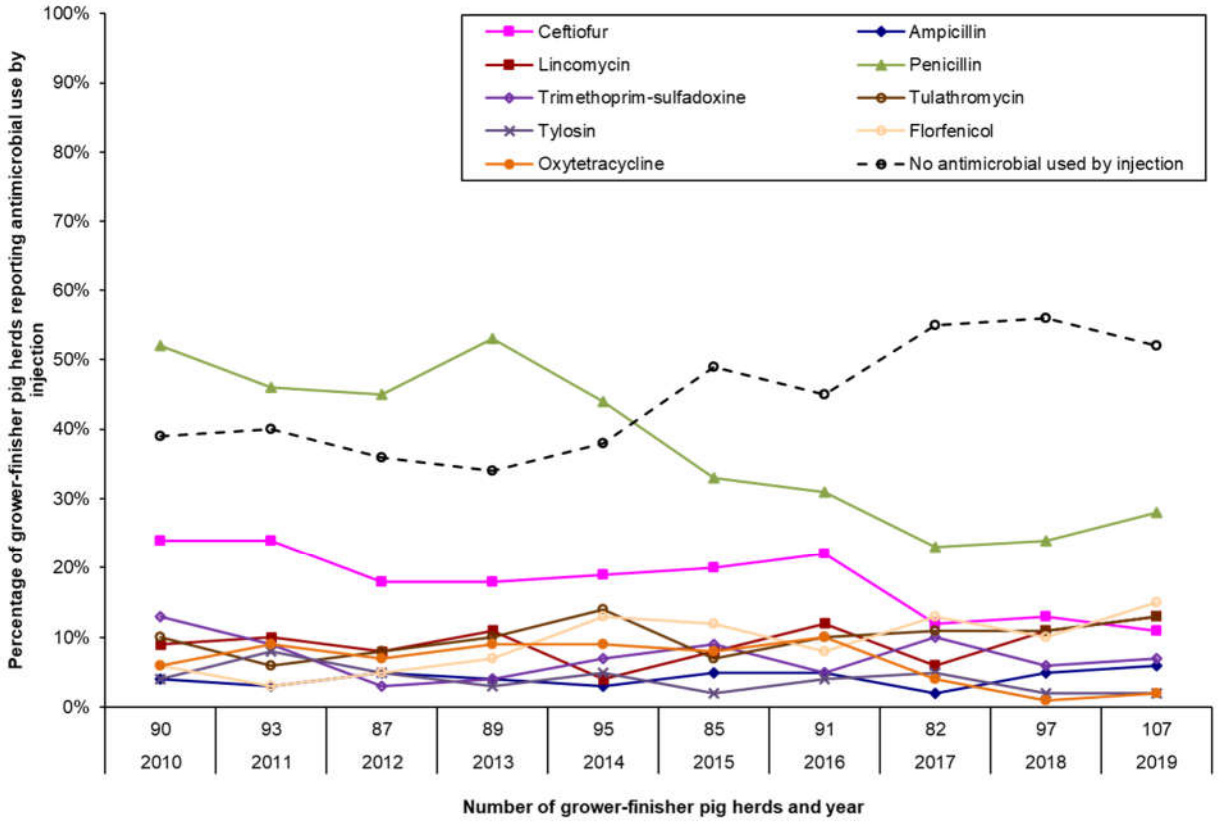
Province/region		Prairies			Ontario			Québec		
Year		2017	2018	2019	2017	2018	2019	2017	2018	2019
Number of herds		40	44	47	22	31	32	20	22	28
Antimicrobial class										
II	Lincosamides	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	1.2
	Macrolides	4.5	2.3	6.8	0.0	4.0	3.8	5.7	1.3	2.0
	Penicillins	0.8	1.8	4.2	3.2	3.4	3.2	6.4	3.0	4.7
	Trimethoprim-sulfonamides	0.0	0.0	0.0	0.0	0.0	0.0	4.5	4.0	6.6
III	Tetracyclines	2.1	0.9	6.1	0.0	1.4	4.9	0.0	0.0	0.0
UC	Pleuromutilins	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Total		**7.4**	**5.5**	**17.4**	**3.2**	**8.9**	**11.9**	**16.6**	**8.3**	**14.5**

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = Pleuromutilins are medically important but uncategorized.
DDDvetCA = Canadian Defined Daily Doses for animals (average labelled dose) in milligrams per kilogram grower-finisher pig weight per day (mg_{drug}/kg_{animal}/day); please refer to Appendix: Supplemental data of the CIPARS 2018: Design and Methods, Table A. 2 for the list of standards available at: https://www.canada.ca/en/public-health/services/surveillance/canadian-integrated-program-antimicrobial-resistance-surveillance-cipars/cipars-reports/2018-annual-report-design-methods.html.. .
For detailed indicator descriptions, please refer to Table 3.1.
The Prairies is a region and includes the provinces of Alberta, Saskatchewan, and Manitoba.

Antimicrobial use by injection

Frequency (Count based measures)

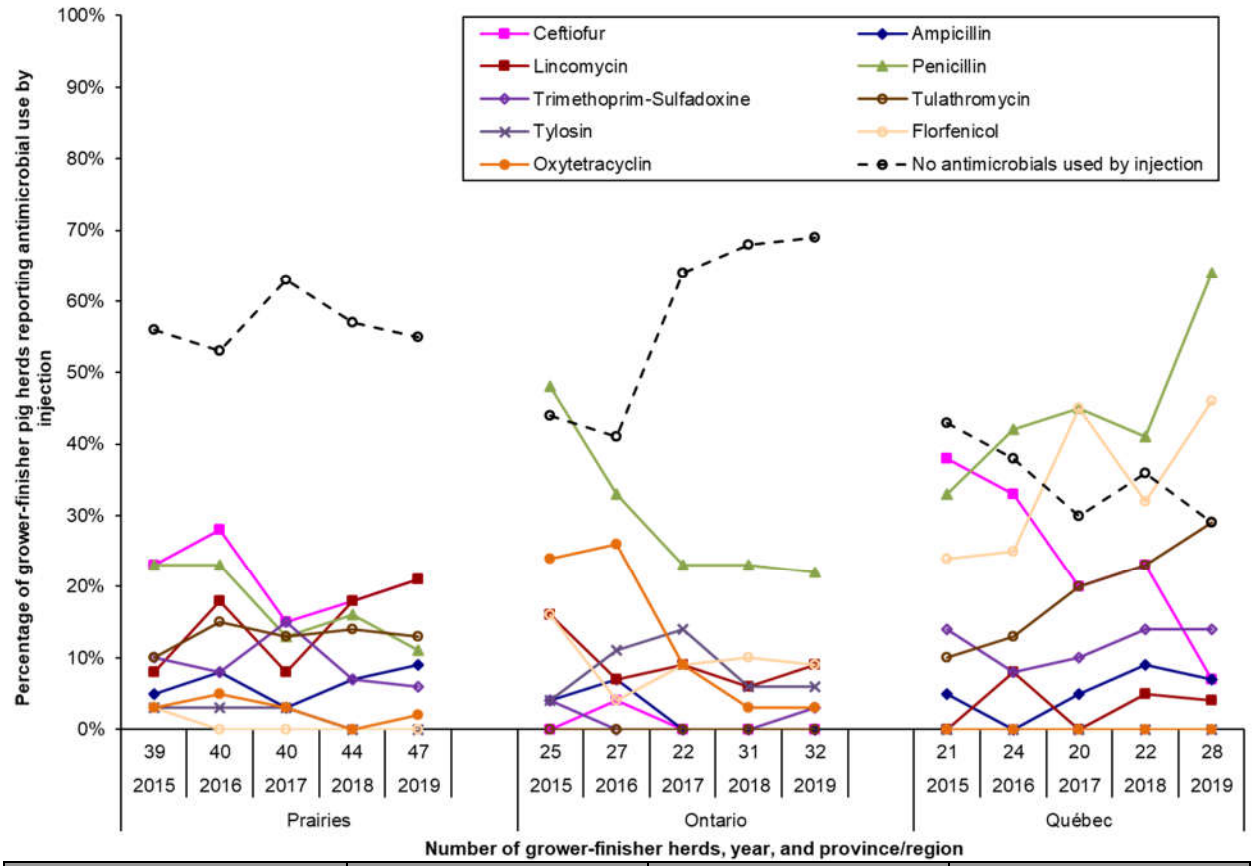
Figure 3.19 Percentage of pig herds reporting antimicrobial use by injection, 2010 to 2019



Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of herds	90	93	87	89	95	85	91	82	97	107
Antimicrobial										
I Ceftiofur	**24%**	24%	18%	18%	19%	20%	22%	12%	**13%**	**11%**
II Ampicillin	**4%**	3%	5%	4%	3%	5%	5%	2%	**5%**	**6%**
II Lincomycin	**9%**	10%	8%	11%	4%	8%	12%	6%	**11%**	**13%**
II Penicillin	**52%**	46%	45%	53%	44%	33%	31%	23%	**24%**	**28%**
II Trimethoprim-sulfadoxine	**13%**	9%	3%	4%	7%	9%	5%	10%	**6%**	**7%**
II Tulathromycin	**10%**	6%	8%	10%	14%	7%	10%	11%	**11%**	**13%**
II Tylosin	**4%**	8%	5%	3%	5%	2%	4%	5%	**2%**	**2%**
III Florfenicol	**6%**	3%	5%	7%	13%	12%	8%	13%	**10%**	**15%**
III Oxytetracycline	**6%**	9%	7%	9%	9%	8%	10%	4%	**1%**	**2%**
No antimicrobials used by injection	**39%**	40%	36%	34%	38%	49%	45%	55%	**56%**	**52%**

Roman numerals I to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure. Antimicrobial use by injection reported by fewer than 5% of herds included Category II: erythromycin; Category III: spectinomycin; Uncategorized: tiamulin is medically important but uncategorized.
For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial during the previous 10 years and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Figure 3.20 Percentage of grower-finisher pig herds reporting antimicrobial use by injection, by province/region, 2015 to 2019

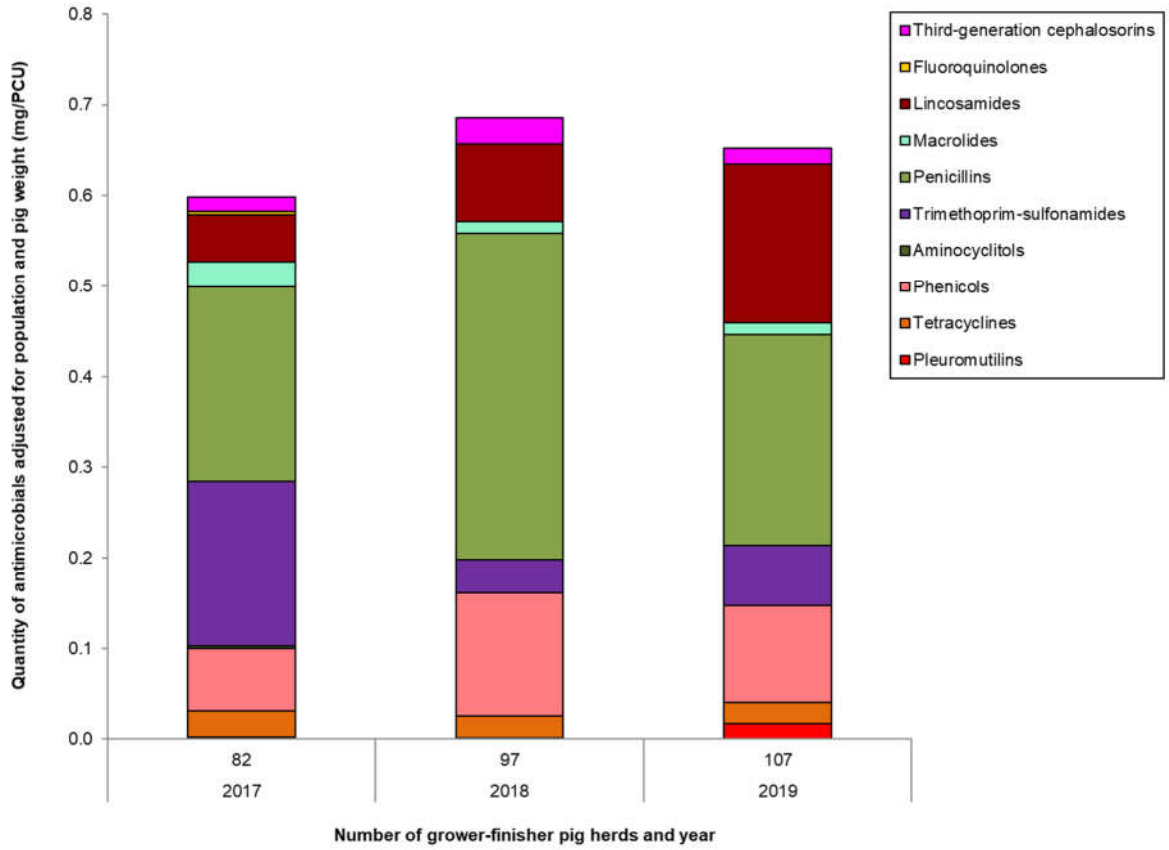


Province/region		Prairies					Ontario					Québec				
Year		2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Number of herds		39	40	40	44	47	25	27	22	31	32	21	24	20	22	28
Antimicrobial																
I	Ceftiofur	23%	28%	15%	18%	21%	0%	4%	0%	0%	0%	38%	33%	20%	23%	7%
II	Ampicillin	5%	8%	3%	7%	9%	4%	7%	0%	0%	0%	5%	0%	5%	9%	7%
II	Lincomycin	8%	18%	8%	18%	21%	16%	7%	9%	6%	9%	0%	8%	0%	5%	4%
II	Penicillin	23%	23%	13%	16%	11%	48%	33%	23%	23%	22%	33%	42%	45%	41%	64%
II	Trimethoprim-sulfadoxine	10%	8%	15%	7%	6%	4%	0%	0%	0%	3%	14%	8%	10%	14%	14%
II	Tulathromycin	10%	15%	13%	14%	13%	0%	0%	0%	0%	0%	10%	13%	20%	23%	29%
II	Tylosin	3%	3%	3%	0%	0%	4%	11%	14%	6%	6%	0%	0%	0%	0%	0%
III	Florfenicol	3%	0%	0%	0%	0%	16%	4%	9%	10%	9%	24%	25%	45%	32%	46%
III	Oxytetracycline	3%	5%	3%	0%	2%	24%	26%	9%	3%	3%	0%	0%	0%	0%	0%
	No antimicrobials used by injection	56%	53%	63%	57%	55%	44%	41%	64%	68%	69%	43%	38%	30%	36%	29%

Roman numerals I to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
Only antimicrobials used by 5% of herds or more in a given year within any province/region are depicted in this figure. Antimicrobial use by injection reported by fewer than 5% of herds included Category II: erythromycin; Category III: spectinomycin.
For the temporal analyses within province/region, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial in the previous 5 years and the previous surveillance year (grey areas). The presence of blue areas indicates significant temporal differences within province/region ($P \leq 0.05$) for a given antimicrobial. The presence of red areas indicates significant provincial/regional differences ($P \leq 0.05$) for a given antimicrobial within the current year (Québec-referent province). The presence of purple areas (2019 surveillance year; Québec-referent province) indicates significant temporal and provincial/regional differences ($P \leq 0.05$) for a given antimicrobial.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Quantity (Weight based measures)

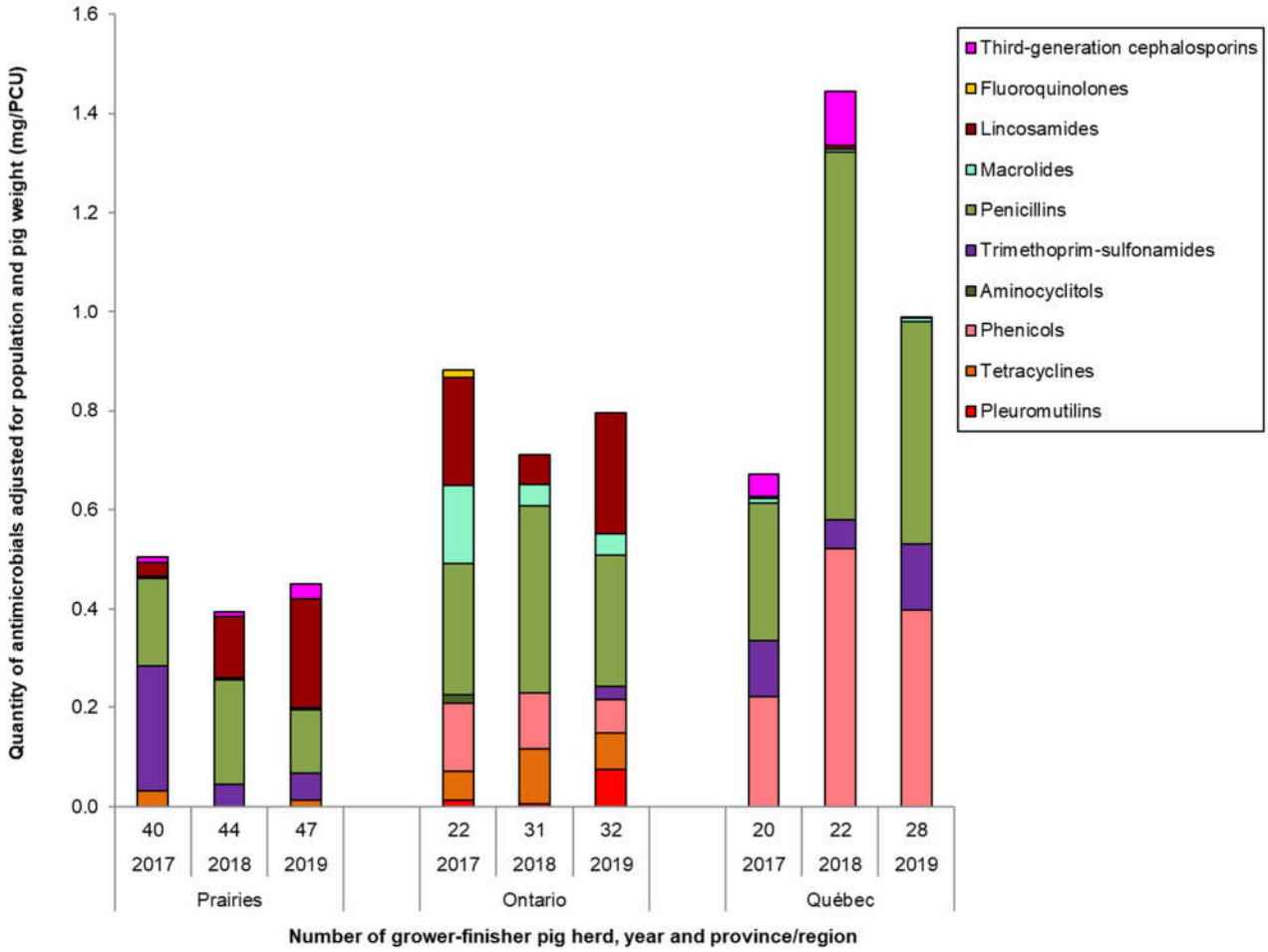
Figure 3.21 The quantity (milligrams) of antimicrobials administered by injection, adjusted for population and pig weight (mg/PCU), 2017 to 2019



Year Number of herds		2017 82	2018 97	2019 107
Antimicrobial class				
I	Third-generation cephalosporins	0.017	0.029	0.017
	Fluoroquinolones	0.004	0.000	0.000
II	Lincosamides	0.051	0.085	0.175
	Macrolides	0.028	0.013	0.014
	Penicillins	0.215	0.361	0.232
	Trimethoprim-sulfonamides	0.182	0.037	0.067
III	Aminocyclitols	0.003	0.000	0.000
	Phenicols	0.069	0.135	0.107
	Tetracyclines	0.029	0.025	0.023
UC	Pleuromutilins	0.002	0.001	0.017
Total		**0.599**	**0.686**	**0.643**

Roman numerals I to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = Pleuromutilins are medically important but uncategorized (UC).
mg/PCU = milligrams/population correction unit.
For detailed indicator descriptions, please refer to Table 3.1.

Figure 3.22 The quantity (milligrams) of antimicrobials administered by injection, adjusted for population and pig weight (mg/PCU) by province/region, 2017 to 2019

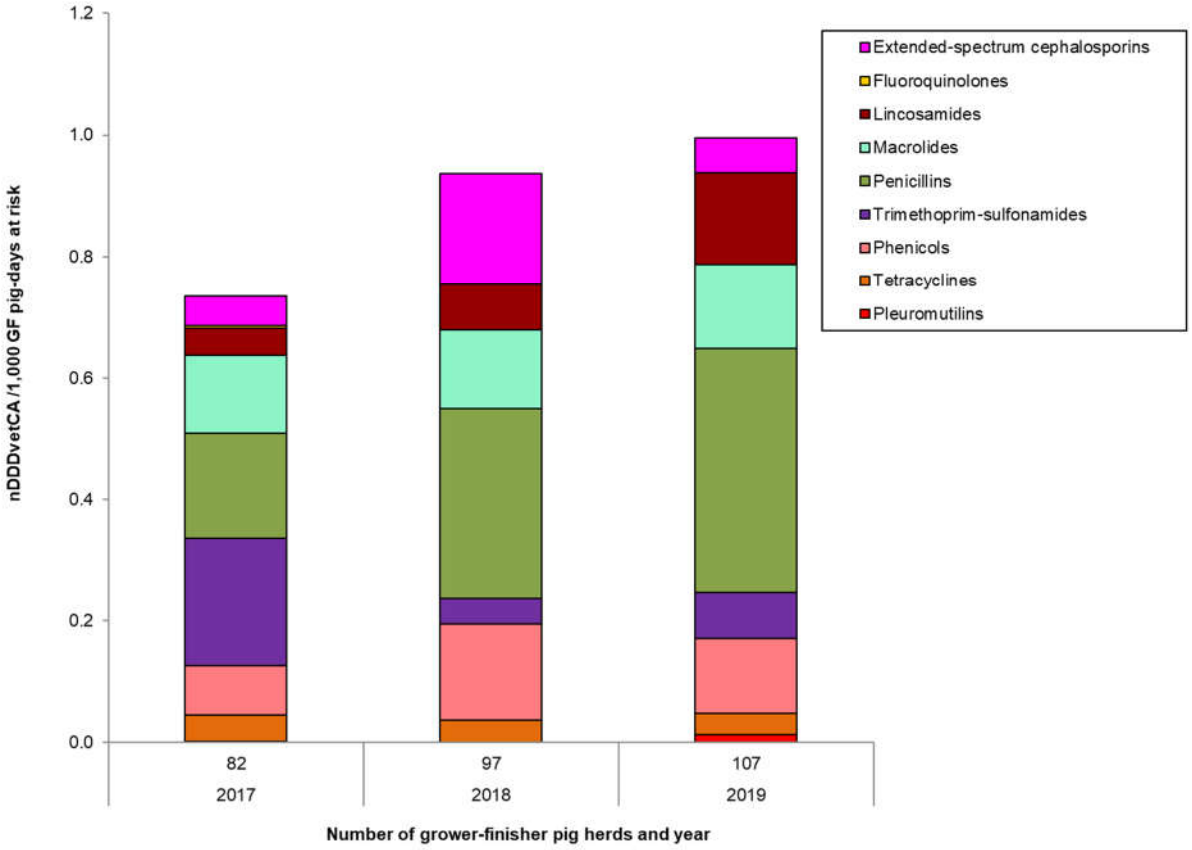


Province/region		Prairies			Ontario			Québec		
Year		2017	2018	2019	2017	2018	2019	2017	2018	2019
Number of herds		40	44	47	22	31	32	20	22	28
Antimicrobial class										
I	Third-generation cephalosporins	0.011	0.010	0.030	0.000	0.000	0.000	0.045	0.108	0.003
	Fluoroquinolones	0.000	0.000	0.000	0.016	0.000	0.000	0.005	0.000	0.000
II	Lincosamides	0.028	0.124	0.221	0.216	0.061	0.244	0.000	0.007	0.000
	Macrolides	0.003	0.004	0.005	0.158	0.043	0.043	0.008	0.005	0.006
	Penicillins	0.180	0.211	0.130	0.266	0.379	0.266	0.280	0.744	0.449
	Trimethoprim-sulfonamides	0.251	0.044	0.056	0.000	0.000	0.027	0.112	0.058	0.133
III	Aminocyclitols	0.000	0.000	0.000	0.018	0.000	0.000	0.000	0.000	0.000
	Phenicols	0.000	0.000	0.000	0.136	0.113	0.068	0.222	0.521	0.398
	Tetracyclines	0.031	0.000	0.013	0.059	0.111	0.073	0.000	0.000	0.000
UC	Pleuromutilins	0.000	0.000	0.000	0.013	0.005	0.074	0.000	0.000	0.000
Total		**0.504**	**0.394**	**0.434**	**0.882**	**0.711**	**0.795**	**0.672**	**1.444**	**0.989**

Roman numerals I to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = Pleuromutilins are medically important but uncategorized (UC).
mg/PCU = milligrams/population correction unit.
For detailed indicator descriptions, please refer to Table 3.1.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Quantity (Dose based measures)

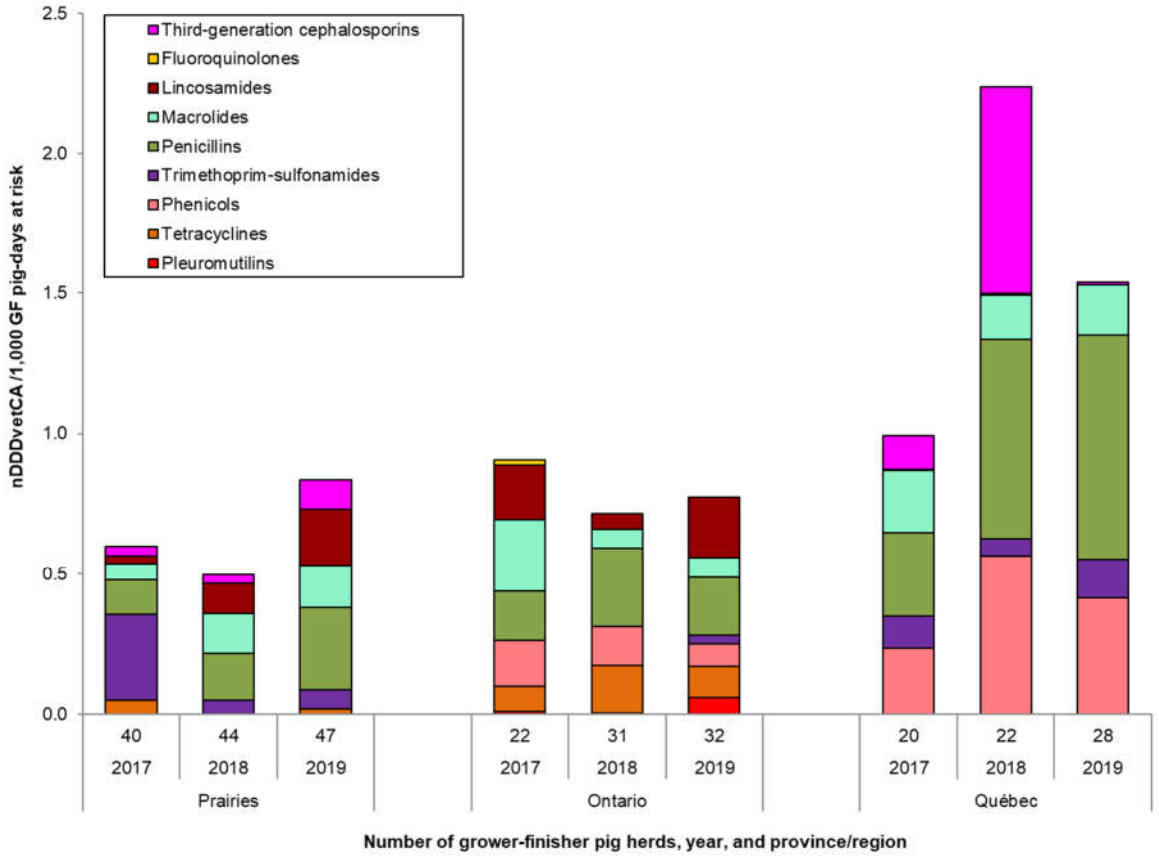
Figure 3.23 Number of Canadian Defined Daily Doses for animals per 1,000 grower-finisher pig-days at risk (nDDDvetCA/1,000 GF pig-days at risk) for antimicrobials administered by injection, 2017 to 2019



Year		2017	2018	2019
Number of herds		82	97	107
Antimicrobial class				
I	Extended-spectrum cephalosporins	0.049	0.184	0.056
	Fluoroquinolones	0.004	0.000	0.000
II	Lincosamides	0.045	0.074	0.151
	Macrolides	0.128	0.130	0.139
	Penicillins	0.173	0.313	0.402
	Trimethoprim-sulfonamides	0.211	0.043	0.076
III	Phenicols	0.080	0.157	0.123
	Tetracyclines	0.044	0.036	0.035
UC	Pleuromutilins	0.002	0.001	0.013
Over all classes		**0.735**	**0.937**	**0.995**

Roman numerals I to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = Pleuromutilins are medically important but uncategorized.
DDDvetCA = Canadian Defined Daily Doses for animals (average labelled dose) in milligrams per kilogram grower-finisher pig weight per day (mg_{drug}/kg_{animal}/day); please refer to Appendix: Supplemental data of the 2018 CIPARS: Design and Methods, Table A. 2 for the list of standards.
For detailed indicator descriptions, please refer to Table 3.1.

Figure 3.24 Number of Canadian Defined Daily Doses for animals per 1,000 grower-finisher pig-days at risk (nDDDvetCA/1,000 GF pig-days at risk) for antimicrobials administered by injection, by province/region, 2017 to 2019



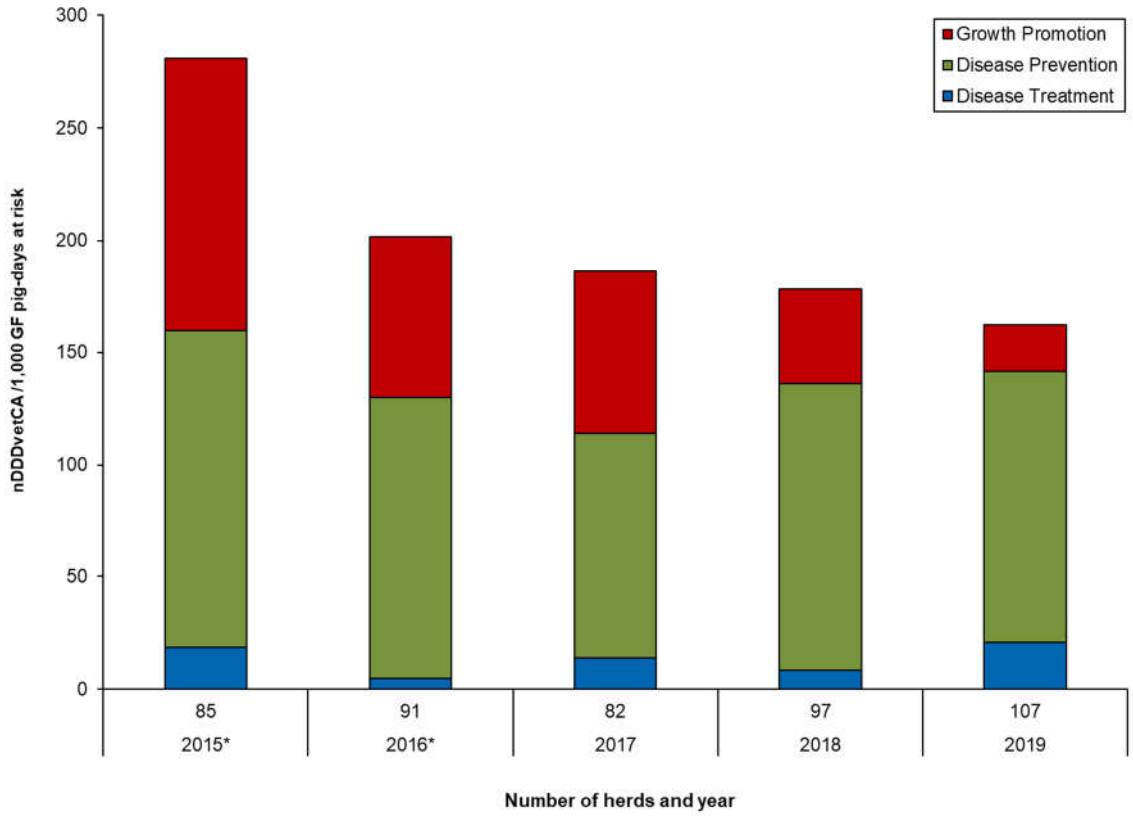
Province/region		Prairies			Ontario			Québec		
Year		2017	2018	2019	2017	2018	2019	2017	2018	2019
Number of herds		40	44	47	22	31	32	20	22	28
Antimicrobial class										
I	Third-generation cephalosporins	0.03	0.03	0.10	0.00	0.00	0.00	0.12	0.74	0.01
	Fluoroquinolones	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
II	Lincosamides	0.03	0.11	0.20	0.19	0.05	0.22	0.00	0.01	0.00
	Macrolides	0.06	0.14	0.15	0.26	0.07	0.07	0.22	0.16	0.18
	Penicillins	0.12	0.17	0.29	0.18	0.28	0.21	0.30	0.71	0.80
	Trimethoprim-sulfonamides	0.30	0.05	0.07	0.00	0.00	0.03	0.12	0.06	0.14
III	Phenicols	0.00	0.00	0.00	0.16	0.14	0.08	0.23	0.57	0.41
	Tetracyclines	0.05	0.00	0.02	0.09	0.17	0.11	0.00	0.00	0.00
UC	Pleuromutilins	0.00	0.00	0.00	0.01	0.00	0.06	0.00	0.00	0.00
Total		**0.60**	**0.50**	**0.84**	**0.91**	**0.72**	**0.77**	**0.99**	**2.24**	**1.54**

Roman numerals I to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. UC = Pleuromutilins are medically important but uncategorized.
DDDvetCA = Canadian Defined Daily Doses for animals (average labelled dose) in milligrams per kilogram grower-finisher pig weight per day (mg_{drug}/kg_{animal}/day); please refer to Appendix: Supplemental data of the 2018 CIPARS: Design and Methods, Table A. 2 for the list of standards.
For detailed indicator descriptions, please refer to Table 3.1.
The Prairies is a region and includes the provinces of Alberta, Saskatchewan, and Manitoba.

Reasons for Antimicrobial use

Quantity (Dose based measures)

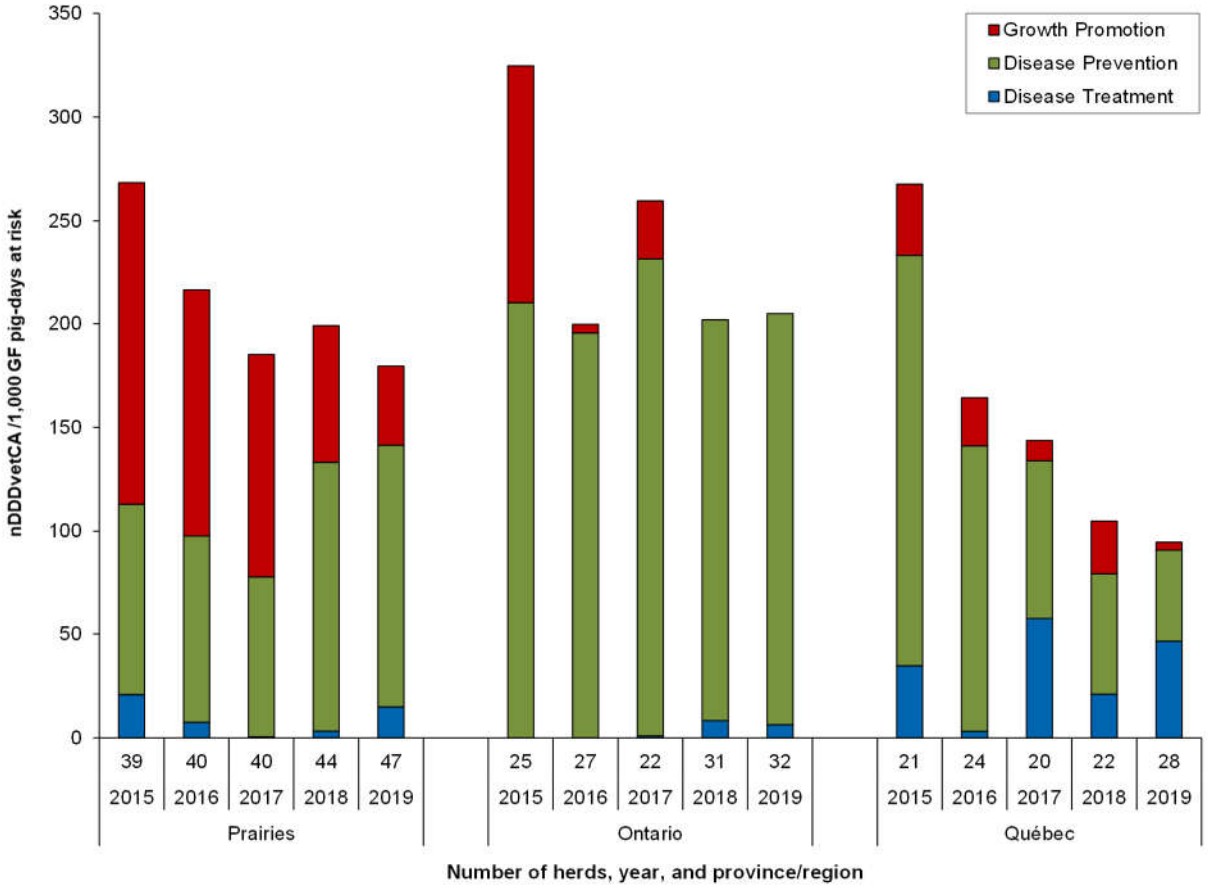
Figure 3.25 Total number of Canadian Defined Daily Doses for animals per 1,000 grower-finisher pig-days at risk (nDDDvetCA/1,000 GF pig-days at risk), by reason for antimicrobial use, 2015 to 2019



Year Number of farms	2015* 85	2016* 91	2017 82	2018 97	2019 107
Growth promotion	121	72	72	42	21
Disease prevention	141	125	100	128	121
Disease treatment	18	5	14	8	21
Total	**281**	**202**	**186**	**178**	**162**

*Data for 2015 and 2016 represent antimicrobial use in feed only.
DDDvetCA = Canadian Defined Daily Doses for animals (average labelled dose) in milligrams per kilogram grower-finisher pig weight per day (mg_{drug}/kg_{animal}/day); please refer to Appendix: Supplemental data of the 2018 CIPARS: Design and Methods, Table A. 2 for the list of standards.
For detailed indicator descriptions, please refer to Table 3.1.

Figure 3.26 Total number of Canadian Defined Daily Doses for animals per 1,000 grower-finisher pig-days at risk (nDDDvetCA/1,000 GF pig-days at risk) by reason for antimicrobial use and by province/region, 2015 to 2019



Province/region	Prairies					Ontario					Québec				
Year	2015*	2016*	2017	2018	2019	2015*	2016*	2017	2018	2019	2015*	2016*	2017	2018	2019
Number of herds	39	40	40	44	47	25	27	22	31	32	21	24	20	22	28
Growth promotion	155	119	107	66	38	115	4	28	0	0	34	23	10	25	4
Disease prevention	92	90	77	130	127	210	195	231	194	199	199	138	76	58	44
Disease treatment	21	8	1	3	15	0	0	1	8	6	35	3	57	21	46
Total	**268**	**217**	**185**	**199**	**180**	**325**	**200**	**260**	**202**	**205**	**268**	**164**	**144**	**105**	**95**

*Data for 2015 and 2016 represent antimicrobial use in feed only.
DDDvetCA = Canadian Defined Daily Doses for animals (average labelled dose) in milligrams per kilogram grower-finisher pig weight per day (mg_{drug}/kg_{animal}/day); please refer to Appendix: Supplemental data of the 2018 CIPARS: Design and Methods, Table A. 2 for the list of standards.
For detailed indicator descriptions, please refer to Table 3.1.
The Prairies is a region and includes the provinces of Alberta, Saskatchewan, and Manitoba.

Chapter 4: Antimicrobial Resistance

The data presented in this section pertains to the antimicrobial resistance data generated from *Salmonella*, generic *Escherichia coli*, and *Campylobacter* from swine in Farm, Abattoir, and Retail surveillance.

Farm Surveillance

Key findings

Salmonella (n = 165)

When data from all provinces were combined, the top 3 *Salmonella* serovars were Typhimurium, I:4,[5],12:i:- and Derby. These same serovars were the top 3 serovars for Ontario and Québec however the ranking did vary with the province. In the prairies Typhimurium and Derby were in the first and second rank whereas I:4,12:d:- was third.

No resistance to meropenem or ciprofloxacin was identified. Two Typhimurium isolates from the Prairies were resistant to 6 or 7 antimicrobial classes.

Nationally, resistance to ampicillin increased significantly between 2010 (27%) and 2019 (47%), and between 2018 (38%) and 2019 (47%). Similarly, streptomycin and tetracycline resistance significantly increased between 2018 (52%, 57% respectively) and 2019 (65%, 60% respectively. There was also a significant increase in streptomycin resistance between 2010 (32%) and 2019 (65%).

There was a significant increase in ampicillin resistance between 2015 and 2019 from 5% to 35% and between 2018 and 2019 from 13% to 35% in the Prairies.

There was also a significant increase in streptomycin resistance between 2015 (26%) and 2019 (50%) and between 2018 (32%) and 2019 (50%) in the Prairies. Streptomycin resistance significantly increased in Ontario from 62% to 73% between 2018 and 2019.

In Québec, while not significant, a decrease was seen in trimethoprim-sulfamethoxazole resistance from 26% to 12% between 2018 and 2019.

While not significant ceftriaxone resistance was trending upward since 2017 in the Prairies but has either trended down or remained relatively stable in the other provinces for the same time frame.

Escherichia coli (n = 628)

Of the 628 isolates, only 15 isolates (2%), were resistant to ceftriaxone. One isolate from Québec was resistant to 6 or 7 classes of antimicrobials. Resistance to either meropenem or ciprofloxacin was not detected in any of the isolates. Three isolates, 1 from the Prairies, and 1 from Québec were resistant to nalidixic acid.

Nationally, ceftriaxone resistance significantly increased from <1% in 2010 to 2% in 2019. Streptomycin resistance significantly decreased from 45% (2015) to 38% (2019). Tetracycline resistance also significantly decreased from 75% in 2010 to 65% in 2019.

In the Prairies and Ontario, no significant changes were detected for the antimicrobials tested. In Québec there was a significant decrease in ampicillin (34%, 24% respectively), streptomycin (59%, 36% respectively and tetracycline (84%, 68% respectively) between 2015 and 2019.

Campylobacter (n = 447)

Twelve percent (50/447) of the isolates were resistant to nalidixic acid and ciprofloxacin. Unlike last year where the resistant isolates were largely from herds in Québec, this year the number of actual isolates from each province was similar however Québec had a slightly higher prevalence of resistance (18%) to these antimicrobials than did the Prairies (8%) or Ontario (10%).

Nationally, ciprofloxacin resistance significantly increased from 8% in 2017 to 12% in 2019.Tetracycline resistance on the other hand significantly decreased from 67% to 63% between 2018 and 2019.

There were no significant changes noted for the Prairies or Ontario in resistance to the antimicrobials tested. Québec had a significant decrease in tetracycline resistance from 85% in 2017 to 74% in 2019.

Multiclass resistance

Table 4.1 Number of antimicrobial classes in resistance patterns of *Salmonella* from farm pigs, 2019

Province or region / serovar		Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
								Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
			0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	MEM	SSS	SXT	AZM	CHL	CIP	NAL	TET
Prairies																					
	Typhimurium	7 (13.5)	1			4	2	2	6	6					6	2	2	6			6
	Derby	6 (11.5)	2	1	2	1			3	2	2	2	2		3		1				3
	I:4,12:d:-	5 (9.6)			5				5						5						5
	Ohio	5 (9.6)	4		1				1						1						1
	Worthington	4 (7.7)	2		2			2		2	2	2	2								
	Agona	3 (5.7)	1	1	1				1	2											
	I:4,12:i:-	3 (5.7)				3			3	3					3						3
	Infantis	3 (5.7)	3																		
	Livingstone	3 (5.7)	2			1			1	1	1	1	1		1	1		1			1
	Putten	3 (5.7)	2	1					1												
	Senftenberg	3 (5.7)	2	1					1												
	Give	2 (3.8)	1		1				1						1	1					
	Schwarzengrund	2 (3.8)			2				2						2						2
	Less common serovars	3 (5.7)	2		1				1						1						
	Total	**52 (100)**	**22**	**4**	**15**	**9**	**2**	**4**	**26**	**16**	**5**	**5**	**5**		**23**	**4**	**3**	**7**			**21**
Ontario																					
	Typhimurium	18 (32.7)	1	2	3	12			15	11					15	2		12			16
	I:4,[5],12:i:-	16 (29.1)	3			13		1	13	13					13						13
	Derby	7 (12.7)			7				7						7						7
	Infantis	3 (5.5)	1			2			2	1	1	1	1		2			2			2
	Muenchen	3 (5.5)	2			1			1	1	1	1	1		1			1			1
	Ohio	3 (5.5)	1			2		2	2	2					2						2
	Uganda	2 (3.6)	2																		
	Less common serovars	3 (5.5)	1	1	1			1	2												1
	Total	**55 (100)**	**11**	**3**	**11**	**30**		**4**	**42**	**28**	**2**	**2**	**2**		**40**	**2**		**15**			**42**
Québec																					
	I:4,[5],12:i:-	19 (32.8)	1	3		15			15	15					15						18
	Typhimurium	17 (29.3)			6	11		3	16	11					15	6	2	9			13
	Derby	6 (10.3)			6				6						6						6
	Brandenburg	5 (8.6)	4	1						1											
	Ohio	3 (5.2)	1			2			2	2	1	1	1		2		1	1			2
	Schwarzengrund	3 (5.2)	2		1				1												1
	Worthington	3 (5.2)		1		2		2	2						2			2			3
	Less common serovars	2 (3.4)	2																		
	Total	**58 (100)**	**10**	**5**	**13**	**30**		**5**	**42**	**29**	**1**	**1**	**1**		**40**	**6**	**3**	**12**			**43**
National																					
	Typhimurium	42 (25.5)	2	2	9	27	2	5	37	28					36	10	4	27			35
	I:4,[5],12:i:-	36 (21.8)	5	3		28		1	28	28					28						31
	Derby	19 (11.5)	2	1	15	1			16	2	2	2	2		16						16
	Ohio	11 (6.7)	6		1	4		2	5	4	1	1	1		5		1	1			5
	Worthington	8 (4.8)	3	1	2	2		4	2	2	2	2	2		2			2			3
	Infantis	7 (4.2)	5			2			2	1	1	1	1		2			2			2
	Brandenburg	5 (3.0)	4	1						1											
	I:4,12:d:-	5 (3.0)			5				5						5						5
	Schwarzengrund	5 (3.0)	2		3				3						2						3
	Less common serovars	27 (16.4)	14	4	4	5		1	12	7	2	2	2		7	2		2			6
	Total	**165 (100)**	**43**	**12**	**39**	**69**	**2**	**13**	**110**	**73**	**8**	**8**	**8**		**103**	**12**	**5**	**34**			**106**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Serovars represented by less than 2% of isolates were classified as ''Less common serovars.''
Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Table 4.2 Number of antimicrobial classes in resistance patterns of *Escherichia coli* from farm pigs, 2019

Province or region	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	MEM	SSS	SXT	AZM	CHL	CIP	NAL	TET
Prairies	272 (43.3)	83	65	104	20			100	79	12	13	12		63	20		20		2	143
Ontario	189 (30.1)	23	56	78	32		1	80	60					78	24		24			151
Québec	167 (26.6)	35	44	62	25	1	4	60	40	1	2	1		65	34	1	20		1	114
National	**628 (100)**	**141**	**165**	**244**	**77**	**1**	**5**	**240**	**179**	**13**	**15**	**13**		**206**	**78**	**1**	**64**		**3**	**408**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

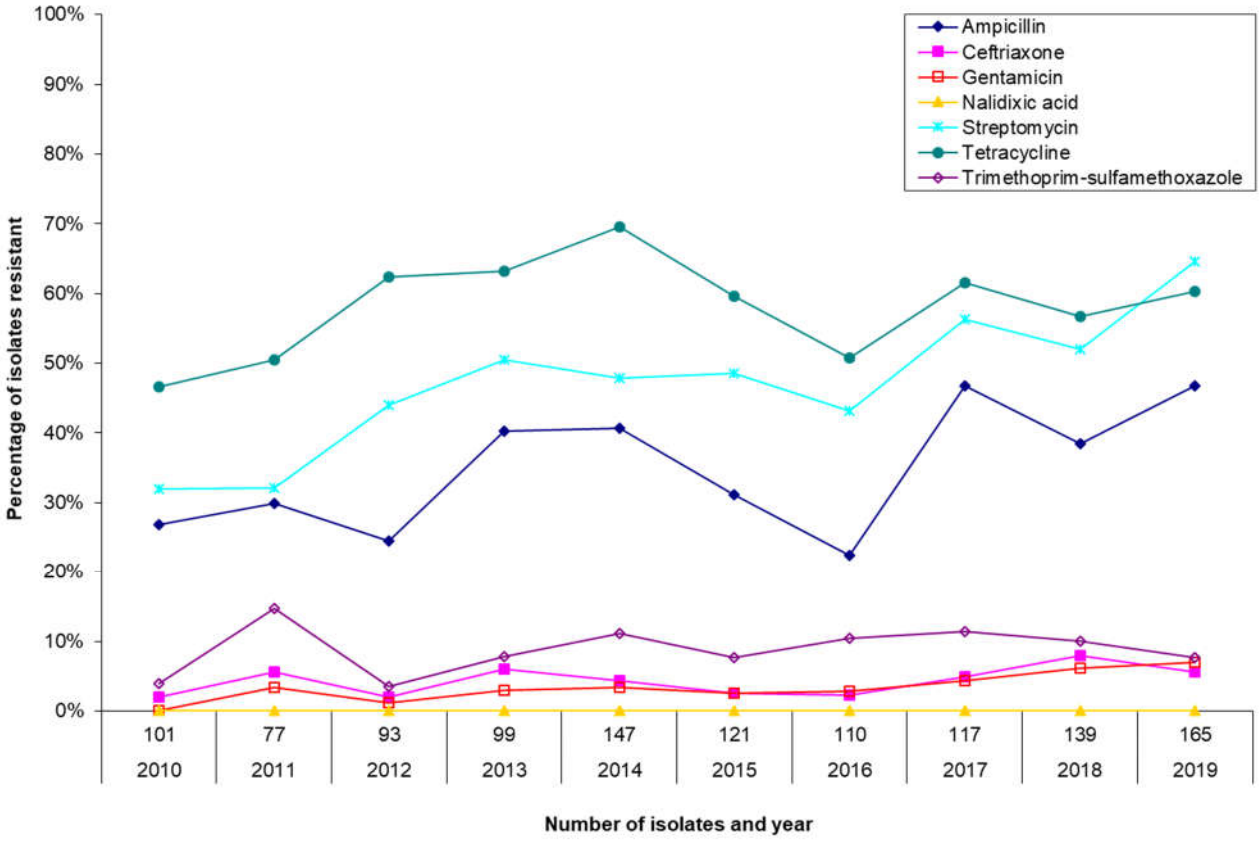
Table 4.3 Number of antimicrobial classes in resistance patterns of *Campylobacter* from farm pigs, 2019

Province or region / species		Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial						
								Aminoglycosides	Lincosamides	Macrolides		Phenicols	Quinolones		Tetracyclines
			0	1	2–3	4–5	6–7	GEN	CLI	AZM	ERY	FLR	CIP	NAL	TET
Prairies															
	Campylobacter coli	204 (100)	55	51	89	9			83	90	90		17	17	102
	Total	**204 (100)**	**55**	**51**	**89**	**9**			**83**	**90**	**90**		**17**	**17**	**102**
Ontario															
	Campylobacter coli	139 (100)	29	36	59	15			56	69	69		14	14	100
	Total	**139 (100)**	**29**	**36**	**59**	**15**			**56**	**69**	**69**		**14**	**14**	**100**
Québec															
	Campylobacter coli	104 (100)	15	42	41	6			23	34	34		19	19	77
	Total	**104 (100)**	**15**	**42**	**41**	**6**			**23**	**34**	**34**		**19**	**19**	**77**
National															
	Campylobacter coli	447 (100)	99	129	189	30			162	193	193		50	50	279
	Total	**447 (100)**	**99**	**129**	**189**	**30**			**162**	**193**	**193**		**50**	**50**	**279**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.

Temporal variations

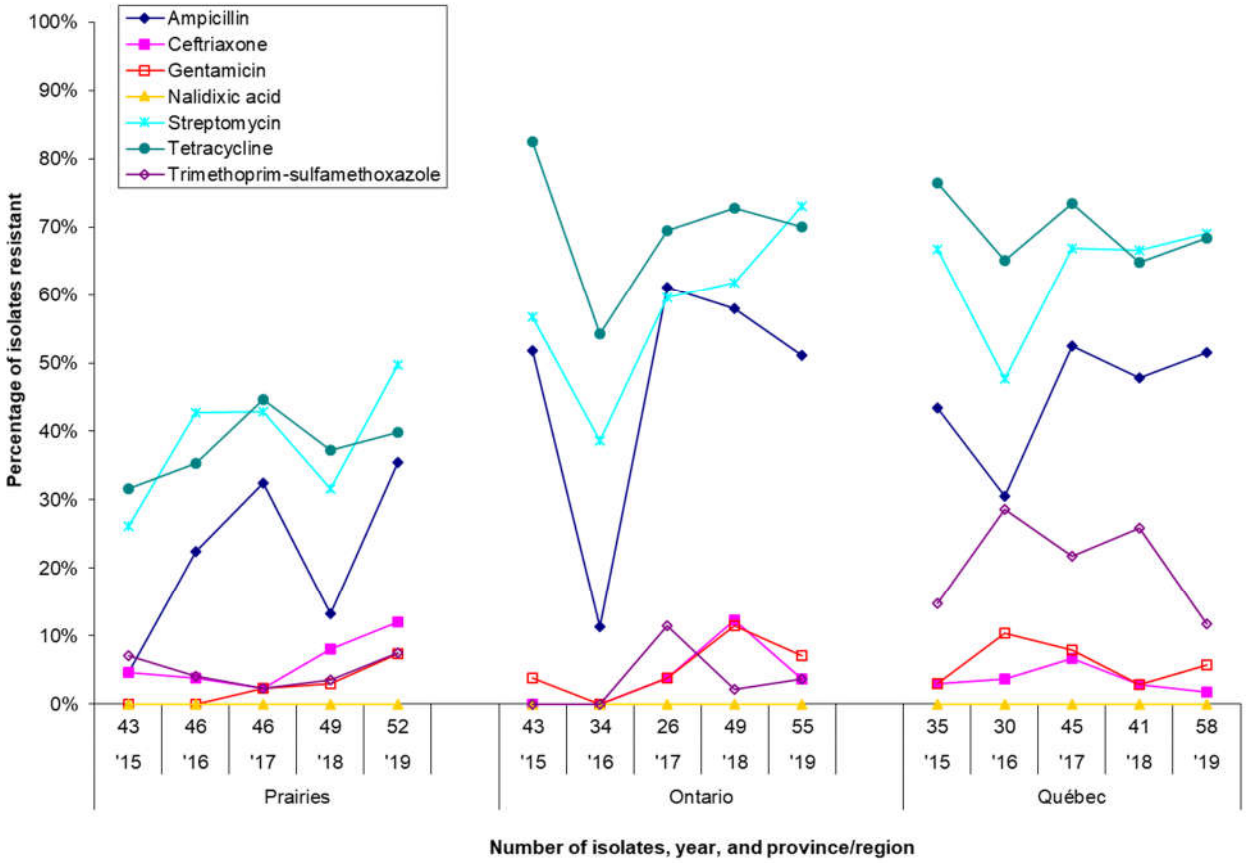
Figure 4.1 Temporal variations in resistance of *Salmonella* isolates from farm pigs, 2010 to 2019



Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of isolates	101	77	93	99	147	121	110	117	139	165
Antimicrobial										
Ampicillin	**27%**	30%	24%	40%	41%	**31%**	23%	47%	**38%**	**47%**
Ceftriaxone	**2%**	6%	2%	6%	4%	**2%**	2%	5%	**8%**	**6%**
Gentamicin	**0%**	3%	1%	3%	3%	**3%**	3%	4%	**6%**	**7%**
Nalidixic acid	**0%**	0%	0%	0%	0%	**0%**	0%	0%	**0%**	**0%**
Streptomycin	**32%**	32%	44%	50%	48%	**49%**	43%	56%	**52%**	**65%**
Tetracycline	**47%**	50%	62%	63%	69%	**60%**	51%	62%	**57%**	**60%**
Trimethoprim-sulfamethoxazole	**4%**	15%	3%	8%	11%	**8%**	10%	11%	**10%**	**8%**

For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial during the previous 10 years, 5 years, and previous surveillance year (grey areas). The presence of blue areas indicates significant temporal differences ($P \leq 0.05$) for a given antimicrobial. Percent of resistant isolates were adjusted for clustering at the herd level.

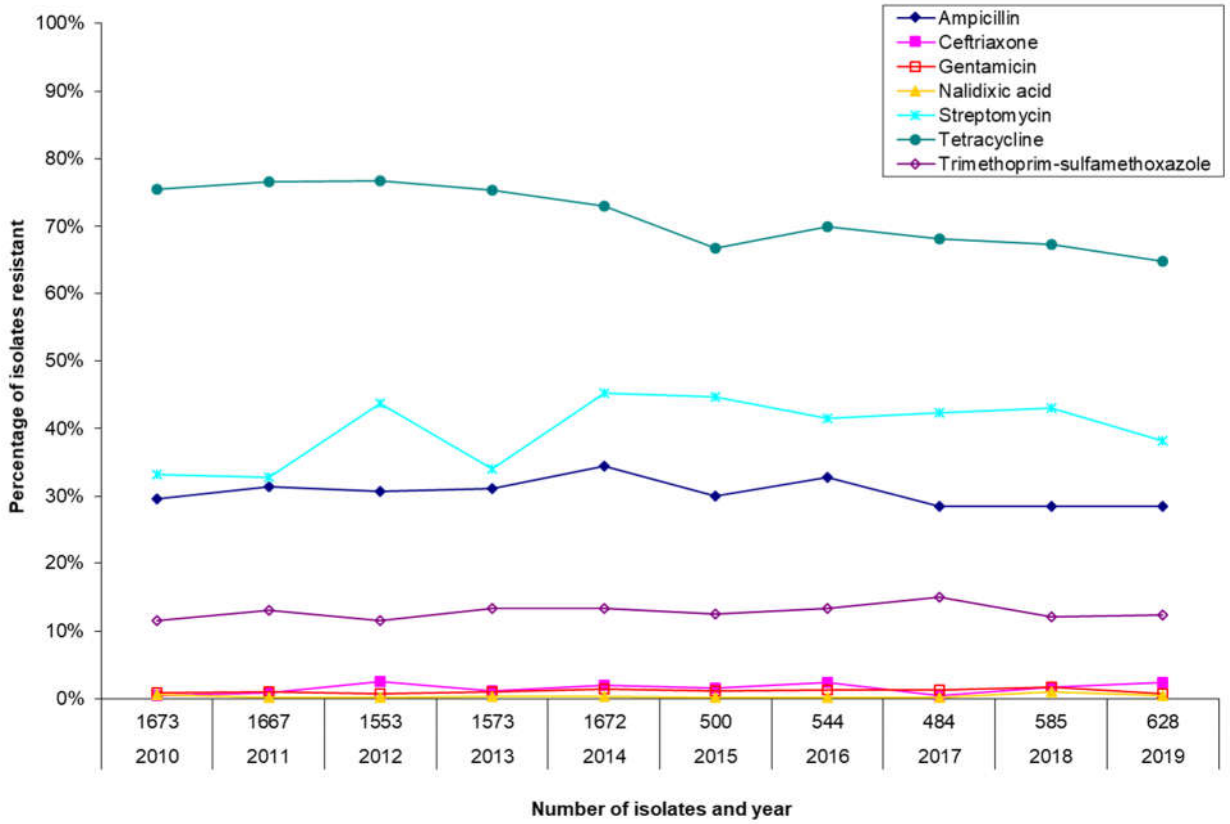
Figure 4.2 Temporal variations in resistance of *Salmonella* isolates from farm pigs, by province/region, 2015 to 2019



Province/region	Prairies					Ontario					Québec				
Year	'15	'16	'17	'18	'19	'15	'16	'17	'18	'19	'15	'16	'17	'18	'19
Number of isolates	43	46	46	49	52	43	34	26	49	55	35	30	45	41	58
Antimicrobial															
Ampicillin	**5%**	23%	32%	**13%**	**35%**	**52%**	11%	61%	**58%**	**51%**	**43%**	31%	52%	**48%**	**51%**
Cefriaxone	**5%**	4%	2%	**8%**	**12%**	**0%**	0%	4%	**12%**	**4%**	**3%**	4%	7%	**3%**	**2%**
Gentamicin	**0%**	0%	2%	**3%**	**7%**	**4%**	0%	4%	**11%**	**7%**	**3%**	10%	8%	**3%**	**6%**
Nalidixic acid	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**
Streptomycin	**26%**	43%	43%	**32%**	**50%**	**57%**	39%	60%	**62%**	**73%**	**67%**	48%	67%	**67%**	**69%**
Tetracycline	**32%**	35%	45%	**37%**	**40%**	**83%**	54%	69%	**73%**	**70%**	**77%**	65%	73%	**65%**	**68%**
Trimethoprim-sulfamethoxazole	**7%**	4%	2%	**4%**	**7%**	**0%**	0%	11%	**2%**	**4%**	**15%**	29%	22%	**26%**	**12%**

For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial during the previous 5 years and previous surveillance year (grey areas). The presence of blue areas indicates significant temporal differences ($P \leq 0.05$) for a given antimicrobial. Percent of resistant isolates were adjusted for clustering at the herd level.
Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

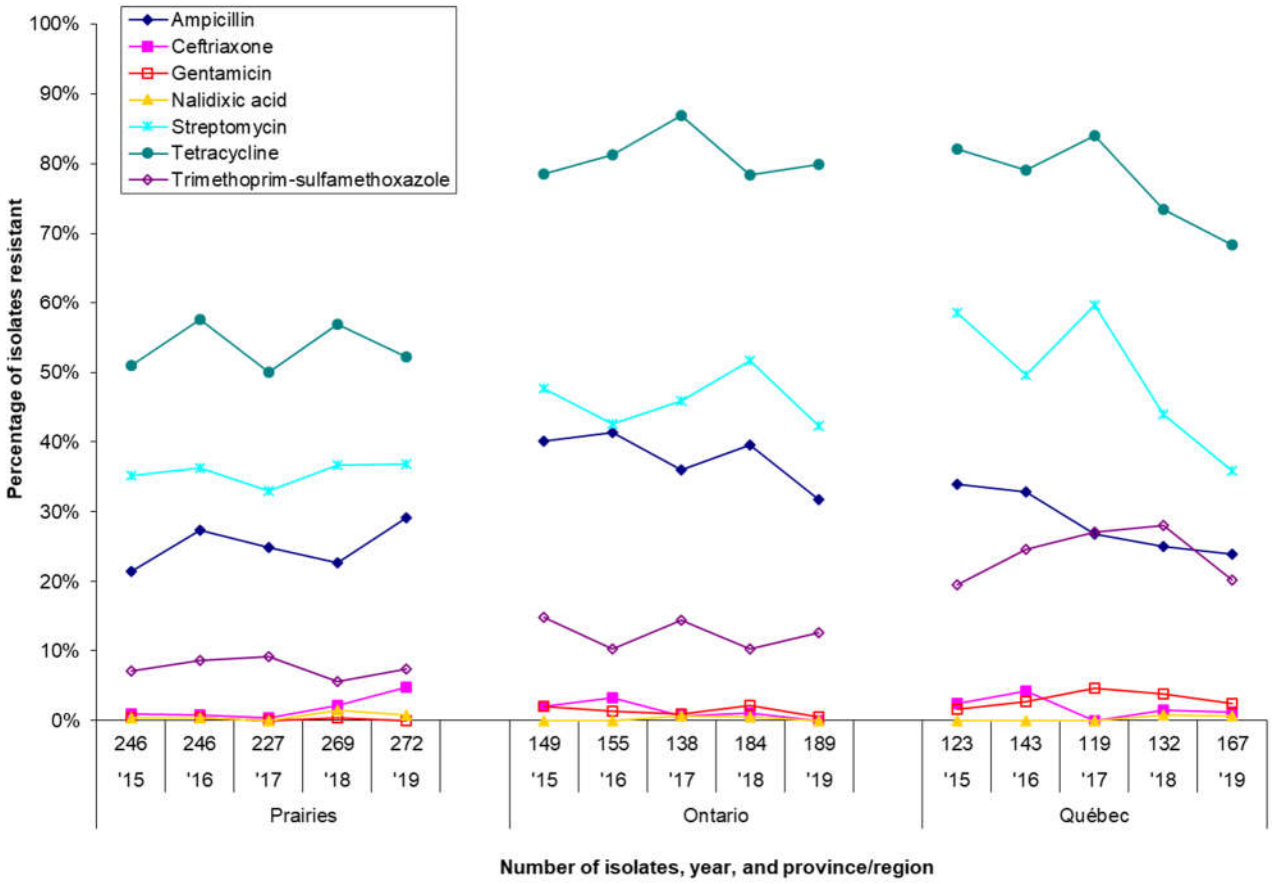
Figure 4.3 Temporal variations in resistance of *Escherichia coli* isolates from farm pigs, 2010 to 2019



Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of isolates	1673	1667	1553	1573	1672	500	544	484	585	628
Antimicrobial										
Ampicillin	**30%**	31%	31%	31%	34%	**30%**	33%	28%	**29%**	**29%**
Ceftriaxone	**0.5%**	1%	2%	1%	2%	**2%**	2%	0%	**2%**	**2%**
Gentamicin	**1%**	1%	1%	1%	1%	**1%**	1%	1%	**2%**	**1%**
Nalidixic acid	**1%**	0.2%	0.3%	0.3%	0.4%	**0.2%**	0.2%	0.2%	**1.0%**	**0.5%**
Streptomycin	**33%**	33%	44%	34%	45%	**44.7%**	42%	42%	**43%**	**38.2%**
Tetracycline	**75.5%**	77%	77%	75%	73%	**67%**	70%	68%	**67%**	**64.8%**
Trimethoprim-sulfamethoxazole	**11%**	13%	12%	13%	13%	**12%**	13%	15%	**12%**	**12%**

For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial during the previous 10 years, 5 years, and previous surveillance year (grey areas). The presence of blue areas indicates significant temporal differences ($P \leq 0.05$) for a given antimicrobial. Percent of resistant isolates were adjusted for clustering at the herd level.

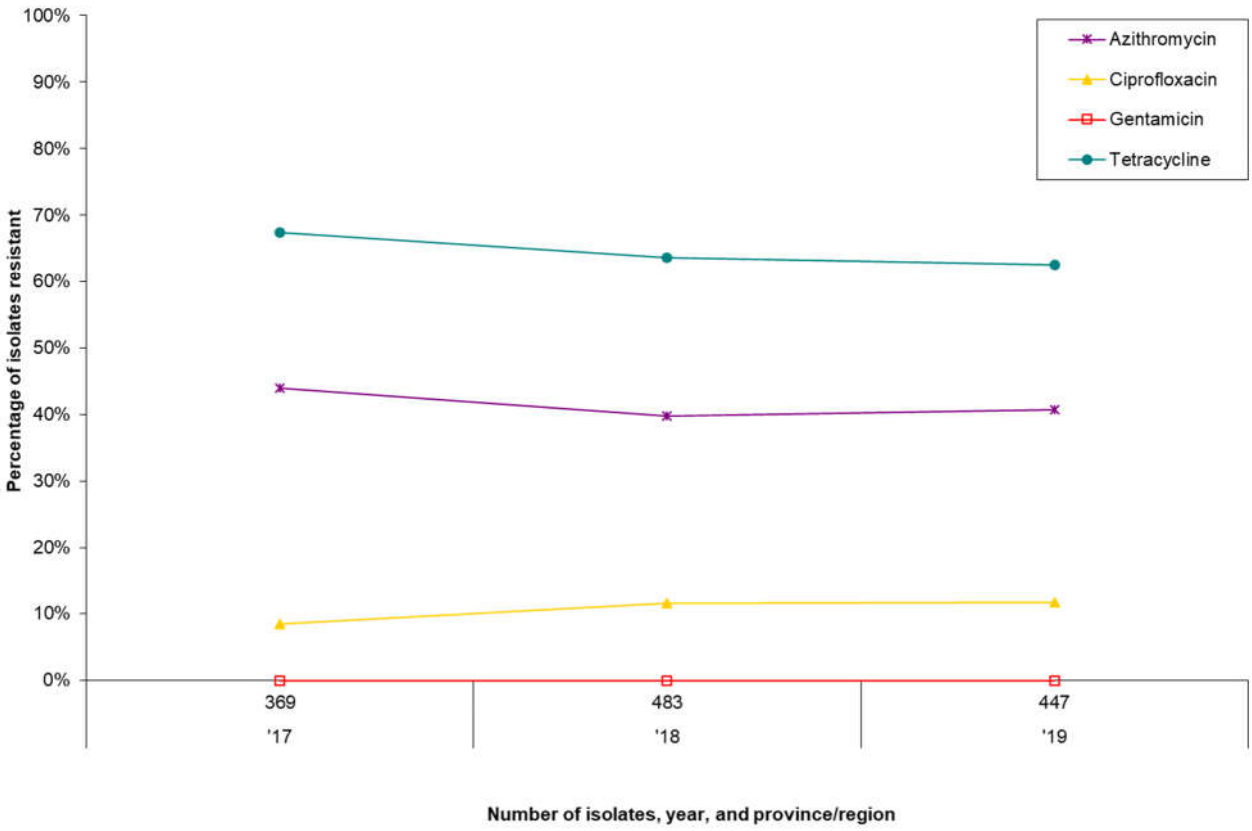
Figure 4.4 Temporal variations in resistance of *Escherichia coli* isolates from farm pigs, by province/region, 2015 to 2019



Province/region	Prairies					Ontario					Québec				
Year	'15	'16	'17	'18	'19	'15	'16	'17	'18	'19	'15	'16	'17	'18	'19
Number of isolates	228	246	227	269	272	149	155	138	184	189	123	143	119	132	167
Antimicrobial															
Ampicillin	**22%**	27%	25%	**23%**	**29%**	**40%**	41%	36%	**40%**	**32%**	**34%**	33%	27%	**25%**	**24%**
Cefriaxone	**1%**	1%	0%	**2%**	**5%**	**2%**	3%	1%	**1%**	**0%**	**2%**	4%	0%	**2%**	**1%**
Gentamicin	**0%**	0%	0%	**0%**	**0%**	**2%**	1%	1%	**2%**	**1%**	**2%**	3%	5%	**4%**	**2%**
Nalidixic acid	**0%**	0%	0%	**1%**	**1%**	**0%**	0%	1%	**1%**	**0%**	**0%**	0%	0%	**1%**	**1%**
Streptomycin	**35%**	36%	33%	**37%**	**37%**	**48%**	43%	46%	**52%**	**42%**	**59%**	50%	60%	**44%**	**36%**
Tetracycline	**51%**	58%	50%	**57%**	**52%**	**78%**	81%	87%	**78%**	**80%**	**82%**	79%	84%	**73%**	**68%**
Trimethoprim-sulfamethoxazole	**7%**	9%	9%	**6%**	**7%**	**15%**	10%	14%	**10%**	**13%**	**20%**	25%	27%	**28%**	**20%**

For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial during the previous 5 years and previous surveillance year (grey areas). The presence of blue areas indicates significant temporal differences ($P \leq 0.05$) for a given antimicrobial. Percent of resistant isolates were adjusted for clustering at the herd level.
Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

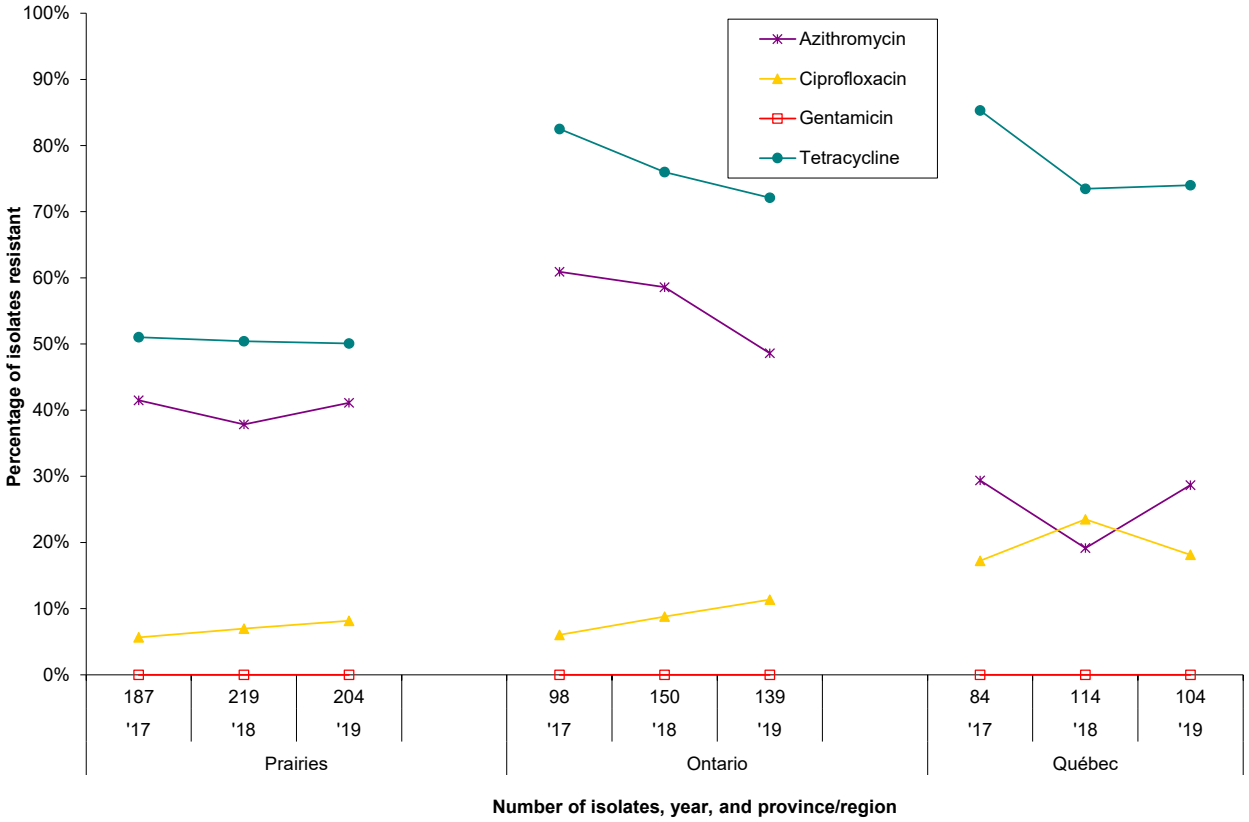
Figure 4.5 Resistance of *Campylobacter* isolates from farm pigs, 2017 to 2019



Province / region	National		
Year	'17	'18	'19
Number of isolates	369	483	447
Antimicrobial			
Azithromycin	44%	40%	41%
Ciprofloxacin	8%	11%	12%
Gentamicin	0%	0%	0%
Tetracycline	67%	64%	63%

For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial during the first year of surveillance and previous surveillance year (grey areas). The presence of blue areas indicates significant temporal differences ($P \leq 0.05$) for a given antimicrobial. Percent of resistant isolates were adjusted for clustering at the herd level.
Campylobacter spp. include unidentified species, some of which may be intrinsically resistant to nalidixic acid.

Figure 4.6 Resistance of *Campylobacter* isolates from farm pigs by province/region, 2017 to 2019



Province/region	Prairies			Ontario			Québec		
Year	'17	'18	'19	'17	'18	'19	'17	'18	'19
Number of isolates	187	219	204	98	150	139	84	114	104
Antimicrobial									
Azithromycin	41%	38%	41%	61%	59%	49%	29%	19%	29%
Ciprofloxacin	6%	7%	8%	6%	9%	11%	17%	24%	18%
Gentamicin	0%	0%	0%	0%	0%	0%	0%	0%	0%
Tetracycline	51%	50%	50%	82%	76%	72%	85%	73%	74%

For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial during the first year of surveillance and previous surveillance year (grey areas). The presence of blue areas indicates significant temporal differences ($P \leq 0.05$) for a given antimicrobial. Percent of resistant isolates are adjusted for clustering at the herd level.
Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Abattoir Surveillance

Key findings

Salmonella (n = 169)

Salmonella Derby, Infantis, I 4,[5],12:i:- and Typhimurium were the most common serovars in 2019. Thirty-eight isolates (22%) were resistant to 4 to 5 classes, distributed across all regions

One *S*. Ohio isolate (1%) from Manitoba was resistant to 6 to 7 classes.

The national trend in increasing resistance to tetracycline, streptomycin, and ampicillin continued in 2019. The increase in streptomycin was consistent across all regions, however there were regional differences in the trend for ampicillin and tetracycline.

Escherichia coli (n = 137)

In 2019, 18 isolates (13%) were resistant to 4 to 5 classes of antimicrobials. Three isolates (2%) were resistant to amoxicillin-clavulanic acid and to ceftriaxone.

There was a decrease in the proportion of isolates resistant to tetracycline nationally.

The proportion of isolates resistant to ampicillin decreased in the Prairies and Québec.

Campylobacter (n = 210)

In 2019, 4 isolates (2%) were resistant to 4 to 5 classes of antimicrobials.

Resistance to ciprofloxacin was higher in Québec isolates (17%) than in the Prairies (9%) and Ontario (9%).

The decreasing national trend in the proportion of isolates resistant to azithromycin continued, due to a decrease in resistant isolates from Québec.

Multiclass resistance

Table 4.4 Number of antimicrobial classes in resistance patterns of *Salmonella* from pigs at abattoir, 2019

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	MEM	SSS	SXT	AZM	CHL	CIP	NAL	TET
Derby	48 (28.4)	20	2	21	5			26	4	1	1	1		26	2		1			26
Typhimurium	22 (13)	1	2	1	18			19	19					19			16			19
I 4,[5],12:i:-	18 (10.7)	1	3	3	11			14	13					14	2	1	1			14
Infantis	18 (10.7)	13		2	3			5	4	3	3	3		4			3			5
London	13 (7.7)	11	1	1					1											2
Putten	9 (5.3)	9																		
Bovismorbificans	5 (3)	5																		
Brandenburg	5 (3)	1	3	1				1	1					1	1					3
Uganda	5 (3)	5																		
Less common sero	26 (15.4)	12	4	8	1	1	1	9	3	1	1	1		11	5	1	2			10
Total	**169 (100)**	**78**	**15**	**37**	**38**	**1**	**1**	**74**	**45**	**5**	**5**	**5**		**75**	**10**	**2**	**23**			**79**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Serovars represented by less than 2% of isolates were classified as "Less common serovars".

Table 4.5 Number of antimicrobial classes in resistance patterns of *Escherichia coli* from pigs at abattoir, 2019

Animal species	Number of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	MEM	SSS	SXT	AZM	CHL	CIP	NAL	TET
Pigs	137	35	32	52	18			56	41	3	3	2		43	18		17			76

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.

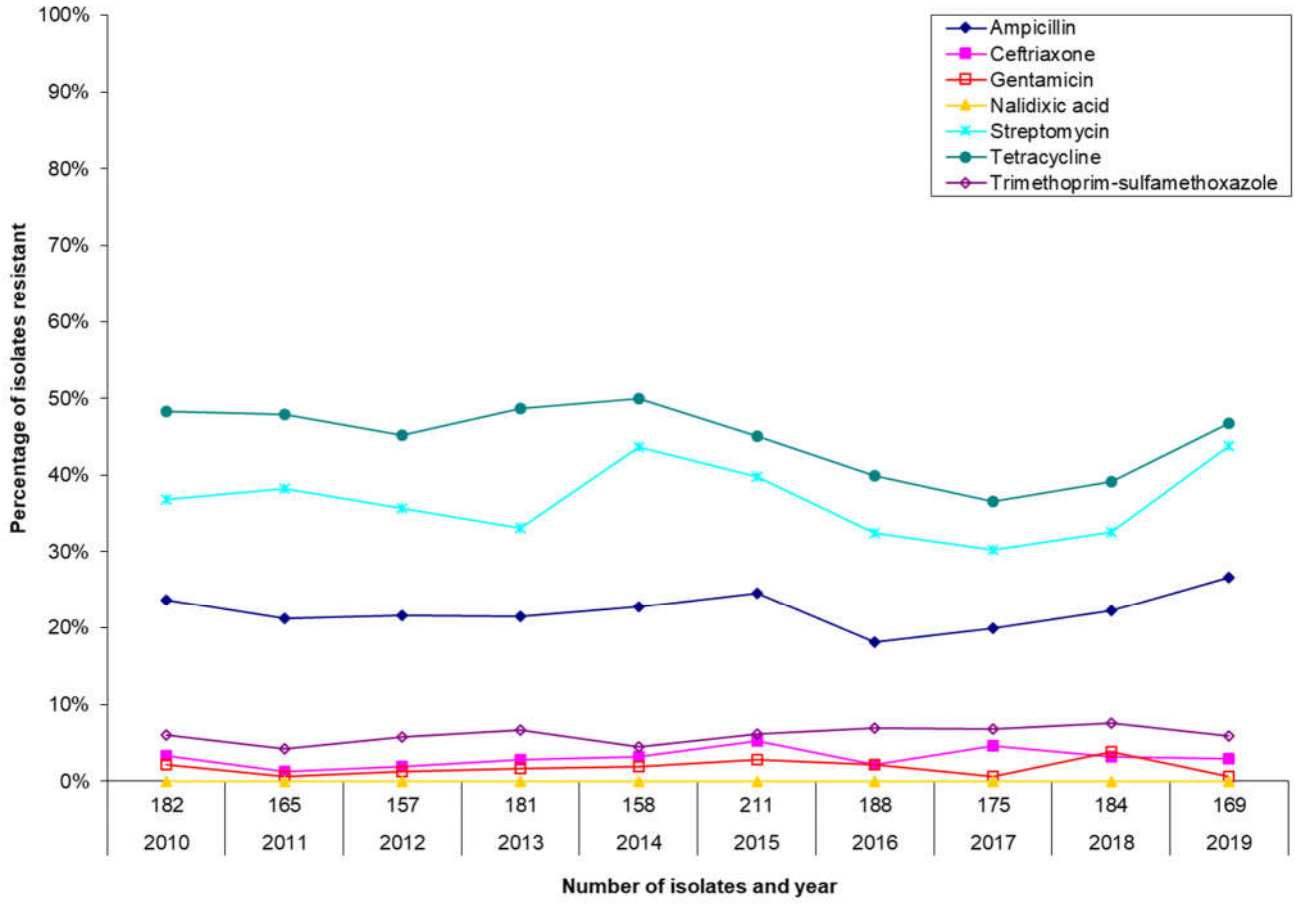
Table 4.6 Number of antimicrobial classes in resistance patterns of *Campylobacter* from pigs at abattoir, 2019

Species	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial								
							Aminoglycosides	Lincosamides	Macrolides		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	CLI	AZM	ERY	FLR	CIP	NAL	TET
Campylobacter jejuni	2 (1)		1	1				1	1	1				2
Campylobacter coli	206 (98)	62	72	68	4			58	59	59		21	21	132
Campylobacter spp.	2 (1)			2					1	1		1	2	2
Total	**210 (100)**	**62**	**73**	**71**	**4**			**59**	**61**	**61**		**22**	**23**	**136**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.

Temporal variations

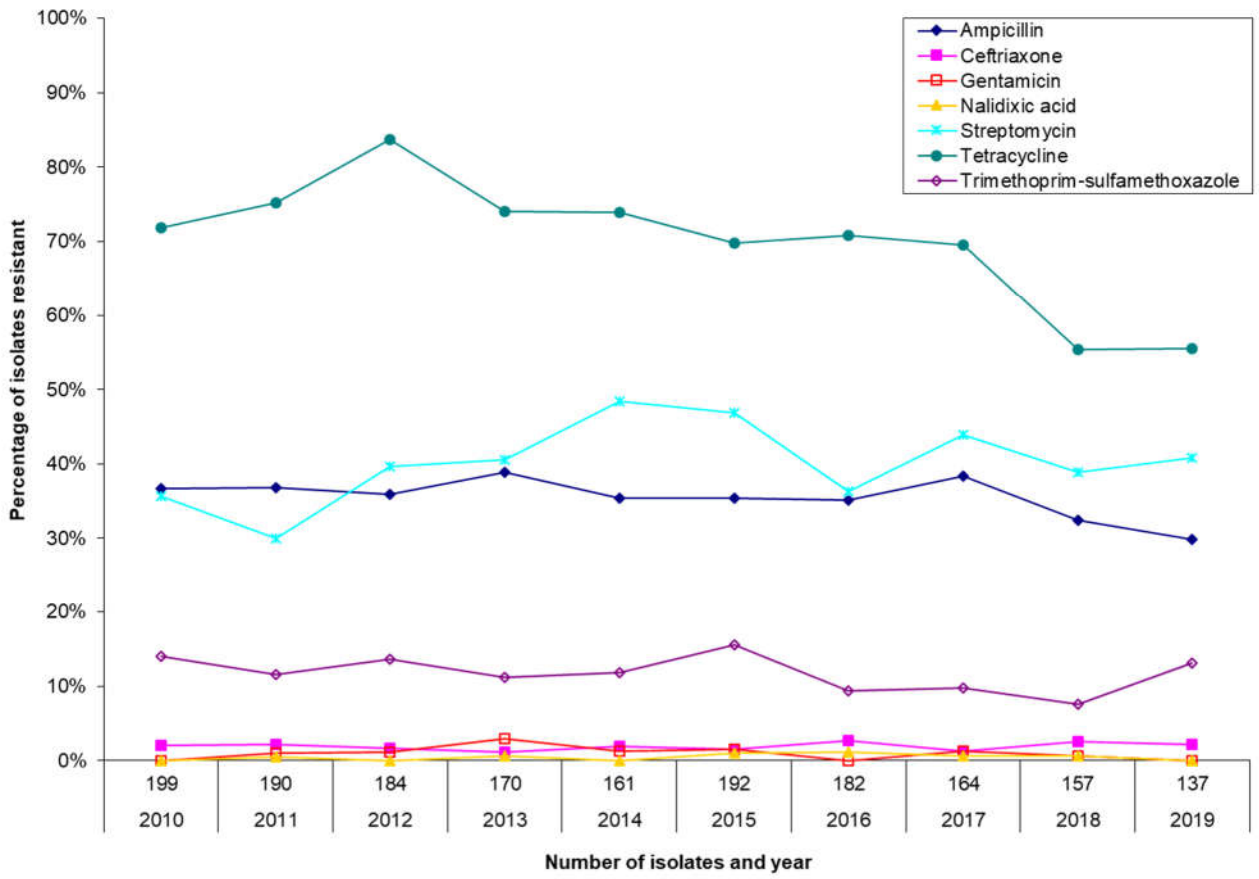
Figure 4.7 Temporal variations in resistance of *Salmonella* isolates from pigs at abattoir, 2010 to 2019



Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of isolates	182	165	157	181	158	211	188	175	184	169
Antimicrobial										
Ampicillin	**24%**	21%	22%	22%	23%	**25%**	18%	20%	**22%**	**27%**
Ceftriaxone	**3%**	1%	2%	3%	3%	**5%**	2%	5%	**3%**	**3%**
Gentamicin	**2%**	1%	1%	2%	2%	**3%**	2%	1%	**4%**	**1%**
Nalidixic acid	**0%**	0%	0%	0%	0%	**0%**	0%	0%	**0%**	**0%**
Streptomycin	**37%**	38%	36%	33%	44%	**40%**	32%	30%	**33%**	**44%**
Tetracycline	**48%**	48%	45%	49%	50%	**45%**	40%	37%	**39%**	**47%**
Trimethoprim-sulfamethoxazole	**6%**	4%	6%	7%	4%	**6%**	7%	7%	**8%**	**6%**

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 10 years, 5 years, and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

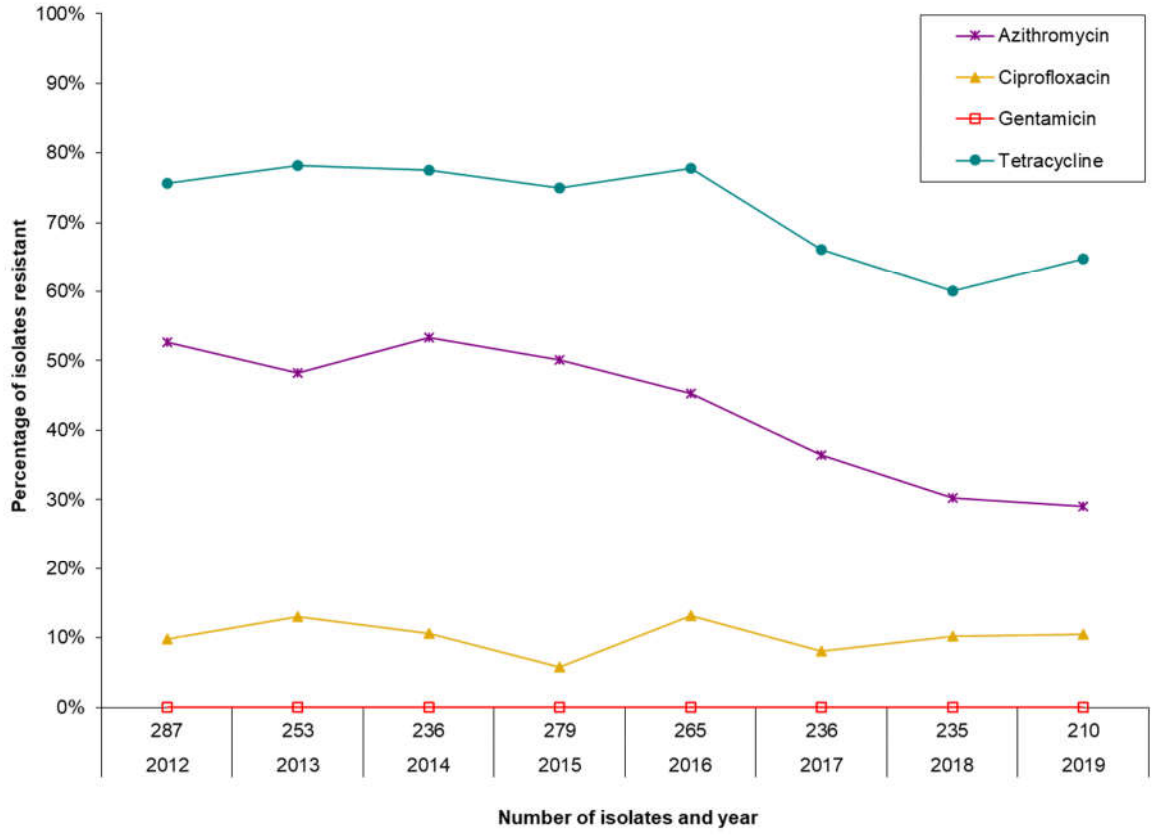
Figure 4.8 Temporal variations in resistance of *Escherichia coli* isolates from pigs at abattoir, 2010 to 2019



Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of isolates	199	190	184	170	161	192	182	164	157	137
Antimicrobial										
Ampicillin	**37%**	37%	36%	39%	35%	**35%**	35%	38%	**32%**	**30%**
Ceftriaxone	**2%**	2%	2%	1%	2%	**2%**	3%	1%	**3%**	**2%**
Gentamicin	**0%**	1%	1%	3%	1%	**2%**	0%	1%	**1%**	**0%**
Nalidixic acid	**0%**	1%	0%	1%	0%	**1%**	1%	1%	**1%**	**0%**
Streptomycin	**36%**	30%	40%	41%	48%	**47%**	36%	44%	**39%**	**41%**
Tetracycline	**72%**	75%	84%	74%	74%	**70%**	71%	70%	**55%**	**55%**
Trimethoprim-sulfamethoxazole	**14%**	12%	14%	11%	12%	**16%**	9%	10%	**8%**	**13%**

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 10 years, 5 years, and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Figure 4.9 Temporal variations in resistance of *Campylobacter* isolates from pigs at abattoir, 2012 to 2019



Year	2012	2013	2014	2015	2016	2017	2018	2019
Number of isolates	287	253	236	279	265	236	235	210
Antimicrobial								
Azithromycin	**53%**	48%	53%	**50%**	45%	36%	**30%**	**29%**
Ciprofloxacin	**10%**	13%	11%	**6%**	13%	8%	**10%**	**10%**
Gentamicin	**0%**	0%	0%	**0%**	0%	0%	**0%**	**0%**
Tetracycline	**76%**	78%	78%	**75%**	78%	66%	**60%**	**65%**

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 10 years, 5 years, and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Retail Surveillance

For Ontario in 2018 to 2019 and the Prairies in 2017 to 2019, a limited number of samples were collected due to difficulties in staffing field personnel. As a result, the sampling target and subsequent isolate yields in this province and region were not achieved and Retail Surveillance results are not presented.

Clinical Surveillance

Key findings

Salmonella (n = 445)

Salmonella Typhimurium, Derby, I 4,[5],12:i:- and Infantis were the most common serovars recovered from clinical pigs in 2019.

Eleven isolates were resistant to 6 to 7 classes of antimicrobials. This included 4 Typhimurium isolates, 2 I 4,[5],12:i:-, 1 Agona, 3 Ohio, and 1 less common serovar.

Although still very rare, this is the fourth year in a row that quinolone resistance has been observed in clinical isolates from pigs.

Multiclass resistance

Table 4.7 Number of antimicrobial classes in resistance patterns of *Salmonella* from pigs, 2019

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial												
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	MEM	SSS	SXT	AZM	CHL	CIP	NAL	TET
Typhimurium	135 (30.3)	19	3	13	96	4	14	97	103	5	2	3		113	45	7	98			109
I 4,[5],12:i:-	111 (24.9)	2	1	10	96	2	13	104	104	12	15	12		108	12	3	23	1		103
Derby	56 (12.6)	12	5	31	8			40	8					39						43
Infantis	19 (4.3)	17			2			1	1	1	1	1		2	2	1	2			2
Brandenburg	16 (3.6)	9	4	1	2		2	3	1	1	1	1		3	2	1	1			7
Agona	12 (2.7)	8		1	2	1	1	4	4	4	3	4		2	1		2	1	2	4
Mbandaka	12 (2.7)		1	6	5		4	11	5	5	5	5		11	4		3			12
Ohio	10 (2.2)	4			3	3	3	5	5	4	4	4		6	4	4	6			6
Less common serovars	74 (16.6)	21	6	25	21	1	7	38	26	9	9	9		45	23	4	15			39
Total	**445 (100)**	**92**	**20**	**87**	**235**	**11**	**44**	**303**	**257**	**41**	**40**	**39**		**329**	**93**	**20**	**150**	**2**	**2**	**325**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Serovars represented by less than 2% of isolates were classified as "Less common serovars".

Appendix

Recovery Results

Table A.1 Farm surveillance recovery rates from pigs, 2006 to 2019

Animal species	Province/region	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted							
			Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*	
Pigs	Prairies	2012	**100%**	232/232	**19%**	43/232				
		2013	**98%**	224/228	**14%**	33/228				
		2014	**99%**	248/252	**16%**	40/252				
		2015	**97%**	228/234	**18%**	43/234				
		2016	**98%**	246/252	**18%**	46/252				
		2017	**97%**	227/234	**20%**	46/234	**80%**	187/234		
		2018	**98%**	269/276	**18%**	49/276	**80%**	220/276		
		2019	**96%**	272/282	**18%**	52/282	**72%**	204/282		
	Ontario	2012	**99%**	167/168	**18%**	31/168				
		2013	**100%**	168/168	**26%**	43/168				
		2014	**100%**	162/162	**41%**	67/162				
		2015	**99%**	149/150	**29%**	43/150				
		2016	**99%**	155/156	**22%**	34/156				
		2017	**100%**	138/138	**19%**	26/138	**71%**	98/138		
		2018	**99%**	184/186	**26%**	49/186	**81%**	150/186		
		2019	**99%**	189/191	**29%**	55/191	**73%**	139/191		
	Québec	2012	**100%**	120/120	**16%**	19/120				
		2013	**100%**	138/138	**17%**	23/138				
		2014	**100%**	156/156	**26%**	40/156				
		2015	**98%**	123/126	**28%**	35/126				
		2016	**99%**	143/144	**21%**	30/144				
		2017	**99%**	119/120	**38%**	45/120	**70%**	84/120		
		2018	**100%**	132/132	**31%**	41/132	**86%**	114/132		
		2019	**99%**	167/168	**35%**	58/168	**62%**	104/168		
	National	2006	**99%**	459/462	**20%**	94/462			**81%**	374/462
		2007	**100%**	612/612	**21%**	136/612			**81%**	495/612
		2008	**99%**	481/486	**13%**	61/486			**92%**	448/486
		2009	**99%**	695/698	**18%**	124/698			**97%**	680/698
		2010	**99%**	566/569	**18%**	101/569			**96%**	545/569
		2011	**100%**	560/560	**14%**	77/560				
		2012	**99%**	519/520	**18%**	93/520				
		2013	**99%**	530/534	**19%**	99/534				
		2014	**99%**	566/570	**26%**	147/570				
		2015	**98%**	500/510	**24%**	121/510				
		2016	**99%**	544/552	**20%**	110/552				
		2017	**98%**	484/492	**24%**	117/492	**75%**	369/492		
		2018	**99%**	585/594	**23%**	139/594	**82%**	484/594		
		2019	**98%**	628/641	**26%**	165/641	**70%**	447/641		

Grey-shaded areas with results represent isolates recovered from CIPARS non-core surveillance (pilot surveillance) and those without results indicate absence or discontinuation of surveillance activity.
Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Table A.2 Abattoir surveillance recovery rates from pigs, 2002 to 2019

Animal species	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted						
		Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*
Pigs	2002	**97%**	38/39	**27%**	103/385			
	2003	**98%**	153/155	**28%**	395/1,393			
	2004	**99%**	142/143	**38%**	270/703			
	2005	**99%**	163/164	**42%**	212/486			
	2006	**98%**	115/117	**40%**	145/359			
	2007	**98%**	93/95	**36%**	105/296			
	2008	**100%**	150/150	**44%**	151/340			
	2009	**98%**	160/163	**45%**	147/327			
	2010	**98%**	199/203	**44%**	182/410			
	2011	**99%**	190/191	**43%**	165/382			
	2012	**100%**	184/184	**42%**	157/370	**78%**	289/370	
	2013	**99%**	166/168	**52%**	171/330	**76%**	237/314	
	2014	**99%**	161/162	**49%**	158/325	**73%**	237/325	
	2015	**98%**	192/195	**55%**	211/385	**72%**	279/385	
	2016	**99%**	182/184	**51%**	188/367	**72%**	265/366	
	2017	**98%**	164/167	**52%**	175/336	**71%**	237/336	
	2018	**97%**	157/162	**57%**	184/324	**73%**	235/324	
	2019	**100%**	137/137	**61%**	169/276	**76%**	210/276	

Grey-shaded areas indicate either: a) isolates recovered from sampling activities outside the scope of CIPARS routine (or "core") surveillance in the specified year (i.e. grey-shaded areas with data) or b) discontinuation or no surveillance activity (i.e. grey-shaded areas with no data).

Table A.3 Retail surveillance recovery rates from pork, 2003 to 2019

CIPARS Component / Animal species	Province / region	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted							
			Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*	
Pork	British Columbia	2005	**31%**	10/32						
		2007	**29%**	23/79	**1%**	1/79				
		2008	**30%**	44/148	**2%**	3/148				
		2009	**26%**	38/145	**1%**	2/145				
		2010	**19%**	31/166	**1%**	2/167				
		2011	**27%**	49/180	**2%**	3/180				
		2012	**25%**	41/167	**0%**	0/167				
		2013	**28%**	33/118	**0%**	0/118				
		2014	**22%**	29/131	**2%**	2/132				
		2015	**21%**	29/136						
		2016	**23%**	40/172						
		2017	**15%**	25/172						
		2018	**10%**	10/98						
		2019	**9%**	17/180						
	Prairies	2005	**30%**	48/162						
		2006	**30%**	49/165	**2%**	3/134				
		2007	**25%**	38/154	**2%**	3/154				
		2008	**23%**	41/176	**1%**	1/176				
		2009	**18%**	29/164	**0%**	0/164				
		2010	**12%**	17/142	**1%**	1/142				
		2011[a]	**11%**	10/90	**1%**	1/90				
		2012	**19%**	26/140	**1%**	2/141				
		2013	**24%**	28/119	**3%**	3/120				
		2014	**22%**	48/223	**1%**	3/223				
		2015	**23%**	50/220						
		2016	**8%**	6/78						
		2017	**6%**	2/31						
		2018	**5%**	1/20						
		2019	**13%**	1/8						
	Ontario	2003	**58%**	90/154	**1%**	1/93	**0%**	0/76	**87%**	66/76
		2004	**71%**	198/279						
		2005	**59%**	179/303						
		2006	**59%**	182/311	**< 1%**	1/255				
		2007	**54%**	172/320	**2%**	6/319				
		2008	**50%**	155/312	**2%**	7/310				
		2009	**41%**	136/328	**2%**	8/327				
		2010	**38%**	84/224	**0%**	0/224				
		2011	**42%**	155/371	**2%**	6/370				
		2012	**37%**	86/231	**2%**	5/231				
		2013	**43%**	100/233	**1%**	3/232				
		2014	**41%**	127/312	**2%**	6/312				
		2015	**42%**	64/152						
		2016	**32%**	51/160						
		2017	**32%**	53/164						
		2018	**25%**	1/4						
		2019	**50%**	2/4						
	Québec	2003	**42%**	61/147	**3%**	1/32	**9%**	3/32	**82%**	28/34
		2004	**38%**	109/290						
		2005	**26%**	79/300						
		2006	**20%**	57/287	**0%**	0/232				
		2007	**22%**	64/287	**1%**	3/288				
		2008	**21%**	60/287	**2%**	5/286				
		2009	**15%**	41/268	**1%**	3/268				
		2010	**16%**	47/296	**1%**	4/296				
		2011	**32%**	122/387	**4%**	17/387				
		2012	**16%**	46/279	**3%**	8/279				
		2013	**20%**	48/239	**<1%**	1/239				
		2014	**18%**	49/276	**<1%**	2/276				
		2015	**13%**	36/272						
		2016	**17%**	43/256						
		2017	**13%**	35/280						
		2018	**14%**	39/284						
		2019	**21%**	57/272						
	Atlantic	2004	**58%**	14/24						
		2007	**39%**	13/31	**3%**	1/30				
		2008	**30%**	17/56	**2%**	1/56				
		2009	**41%**	82/200	**3%**	5/199				
		2010	**39%**	74/190	**4%**	8/190				
		2011	**43%**	95/223	**3%**	7/221				
		2012[d]	**25%**	12/48	**0%**	0/48				
		2013	**40%**	57/143	**1%**	2/142				
		2014	**41%**	86/209	**6%**	13/208				
		2015[e]								
		2016[e]								
		2017[e]								
		2018[e]								
		2019[e]								

See notes on following page.

Table A.3 Retail surveillance recovery rates from pork, 2003 to 2019 (continued)

Grey-shaded areas indicate either: a) isolates recovered from sampling activities outside the scope of CIPARS routine (or "core") surveillance in the specified year (i.e. grey-shaded areas with data) or b) discontinuation or no surveillance activity (i.e. grey-shaded areas with no data).
For Ontario in 2018 and 2019, and the Prairies in 2016-2019, a partial year of retail sampling was conducted due to difficulties in staffing field personnel. As a result, the sampling target and subsequent isolate yields in this province were not achieved and results should be interpreted with caution.
[a] In 2011, due to an unforeseeable pause in retail sampling in Saskatchewan of approximately 3 months, the expected number of samples was not met and thus, results for the Prairies for this year should be interpreted with caution.
[b] Enhancement to the *Salmonella* recovery method yielded higher recovery rates from retail chicken in 2007 than in prior years.
[c] For the Atlantic region, recovery results are not presented for *Campylobacter* in 2007 and 2008 as well as for Enterococcus in 2007, 2008, and 2009 due to concerns regarding harmonization of laboratory methods.
[d] Due to an unforeseeable pause in retail sampling in the Atlantic region from April through December in 2012, the expected number of samples was not achieved and thus, results for this region in 2012 are not representative and potentially lack the precision necessary to be included as regular surveillance data. For this reason, these data are not presented anywhere else in this chapter.
[e] No retail sampling was conducted in the Atlantic region from 2015 to 2019.

Abbreviations

Provinces

BC British Columbia

AB Alberta

SK Saskatchewan

MB Manitoba

ON Ontario

QC Québec

NB New Brunswick

NS Nova Scotia

PE Prince Edward Island

NL Newfoundland and Labrador

Territories

YT Yukon

NT Northwest Territories

NU Nunavut

Regions

Prairies: AB, SK, MB

Maritimes: NB, NS, PE

Atlantic: NB, NS, PE, NL

Antimicrobials

AMC Amoxicillin-clavulanic acid

AMP Ampicillin

AZM Azithromycin

CHL Chloramphenicol

CIP Ciprofloxacin

GEN Gentamicin

MEM Meropenem

NAL Nalidixic acid

SSS Sulfisoxazole

STR Streptomycin

CLI Clindamycin

CRO Ceftriaxone

ERY Erythromycin

FLR Florfenicol

FOX Cefoxitin

SXT Trimethoprim-sulfamethoxazole

TEL Telithromycin

TET Tetracycline

TIO Ceftiofur