CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire

Université de Montréal

Research results and strategies on AMU reduction in Canadian poultry and their impact

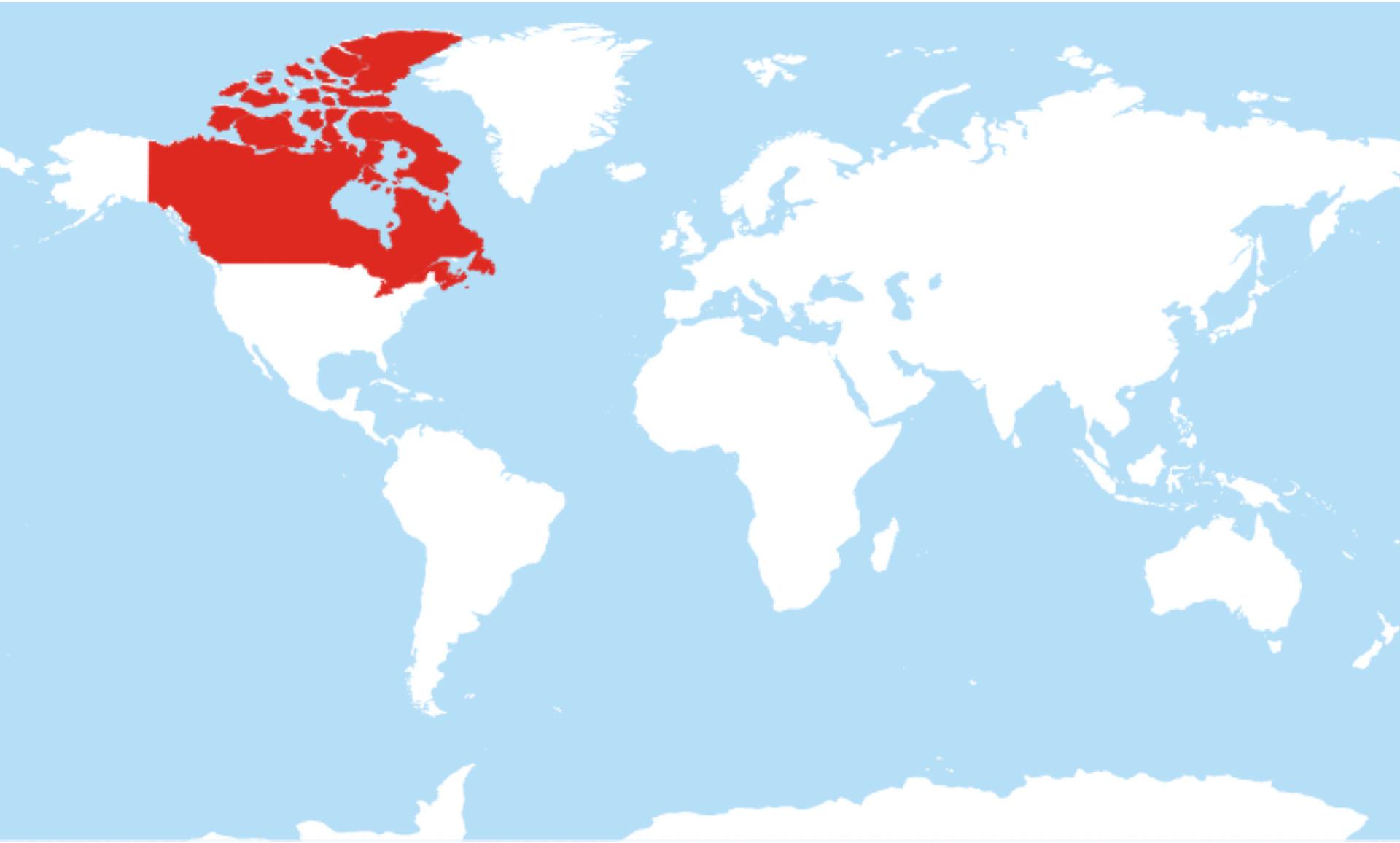
Martine Boulianne, DMV, PhD, Dip ACPV

Chair in Poultry Research, Faculty of Veterinary Medicine, University of Montreal

Outline of the presentation

- A quick Canadian portrait
  - Political structure and legislation
  - Structure of the Canadian broiler chicken industry
  - Some statistics
- Brief description of the Chair in Poultry Research
- A short history on AMR and AMU surveillance programs
  - CIPARS surveillance program
    - 2003 annual report on Salmonella Heidelberg data and Quebec voluntary ban
  - Chicken Farmers of Canada
    - CIPARS results and Media influence on public perception
    - Publication by Dutil et al.,
    - CFC internal study on AMU and producers' perception
    - Meetings with the poultry industry stakeholders
  - Chair in Poultry Research
    - Various research projects to support the poultry producers in adopting changes

Where is Canada located?



https://www.freeworldmaps.net/northamerica/canada/location.html

Canada: provinces and territories

https://simple.wikipedia.org/wiki/Provinces_and_territories_of_Canada

Antimicrobial use

- Federal: drug licensing
- Provincial: Drug use regulations
  - Differences between provinces in terms of
    - Veterinary prescription
    - Access to medications

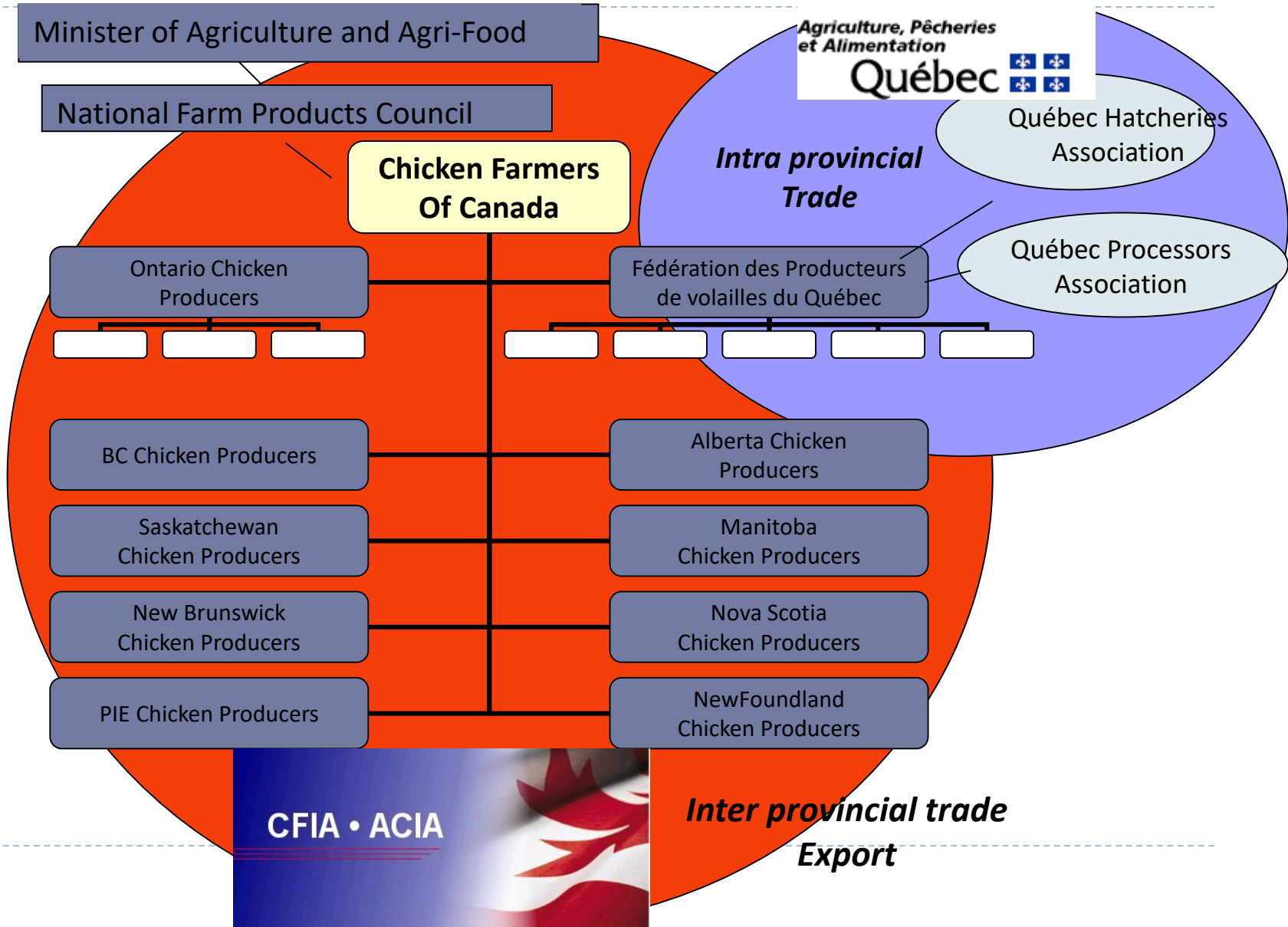
Structure of the poultry industry

- No vertical integration
- At the basis: the producer
- Different segments:
  - ChickenTurkey
  - Commercial eggs
  - Incubation eggs

Structure of the poultry industry

- Poultry production in Canada is managed by a supply management system which was created in the 70s
- Producers must acquire quotas to produce
- Price paid to the producer is based on production costs
- Production is predicted according to consumption

Structure of the Canadian chicken industry



Some Canadian statistics…

- Per capita consumption: 35,8 kg of chicken (2021)
- 2877 chicken producers
- Sustains 101,900 jobs
- 1,3 Billions kg (eviscerated weight) in 2021
- 185 processors and further processors
- Contributes $8 billion to Canada's GDP

https://www.chickenfarmers.ca/good-for-canada/
https://agriculture.canada.ca/en/international-trade/market-intelligence/reports/customized-report-service-canadian-poultry-meat-trends

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

Canadian broiler chicken production

Starter phase | Growth phase | Finisher phase

0 day | 10 days | 28 days | 35 days

Antibiotics
Anticoccidials

Antibiotics
Anticoccidials

Antibiotics
Anticoccidials

Conventional prevention programs

★ Previous use of ATM at the hatchery

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

Chair in Poultry Research

- Established in May 1999
- First industry Chair at the Faculté de médecine vétérinaire

Les Éleveurs de volailles du Québec

Fédération des producteurs d'œufs du Québec

Founding members

Quebec Poultry Producers

Quebec Egg Board

Quebec Hatchery association

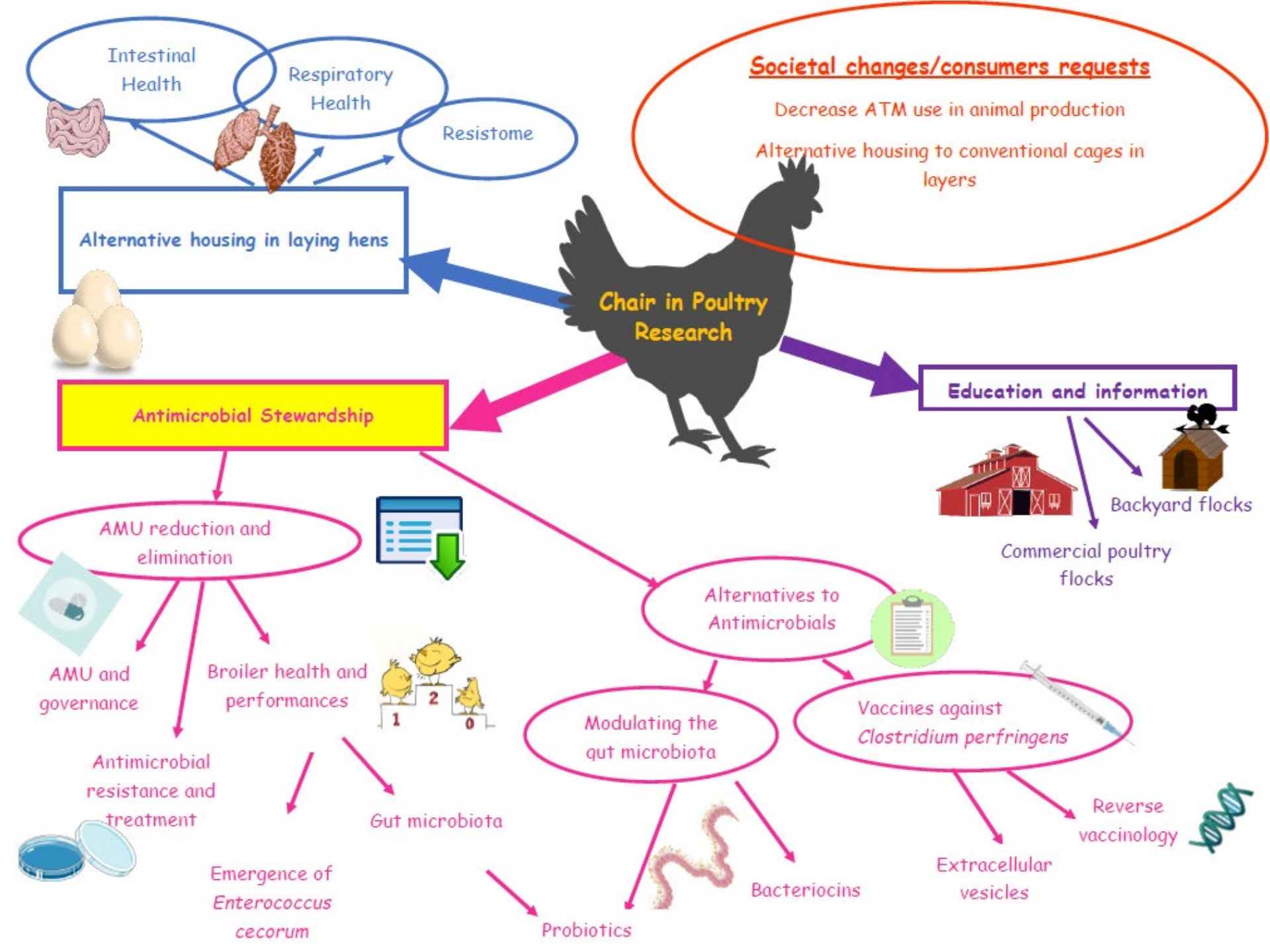
Quebec Poultry Abattoir Association

Quebec Incubation Egg Producers

Les COUVOIRIERS du Québec

Les Producteurs d'œufs d'incubation du Québec

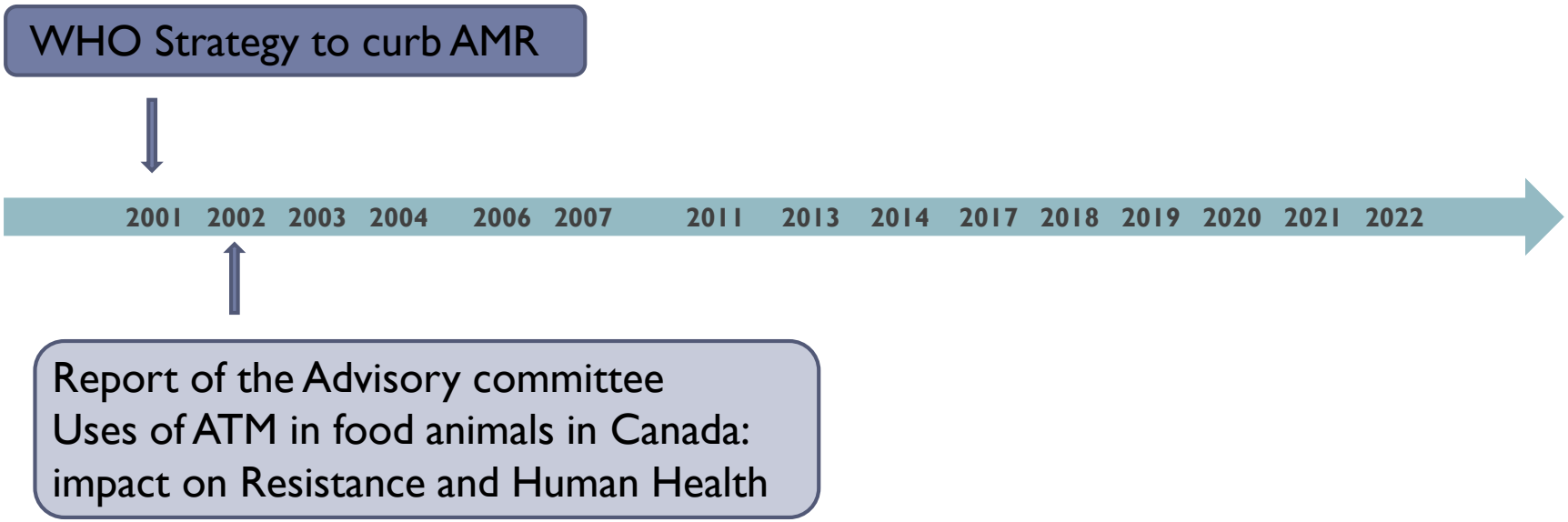
AAAQ


Intestinal Health
Respiratory Health
Resistome
Societal changes/consumers requests
Decrease ATM use in animal production
Alternative housing to conventional cages in layers
Alternative housing in laying hens
Chair in Poultry Research
Education and information
Backyard flocks
Commercial poultry flocks
Antimicrobial Stewardship
AMU reduction and elimination
AMU and governance
Broiler health and performances
Antimicrobial resistance and treatment
Emergence of Enterococcus cecorum
Gut microbiota
Probiotics
Alternatives to Antimicrobials
Modulating the gut microbiota
Bacteriocins
Vaccines against Clostridium perfringens
Extracellular vesicles
Reverse vaccinology

A short history on AMR and AMU surveillance programs in Canada

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

- Initial steps…



A short history on AMR and AMU surveillance programs in Canada

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

- Initial steps…

WHO Strategy to curb AMR

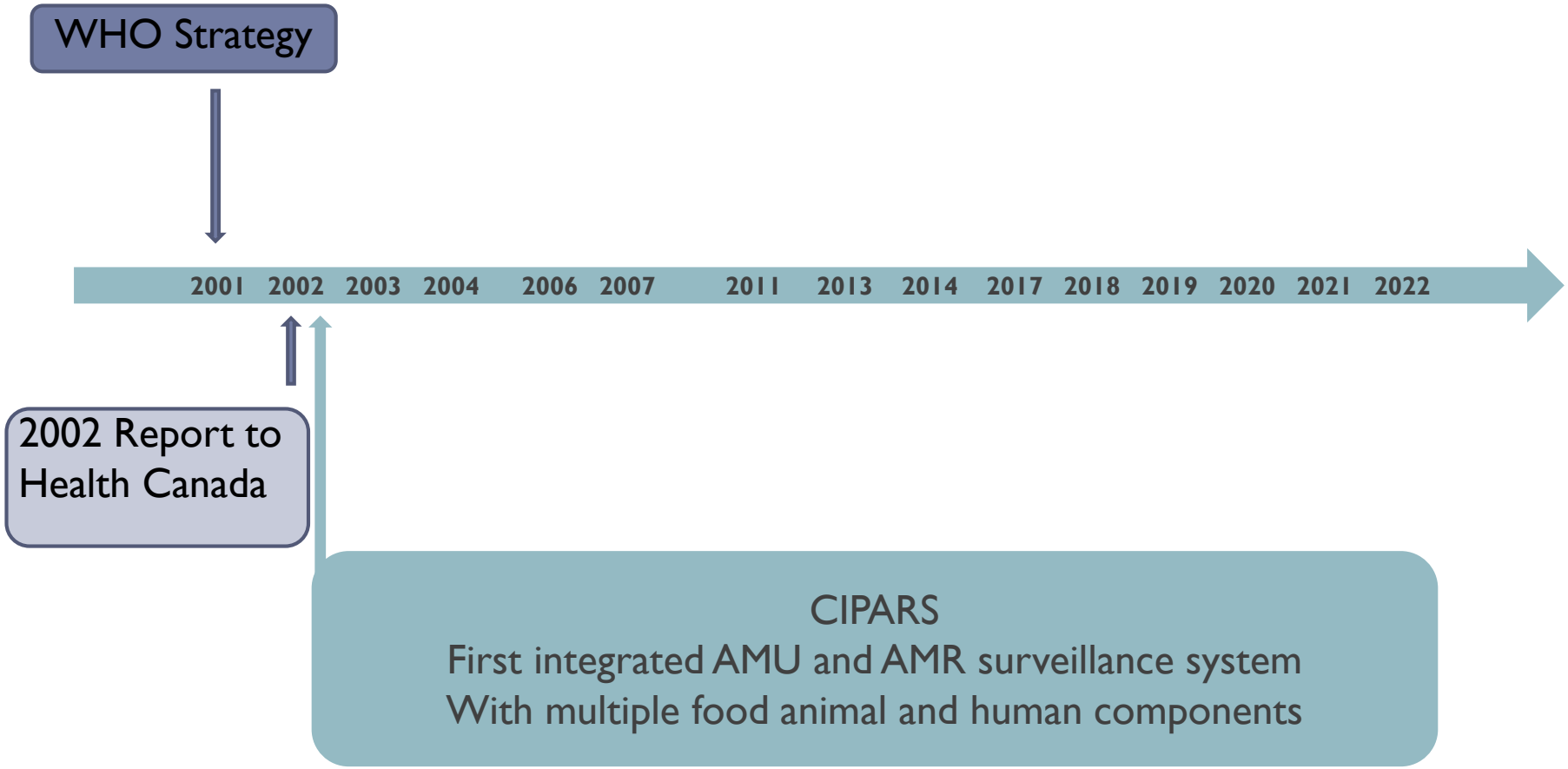
Report of the Advisory committee
Uses of ATM in food animals in Canada:
impact on Resistance and Human Health

A series of recommendations
-Integrated approaches through Health Canada
-Develop a coordinated, ongoing, national surveillance system for AMR in major pathogens affecting food animals
-ATM regulations, Compulsory Vet Prescription, implementation of the CVMA prudent use principles…

A short history on AMR and AMU surveillance programs in Canada

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

- Initial steps…



A short history on AMR and AMU surveillance programs in Canada

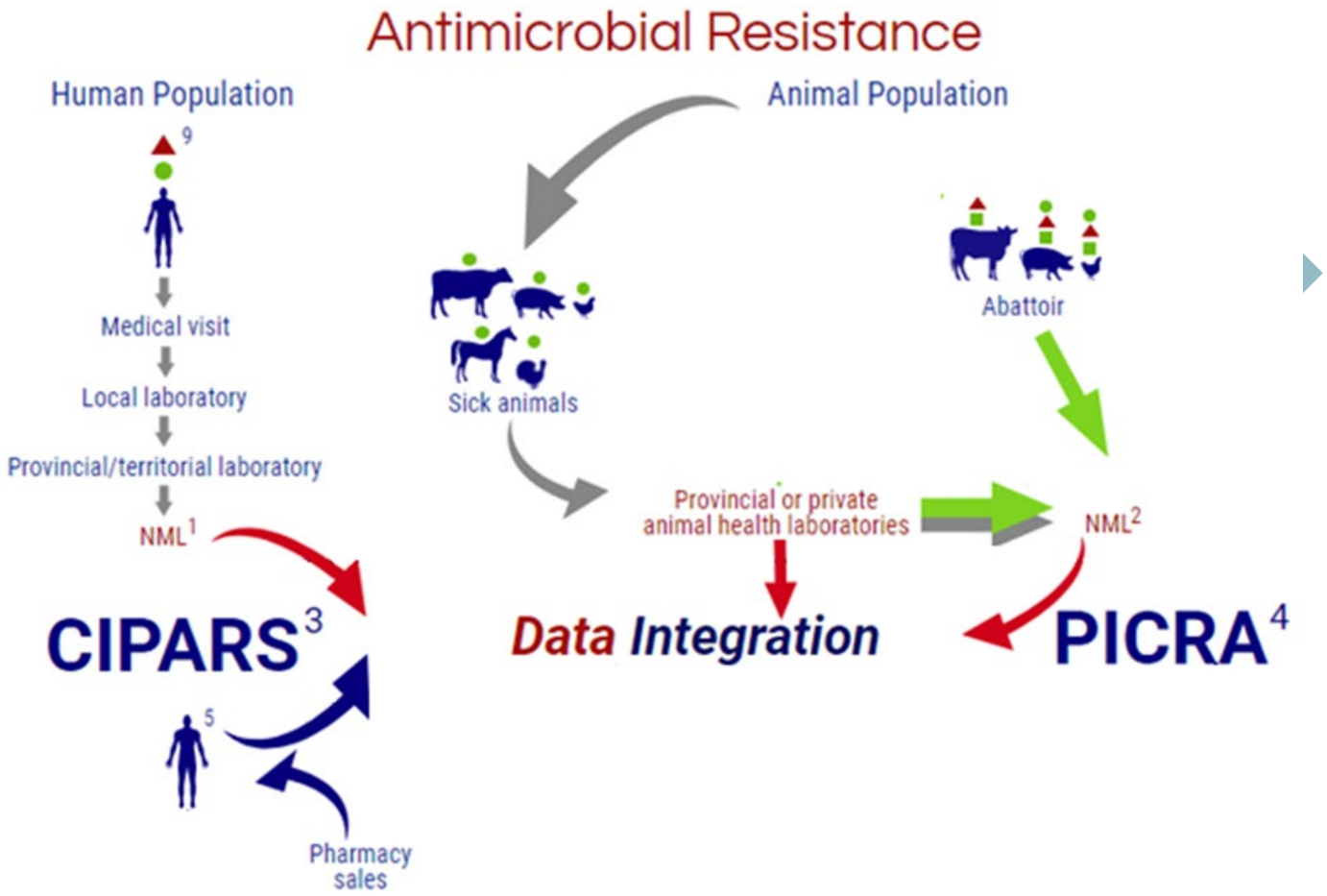
CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

- Initial steps…

WHO Strategy

2001 2002

2002 Report to Health Canada

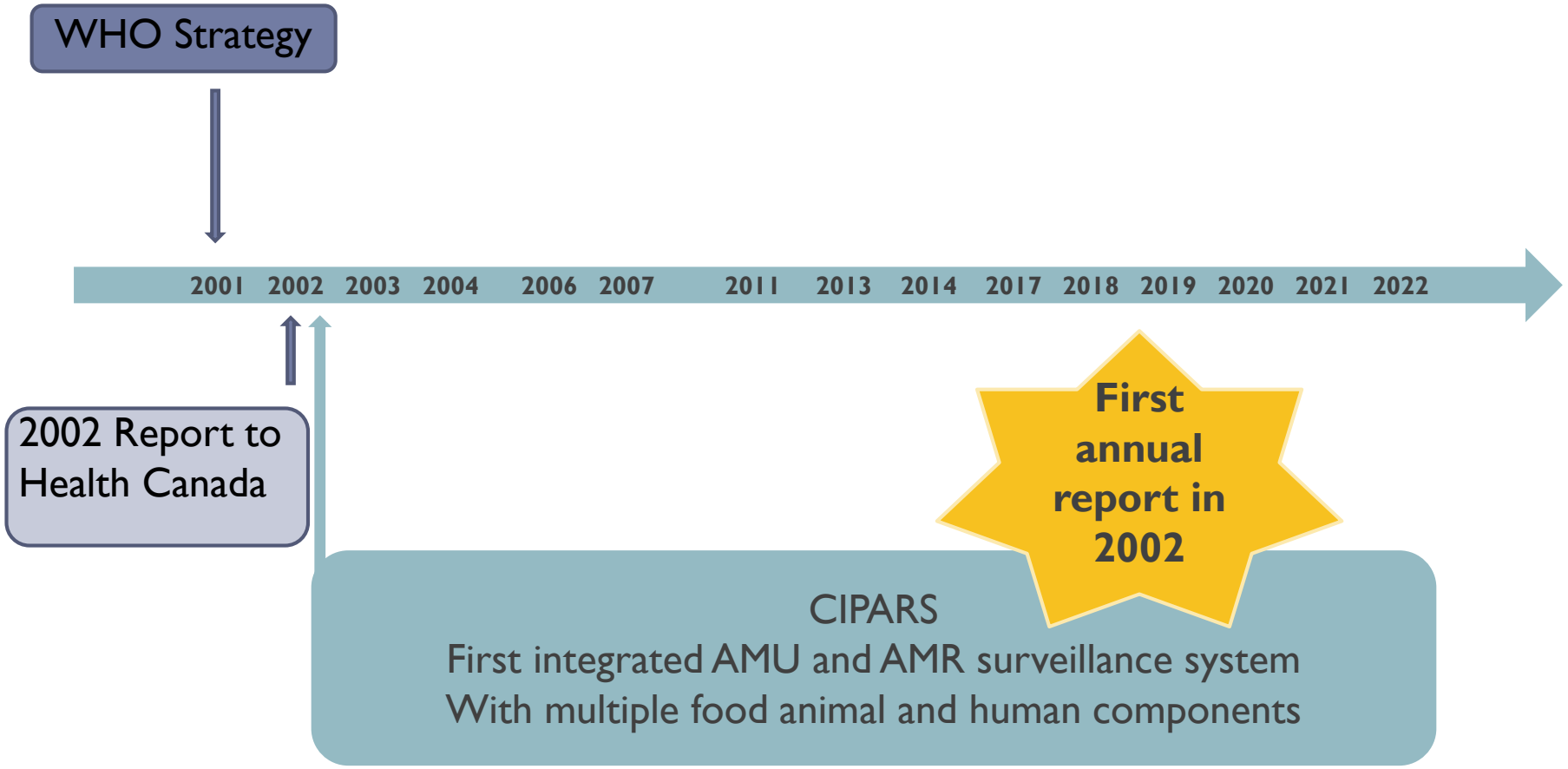


4 CIPARS

A short history on AMR and AMU surveillance programs in Canada

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

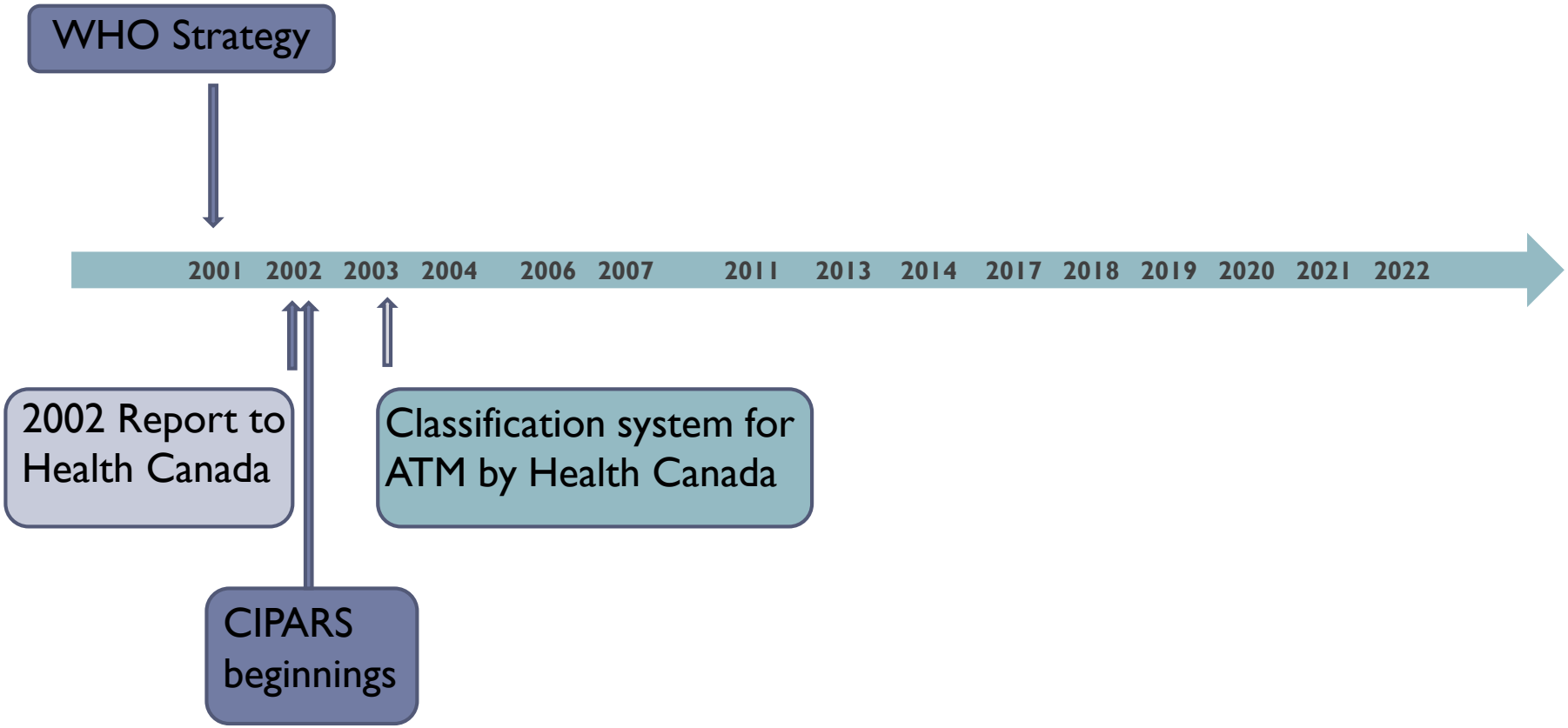
- Initial steps…



A short history on AMR and AMU surveillance programs in Canada

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

- Initial steps…



Antibiotics categorization in Canada

Categories	Preferred option for treatment of serious human infections	No or limited alternatives available
I- Very high importance	Yes	Yes
II- High importance	Yes	No
III- Medium importance	No	No/yes
IV- Low importance	Not applicable	Not applicable

Important for human medicine

*Serious infections are considered those which if left untreated would lead to significant morbidity requiring emergency care including hospitalization and/or mortality.

Antibiotics used in poultry, based on their categorization

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

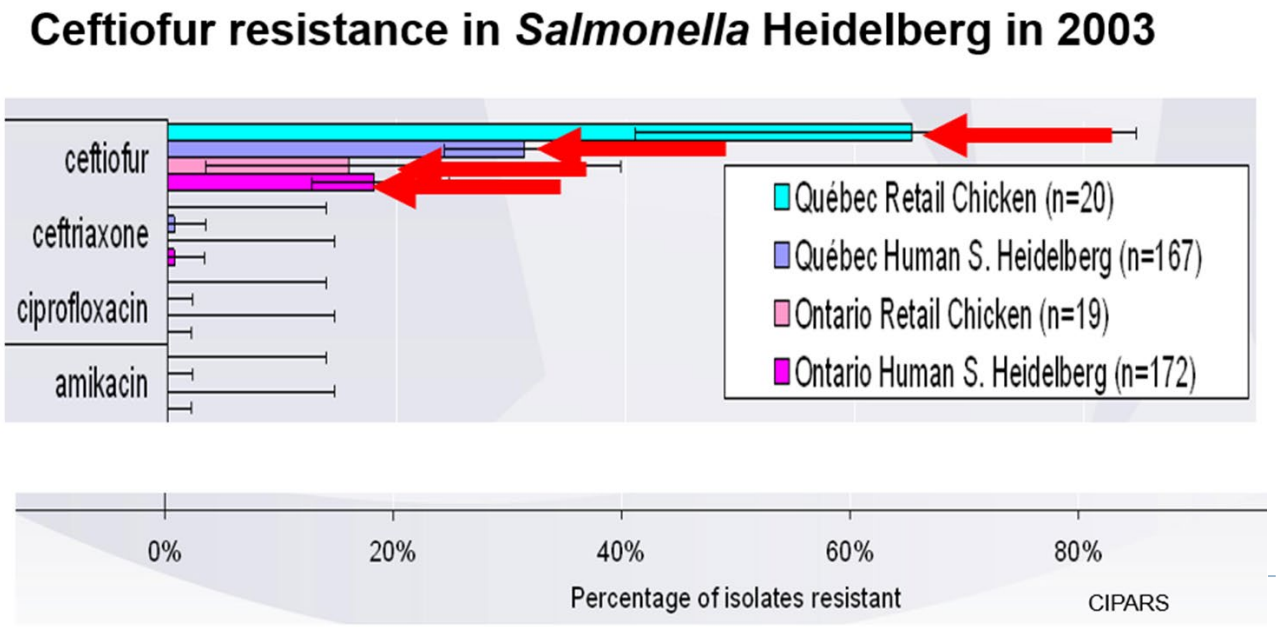
Categories	Antibiotic class
I- Very high importance	Cephalosporins 3rd generation (Ceftiofur) Fluoroquinolones (Enrofloxacin)
II- High importance	Aminoglycosides (**Spectinomycin**[1], gentamycin, neomycin, streptomycin) Lincosamides (**Lincomycin**[1]) Macrolides (**Tylosin**[1], erythromycin) Penicillin (Penicillin G, amoxicillin) Streptogramins (**Virginiamycin**[1]) Trimethoprim – sulfamethoxazole (combination)
III- Medium importance	**Bacitracin**[1] Sulphonamides (Sulfamethazine, sulfaquinoxaline) Tetracyclines
IV- Low importance	**Ionophors**[1] Flavophospholipol (Bambermycine)

Not categorized: **Chemical coccidiostats**[1] **and** Orthomycin (**Avilamycin**[1])

[1] ***Frequently used in prevention programs***

In 2003 and 2004

- CIPARS reports the emergence of ceftiofur-resistant *Salmonella* Heidelberg in both retail chicken and humans
- Observed mostly in the province of Quebec
- Quebec hatcheries decide on a voluntary withdrawal in February 2005



CIPARS

In 2003 and 2004

- CIPARS reports the emergence of ceftiofur-resistant *Salmonella* Heidelberg in both retail chicken and humans
- Observed mostly in the province of Quebec
- Quebec hatcheries decide on a voluntary withdrawal in February 2005
- … with partial reinstitution of ceftiofur use in 2007 (in rotation)

In 2003 and 2004

Dutil et al., 2010.

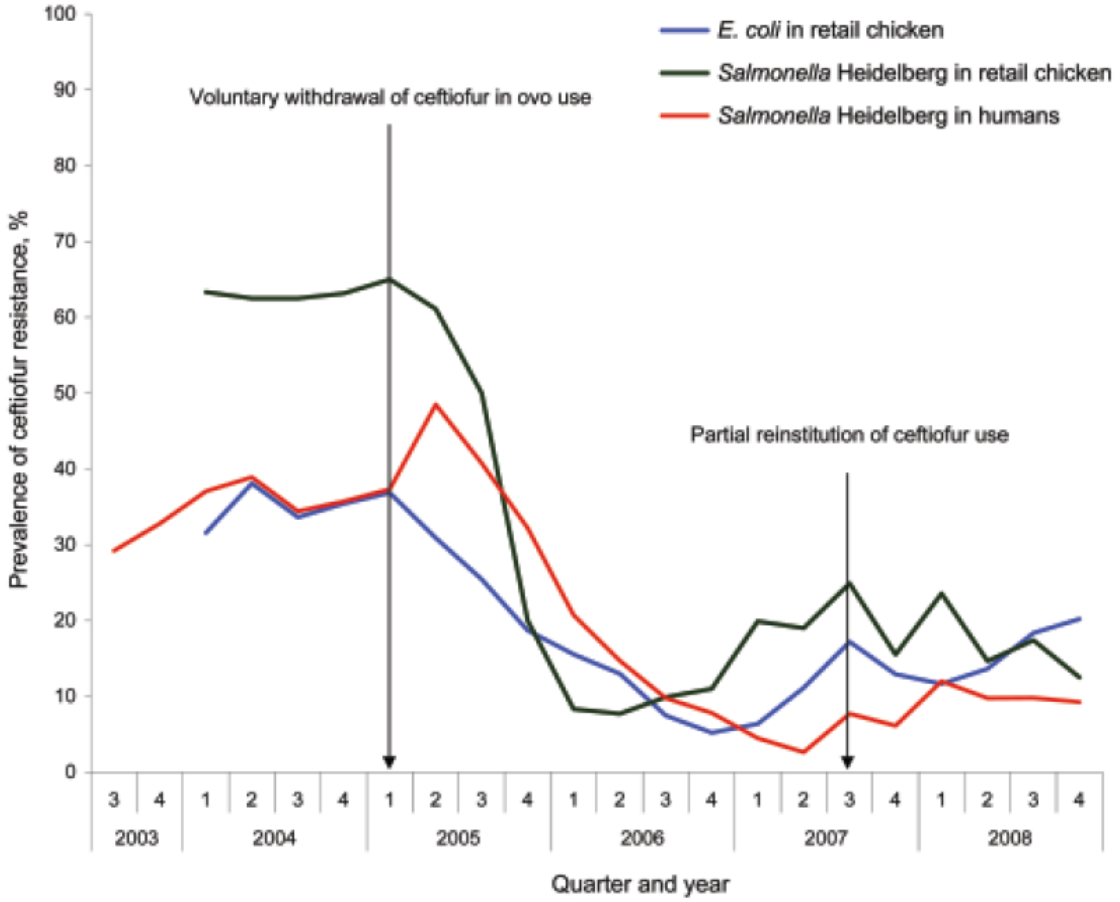
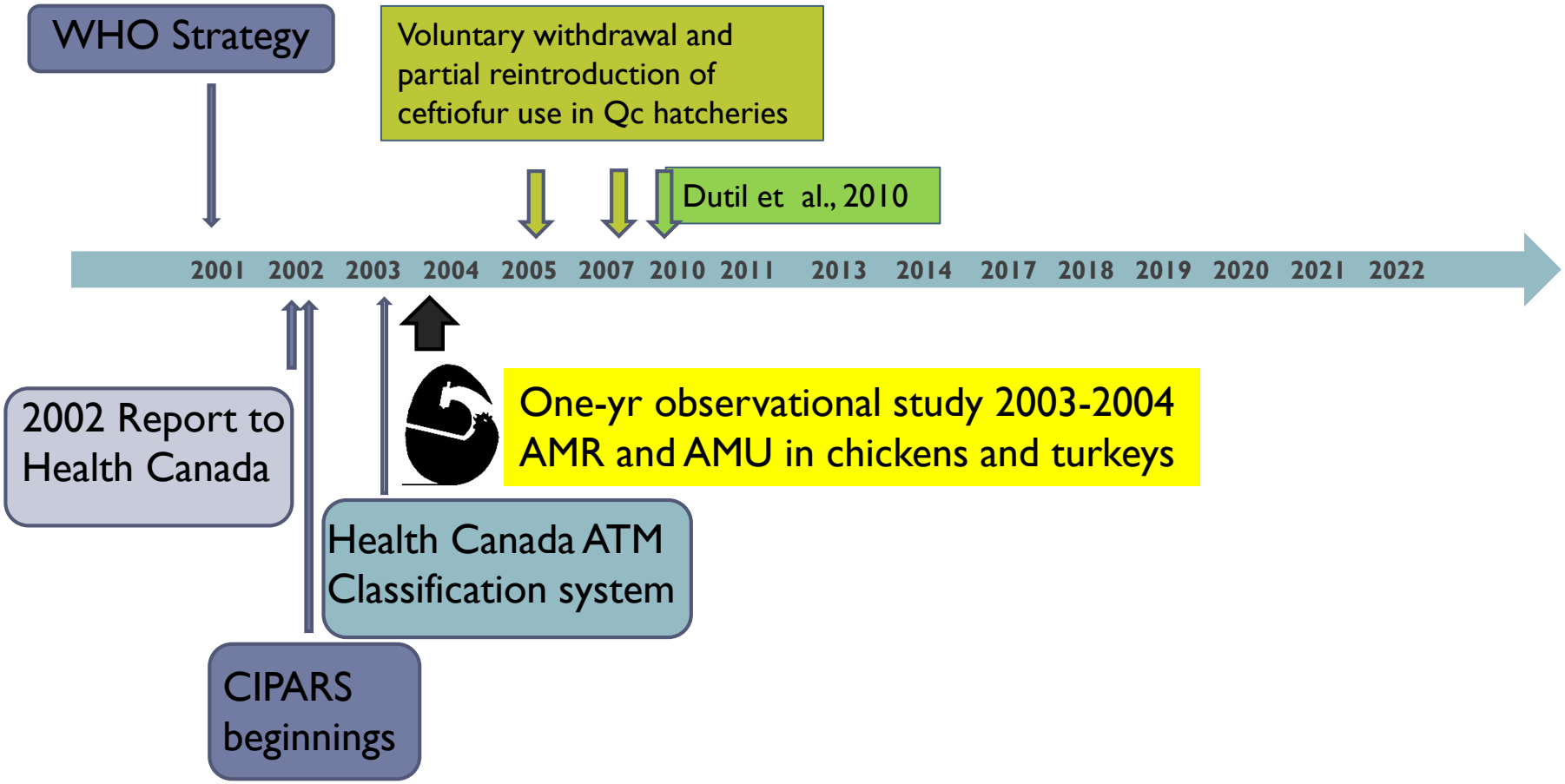


Figure 2. Prevalence of ceftiofur resistance (moving average of the current quarter and the previous 2 quarters) among retail chicken *Escherichia coli*, and retail chicken and human clinical *Salmonella enterica* serovar Heidelberg isolates during 2003–2008 in Québec, Canada.

A short history on AMR and AMU surveillance programs in Canada

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

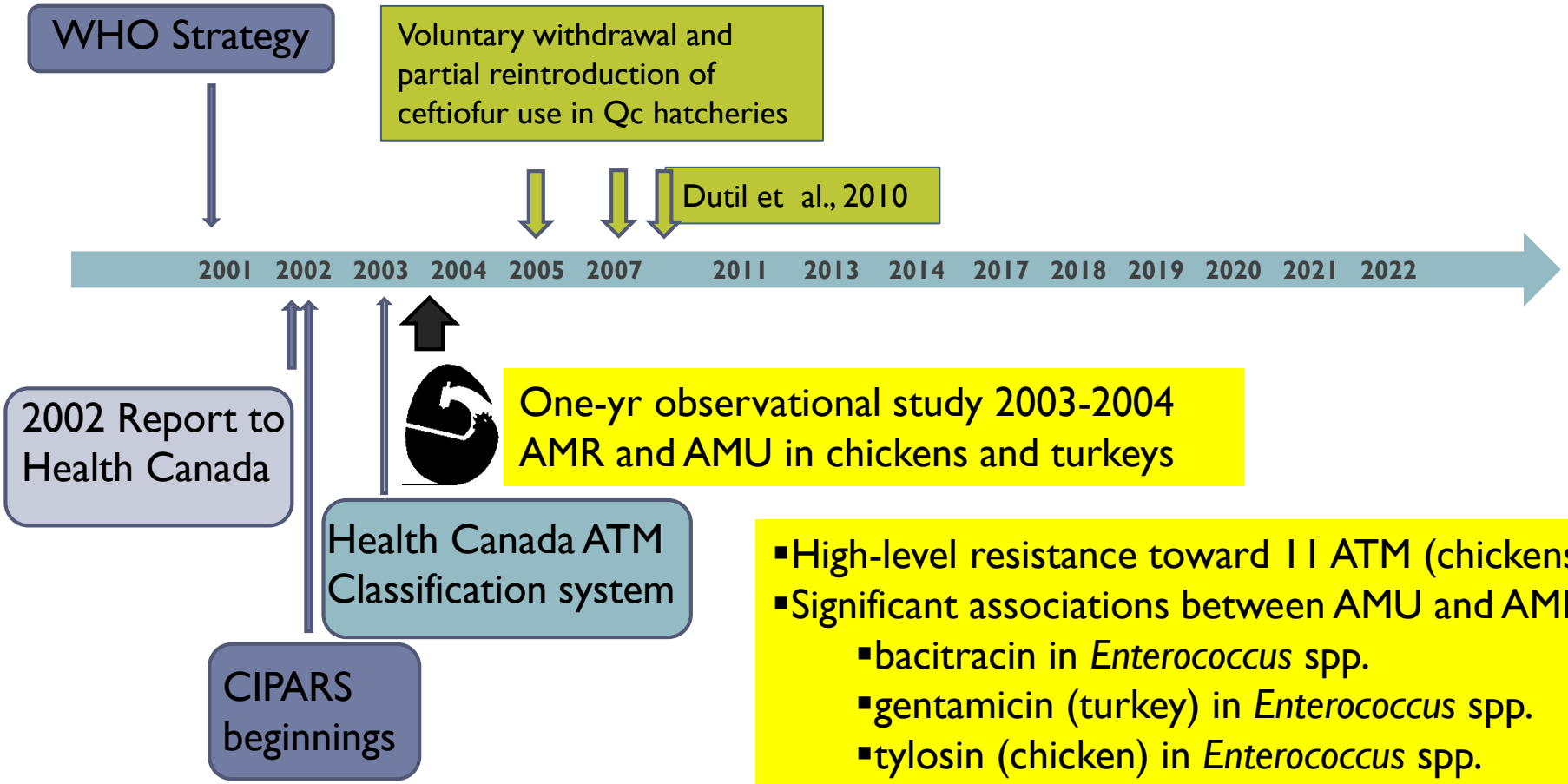
- Initial steps…



A short history on AMR and AMU surveillance programs in Canada

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

- Initial steps…

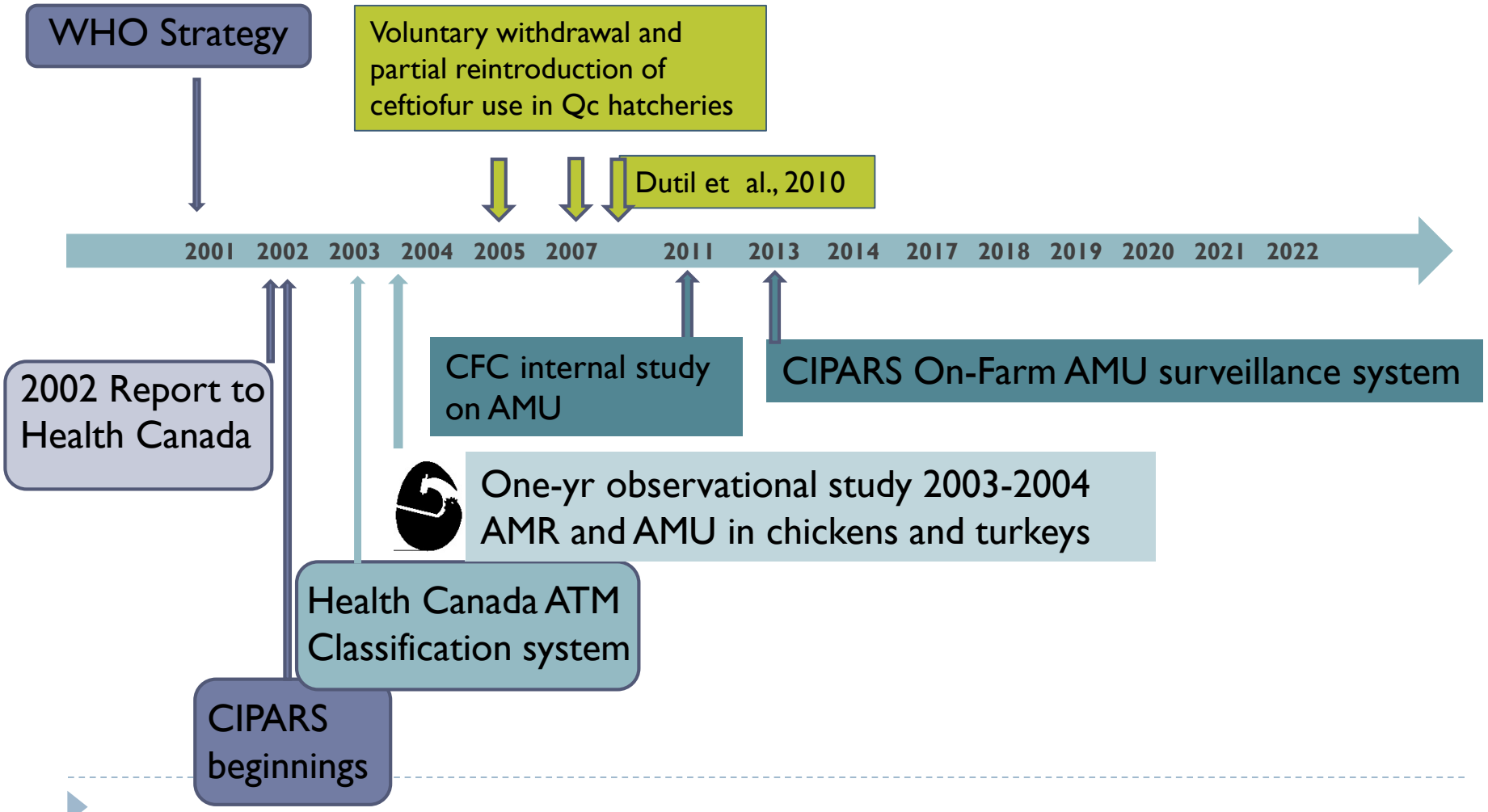


- High-level resistance toward 11 ATM (chickens)
- Significant associations between AMU and AMR
  - bacitracin in *Enterococcus* spp.
  - gentamicin (turkey) in *Enterococcus* spp.
  - tylosin (chicken) in *Enterococcus* spp.
  - Tetracycline (turkey) in *E. coli*
  - Ceftiofur (chicken) in *E. coli*

A short history on AMR and AMU surveillance programs in Canada

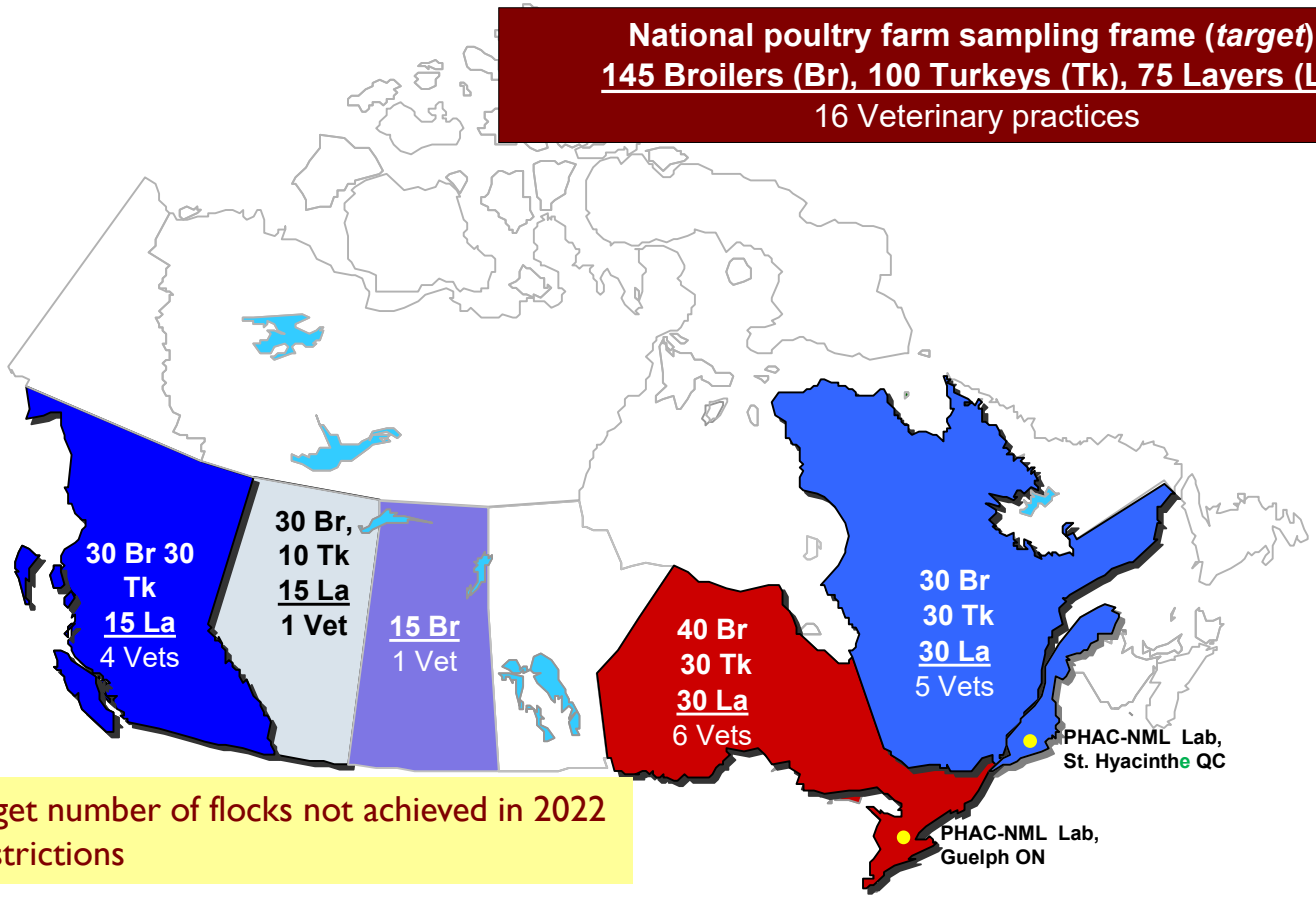
CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

- Initial steps…



CIPARS Design and Methods

National poultry farm sampling frame (*target*):
145 Broilers (Br), 100 Turkeys (Tk), 75 Layers (La)
16 Veterinary practices

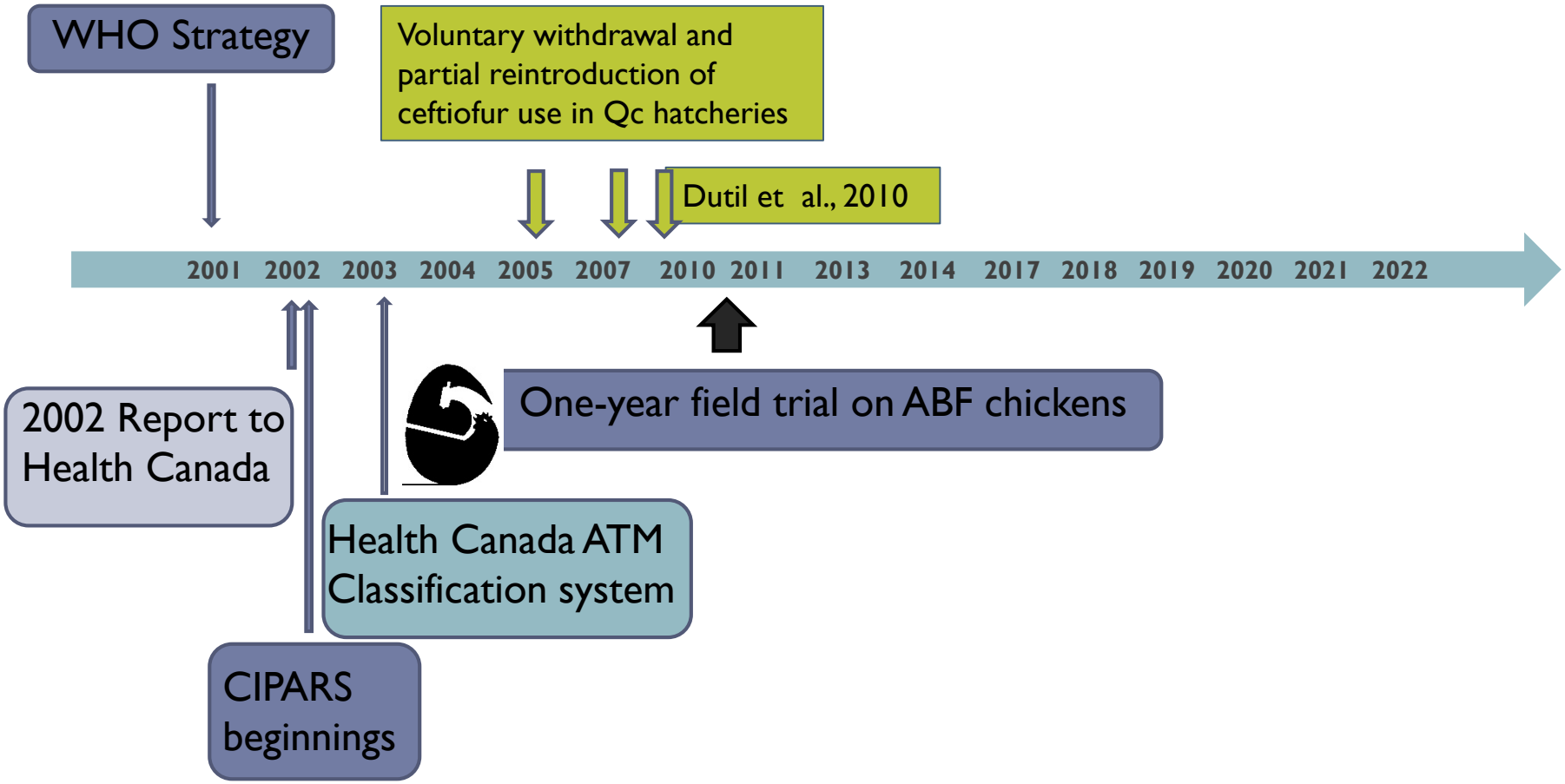


CAUTION! Target number of flocks not achieved in 2022 due to HPAI restrictions

A short history on AMR and AMU surveillance programs in Canada

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

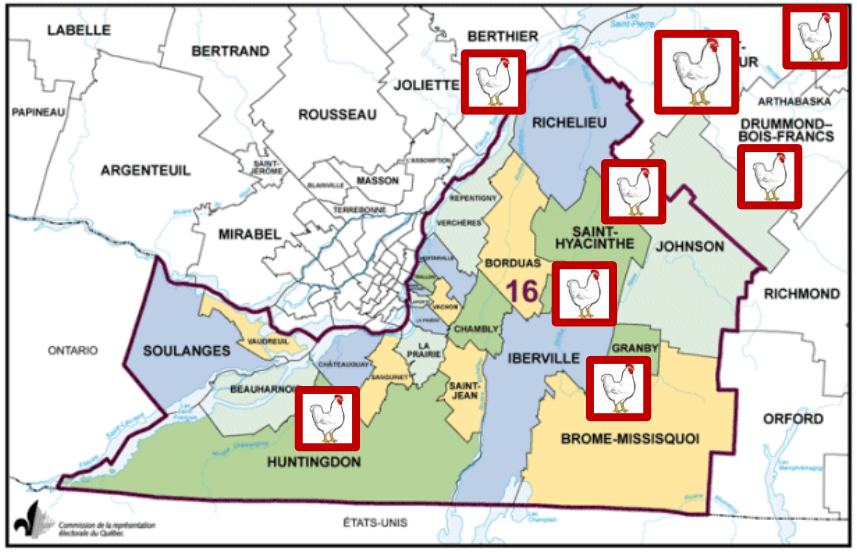
- Initial steps…

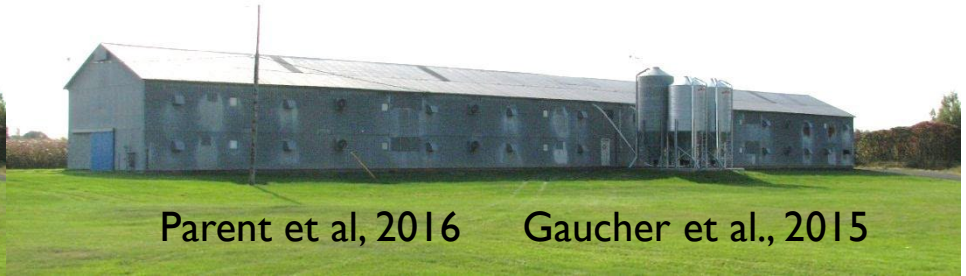


Field trial on ABF chicken flocks

Results (one year prospective study in 8 farms)

- *Even with similar management and feed, necrotic enteritis affected 25% of the flocks*
  - *Clostridium perfringens can persist in consecutive flocks*





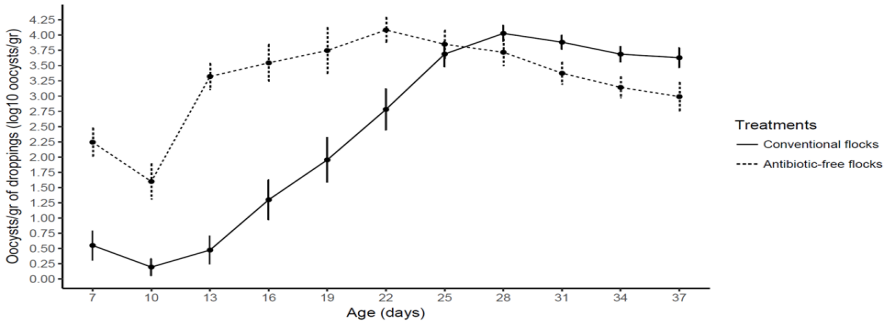
Parent et al, 2016 Gaucher et al., 2015

Field trial on ABF chicken flocks

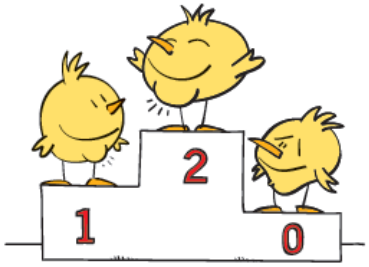
CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

Results (one year prospective study in 8 paired barns)

- *Even with similar management and feed, necrotic enteritis affected 25% of the flocks (Clostridium perfringens a resident of the barn microflora?)*
- *Importance of coccidia prevention*
- *Importance of optimal brooding*

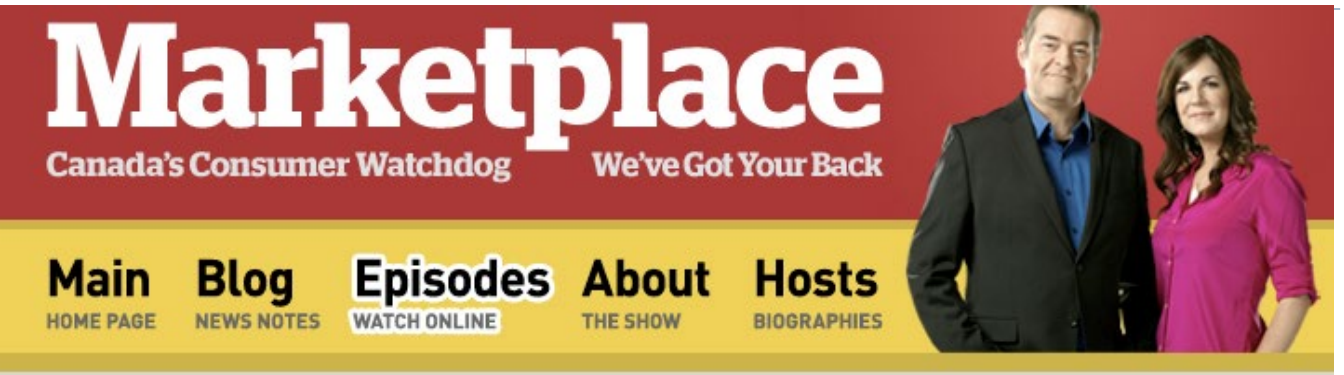


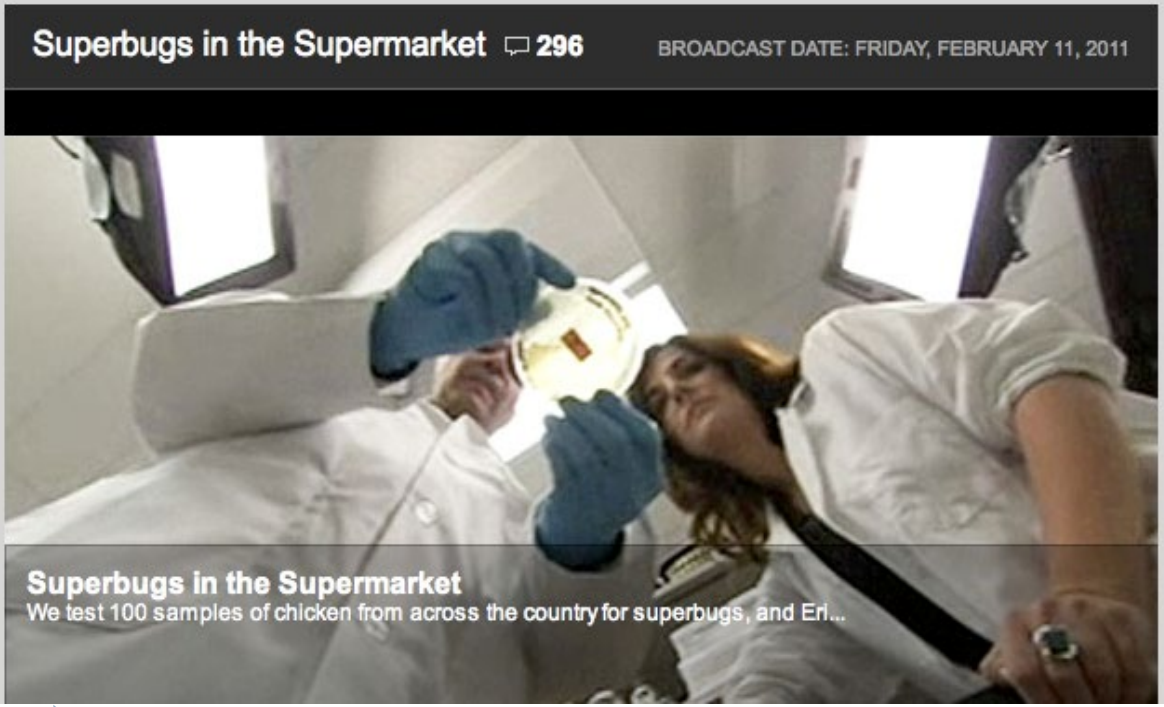
Parent et al., 2018



https://www.cra-fmv.org/poussin-podium

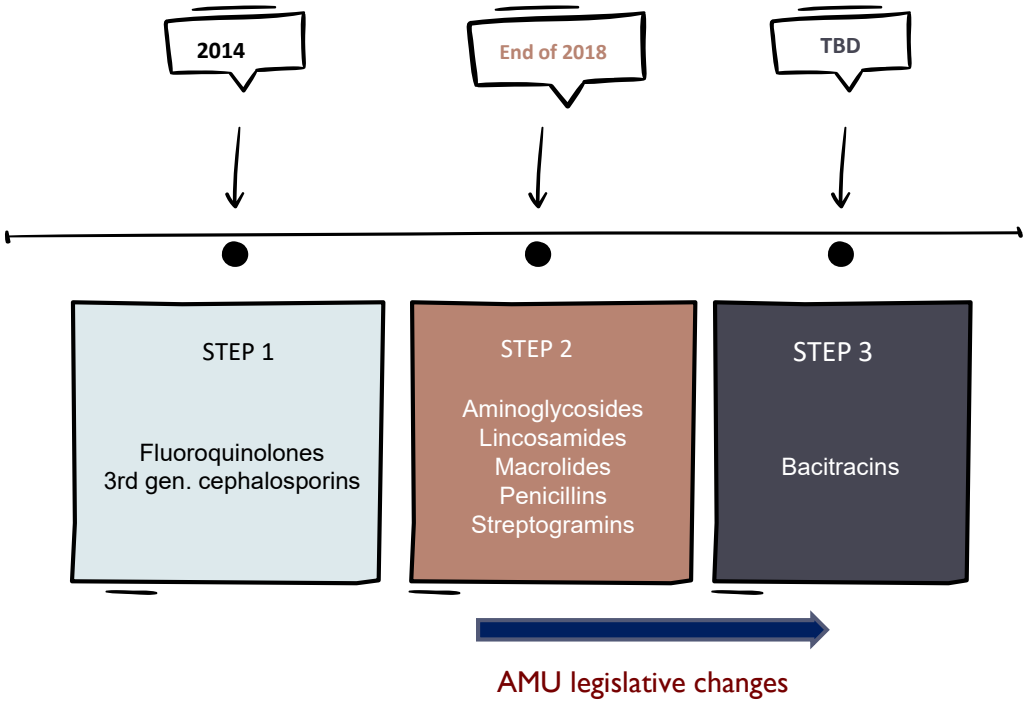
In 2011 chickens became a problem to the public





Chicken Farmers of Canada launched a voluntary strategy in 2012

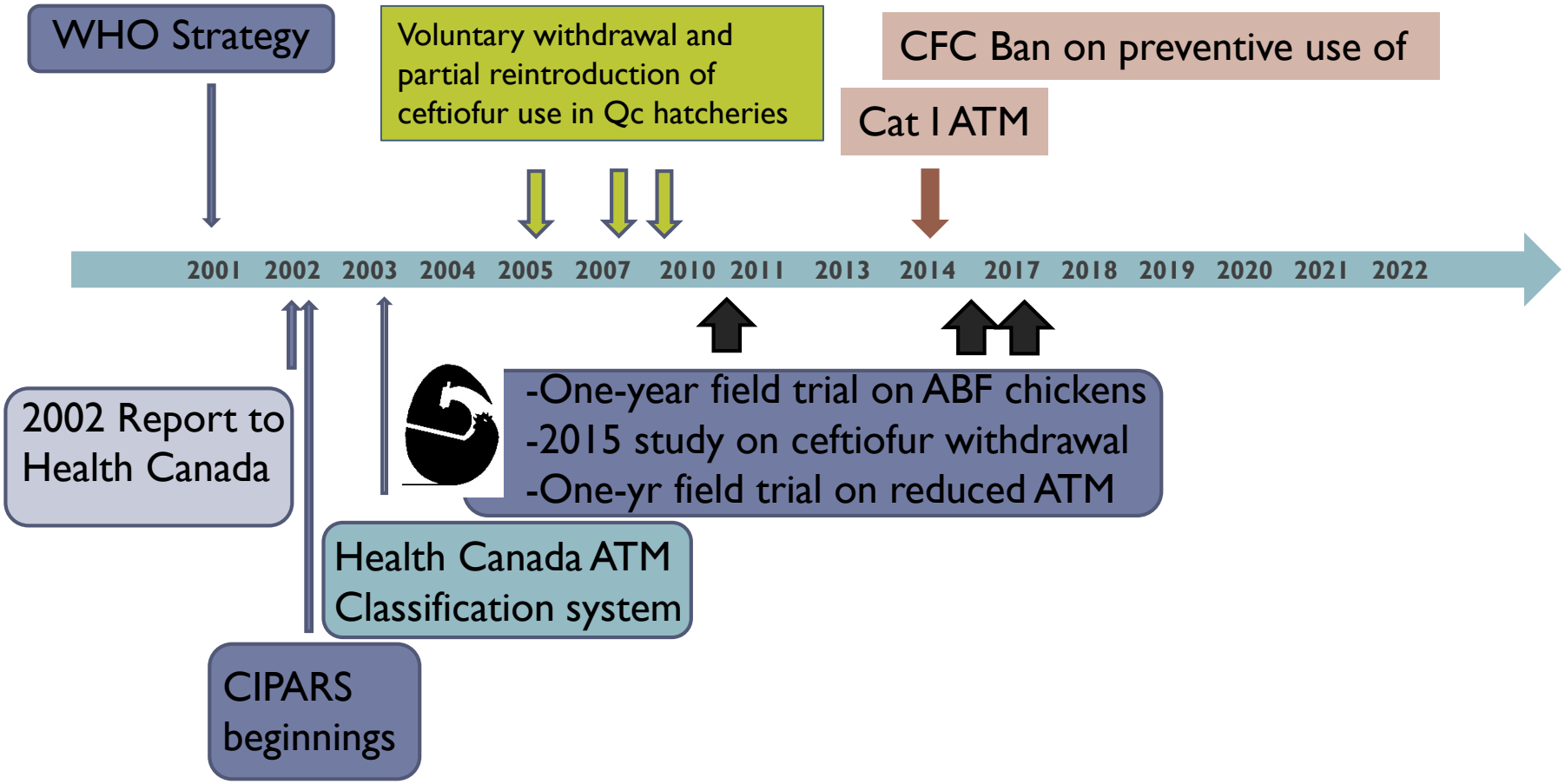
CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal



*The strategy involved preventive uses only
** To be determined, ongoing review of the impact
***Enhanced veterinary oversight/veterinary prescription only use, removal of growth promotion claims in some antibiotics, and mandatory reporting of sales and distribution data.

A short history on AMR and AMU surveillance programs in Canada

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

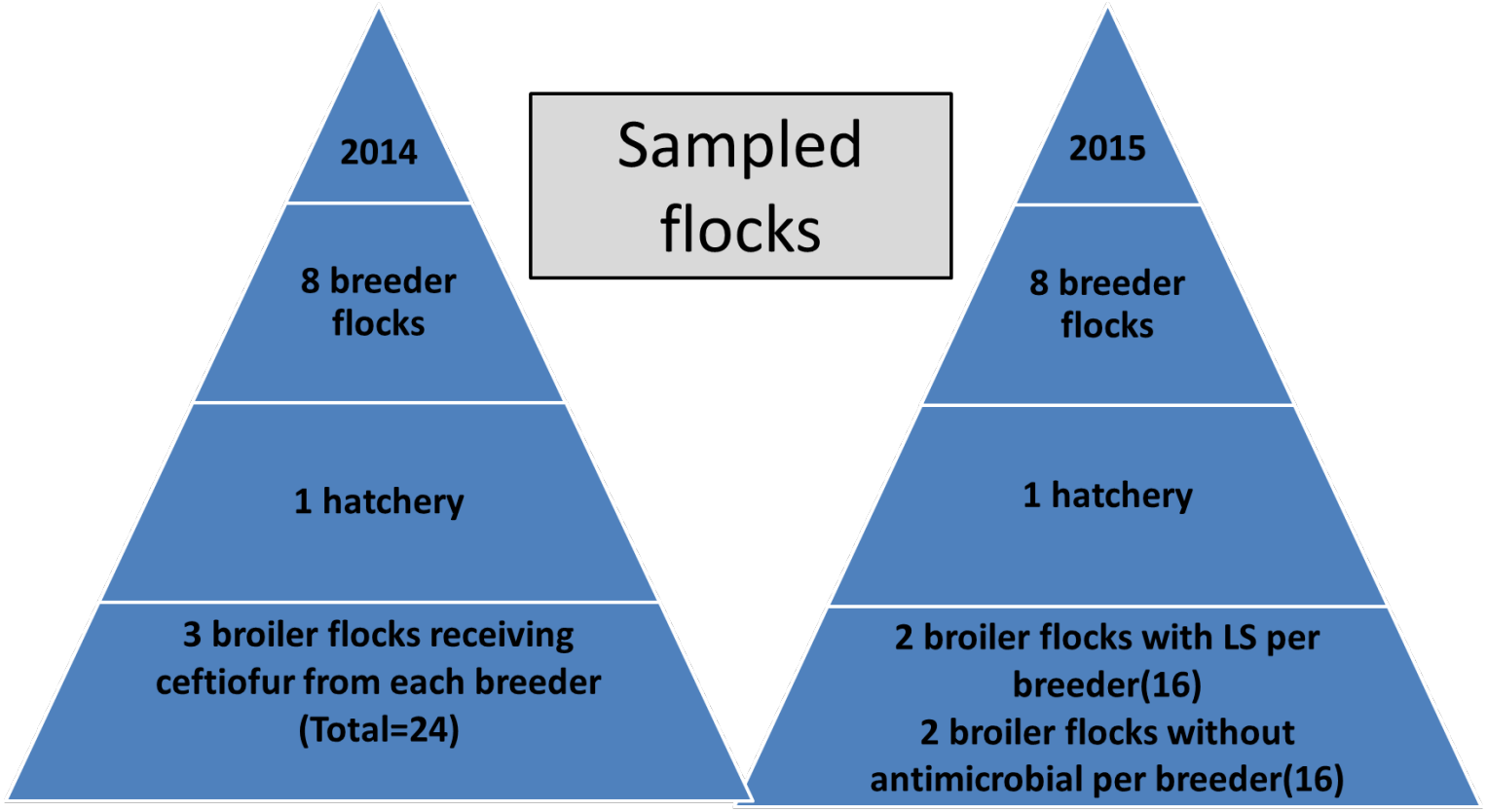


AMU at the hatchery

Vertical transmission of ceftiofur resistance genes, virulence genes of ExPECs and antimicrobial resistance profiles in breeders and their progeny after ceftiofur ban in broiler hatcheries

- Verify if the removal of ceftiofur from the hatchery decreased resistance to this antibiotic in *E. coli* strains, 12 months after withdrawal

Vertical transmission of ceftiofur resistance genes, virulence genes of ExPECs and antimicrobial resistance profiles in breeders and their progeny after ceftiofur ban in broiler hatcheries

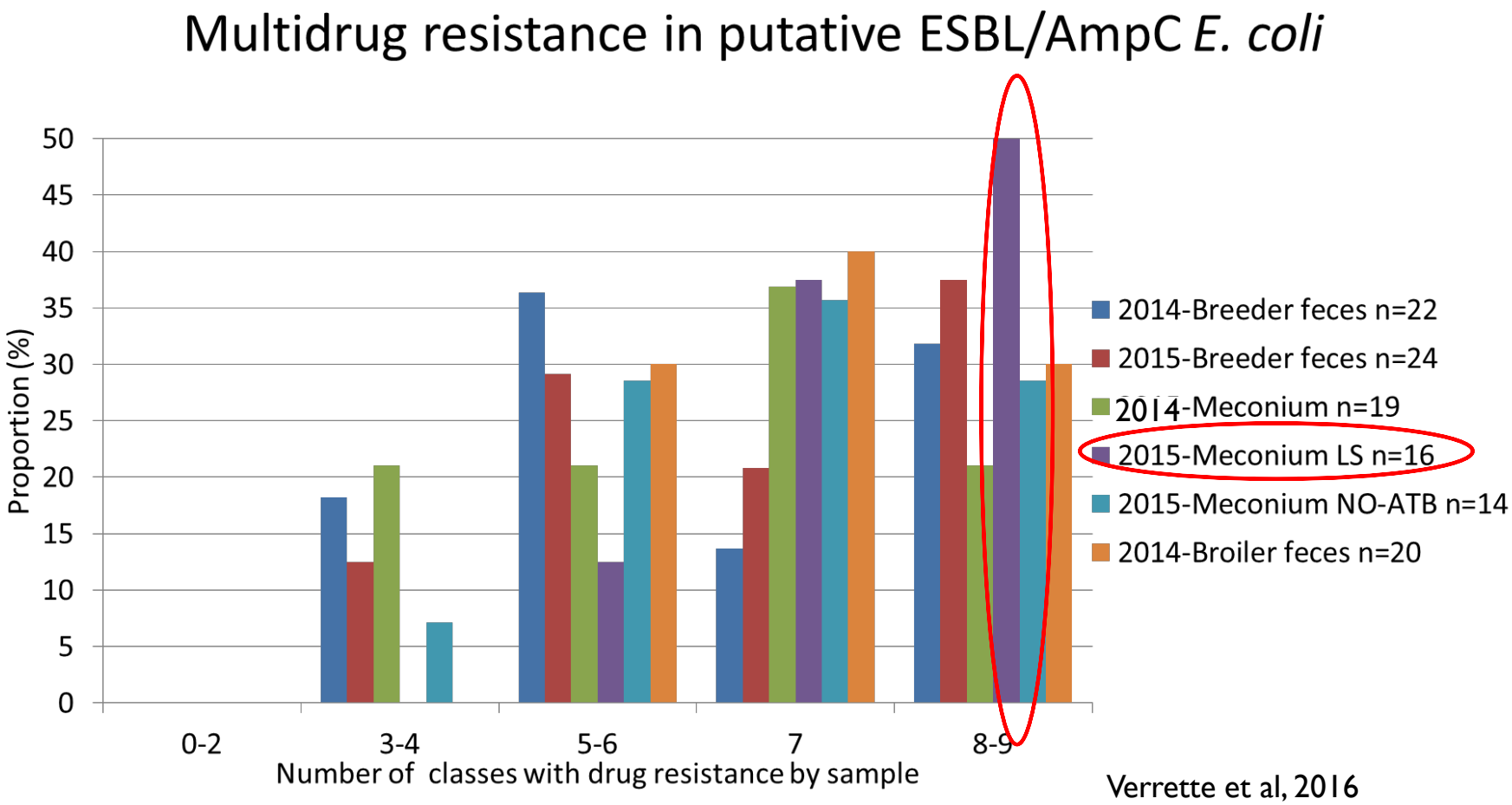


Withdrawal of *in ovo* ceftiofur administration can lead to reduced prevalence of resistant genes in meconium

Sample		Sampling year	No of samples (isolates)	% samples with one or more isolates positive for:		
				bla$_{TEM}$	*bla*$_{CMY-2}$	*bla*$_{CTX-M}$
Pooled feces Breeder		2014	22 (110)	68	0	0
		2015	1 (4)	0	100	0
Meconium	Ceftiofur	2014	20 (100)	45	90[a]	20[a]
	LS	2015	16 (80)	56	50[b]	0[b]
	Without AM	2015	14 (70)	71	36[b]	0[b]
Pooled feces Broiler	Ceftiofur	2014	20 (100)	50	60[a]	5
	LS	2015	16 (80)	69	44[b]	6
	Without antimicrobial	2015	14 (70)	43	50	0

Verrette et al, 2016

Replacing ceftiofur with another molecule is not the answer…



Verrette et al, 2016

Antimicrobial use (AMU) reduction of preventive antibiotics in broiler chickens

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

- Commercial field trial in collaboration with the industry
  - One-yr prospective study in paired barns on 7 farms
  - Strategies to reduce ATB use in broiler chickens
    - Impact on performances and intestinal health
    - Impact of antibiotic on caecal microbiota composition

Antimicrobial use (AMU) reduction of preventive antibiotics in broiler chickens

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

x84 flocks

J0 **Slaughter**

7 commercial farms in Quebec

2 houses per farm

House 1
Reduction of antibiotics

- Flock 1
- Flock 2
- Flock 3
- Flock 4
- Flock 5
- Flock 6

Paired
- Chicks
- Feed
- Management

House 2
Conventional

- Flock 1
- Flock 2
- Flock 3
- Flock 4
- Flock 5
- Flock 6

Treatment 1 (n = 21)
Treatment 2 (n = 21)
(Random allocation)

Conventional (n = 42)

Treatments 1 and 2

Ionophores (Category 4)
- Monensin
- Narasin
- Salinomycin

Organic acid
- Calcium butyrate

Conventional

Anticoccidials and antibiotics
- Ongoing program at the mill
- Anticoccidials: Combination chemical/ionophore
- Antibiotics: Category II to IV

Poultry Science
Volume 99, Issue 9, September 2020, Pages 4303-4313

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

Immunology, Health and Disease

Impacts of antibiotic reduction strategies on zootechnical performances, health control, and *Eimeria* spp. excretion compared with conventional antibiotic programs in commercial broiler chicken flocks

Eric Parent *, †, Marie Archambault †, Robert J. Moore ‡, Martine Boulianne *, †

Zootechnical parameter	Ionophores (n = 21)		Ionophores and butyric acids (n = 21)		Conventional (n = 42)		P-value
	Mean	SE	Mean	SE	Mean	SE	
Slaughter weight (kg)	2.44	0.07	2.41	0.04	2.43	0.03	0.40
Feed conversion ratio	1.62	0.04	1.64	0.02	1.64	0.02	0.23
Average daily gain (g/D)	66.7	1.1	65.7	1.1	66.1	0.9	0.34
Age at slaughter (days)	36.7	1.0	36.7	0.3	36.6	0.3	0.66
Mortality (%)	2.92	0.58	3.03	0.38	3.18	0.33	0.43
Total condemnations (%)	1.74	1.17	1.62	1.17	1.70	1.15	0.64

Factors explaining the microbiota variation

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

Effect size and significance of farm-level factors with the microbiota composition evaluated by the ANOSIM (n = 1002).

	ANOSIM (analysis of similarities)	
Factor	R-value	p-value
Paired flocks	0.37	0.001
Farm	0.24	0.001
Feed mill	0.12	0.001
ATB program	0.04	0.002
Hatchery	0.04	0.017

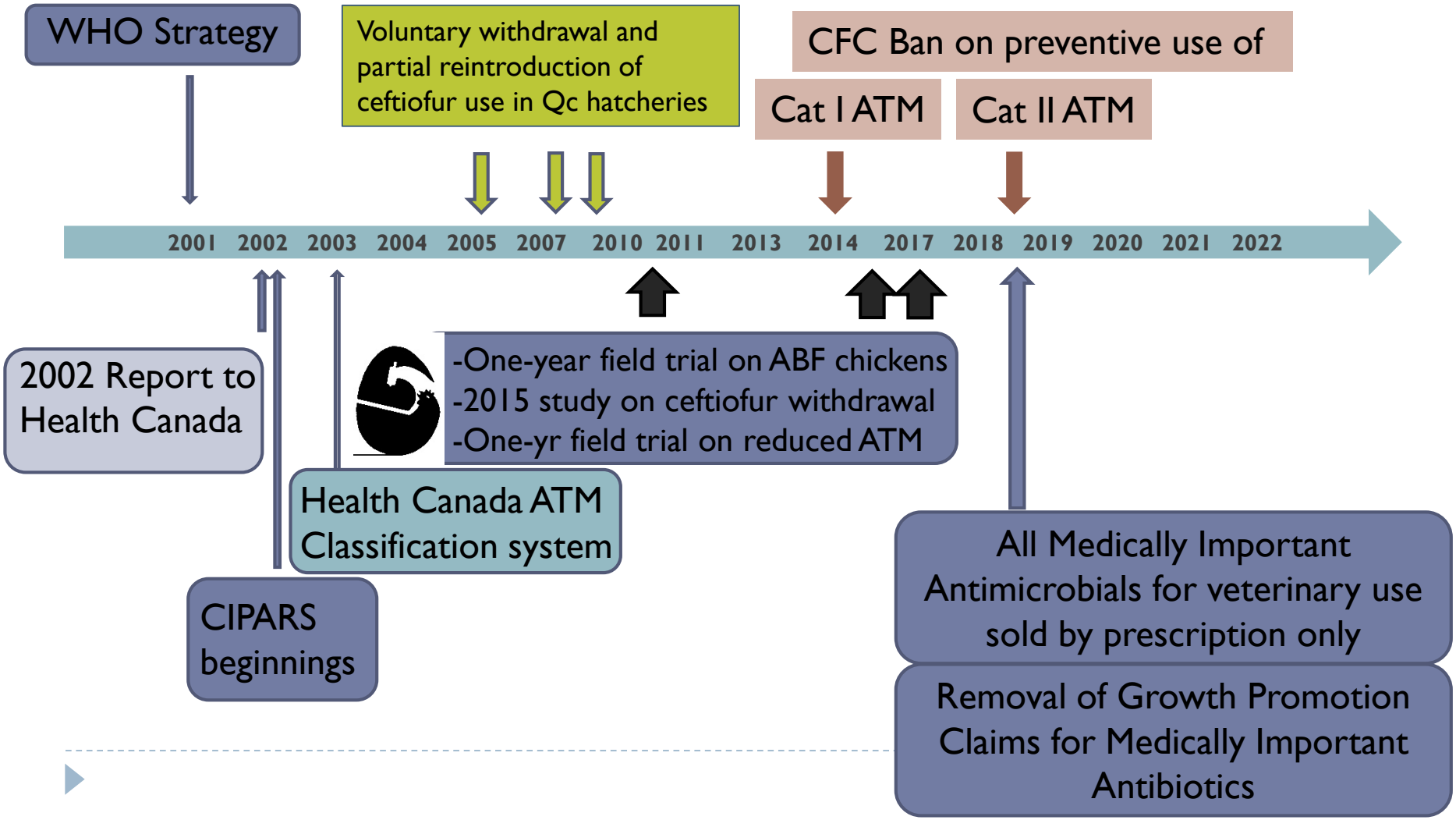
0 = R-value → 1

Even distribution within and between groups

Higher dissimilarity between groups than within groups

A short history on AMR and AMU surveillance programs in Canada

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal



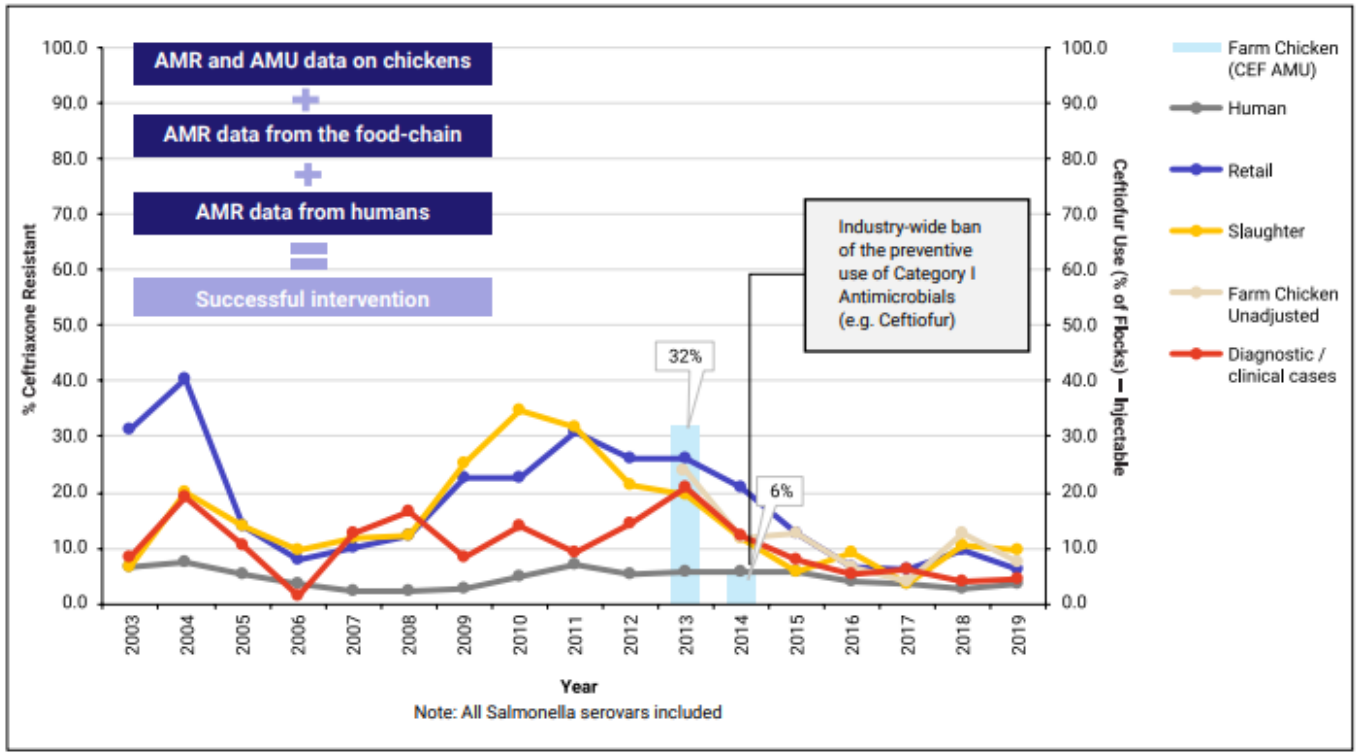
Consequence of the bans?

- Increased early mortality (variable)
- Emergence of Enterococcal spondylitis and osteomyelitis
  - Mostly *Enterococcus cecorum*
  - Multi-resistant bacteria
- Increased use of Category II antibiotics in some provinces

CIPARS captured human and animal data before and after the voluntary intervention by the industry – public health impact

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

Figure 47. Temporal variation in frequency of ceftriaxone resistance (%) among all *Salmonella* serovars as well as ceftiofur use (% of flocks) by host species (chicken and human) and CIPARS surveillance component, 2003-2019

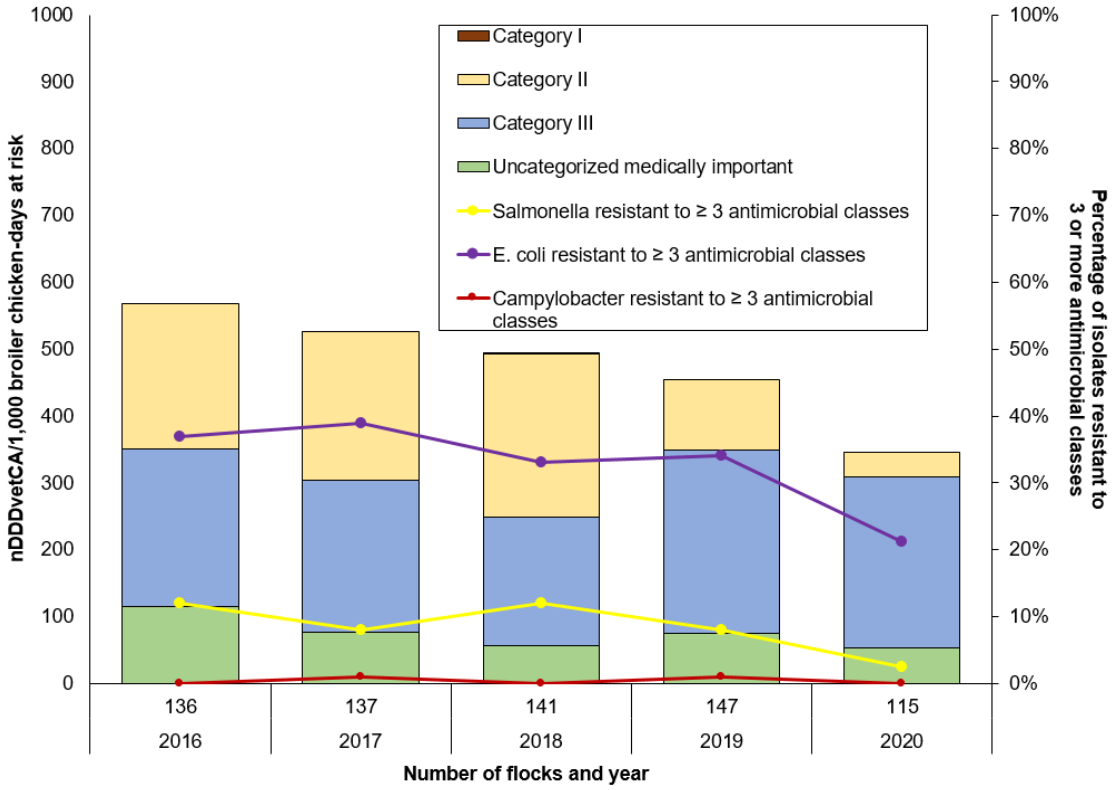


Source: **CARSS Report, 2022**. https://www.canada.ca/en/public-health/services/publications/drugs-health-products/canadian-antimicrobial-resistance-surveillance-system-report-2022.html#a4.5.1

CIPARS AMU and AMR surveillance in broiler chickens

- AMU has **decreased** since 2016, as well as resistance to ≥ 3 antimicrobial classes in *Salmonella, E. coli*, and *Campylobacter*

- The diversity of antimicrobial classes reported to be used has **decreased**, consistent with the timing of the elimination of preventive uses of Category II antimicrobials.



CIPARS Farm - Integrated AMU and AMR

CHAIRE EN RECHERCHE AVICOLE
Faculté de médecine vétérinaire
Université de Montréal

Acknowledgements

- To the first Canadian veterinary epidemiologists who developed CIPARS
  - To Drs Rebecca Irwin and Lucie Dutil for their leadership
  - To Dr. Agnes Agunos for her contagious smile and generous support
- To Canadian poultry producers for accepting such a challenge
- Staff and students from the Chair in Poultry Research