WORLD ANIMAL PROTECTION

EXECUTIVE SUMMARY

Reducing antibiotic use

in farming through improvements to animal welfare

Executive summary

Background

The therapeutic use of antibiotics and antimicrobials to treat and cure bacterial diseases is a vital component of protecting the health and welfare of animals used in food production. When an animal is ill, the prompt diagnosis and treatment of disease by a licensed veterinarian is a necessary step in restoring animal health and preventing the spread of disease to other animals on the farm.

However, for decades there has been a growing reliance worldwide on administering antibiotics before animals become sick to *prevent and control* the spread of disease rather than to *treat and cure* a sick animal or a disease outbreak among multiple animals. Prophylactic antimicrobial use (AMU) has emerged as a symptom of intensive animal agriculture that houses animals in barren, crowded conditions, and prioritizes practices that drive production and efficiencies over animal health and welfare. These conditions lead to stressed, immune-compromised animals vulnerable to illness and infection. Prophylactic AMU has enabled these low-welfare conditions to persist without health impacts to animals that may otherwise occur when keeping animals in sub-optimal environments. When it was discovered that some antibiotics had the added benefit of improving feed efficiency and promoting growth/weight gain, their use escalated.[1,2]

Continued and regular use of antibiotics contributes to the rise and spread of antibiotic resistant bacteria, sometimes called "superbugs".[3] Of particular concern is the use in animal agriculture of critically important antimicrobials needed to treat human illnesses. The World Health Organization (WHO) has called antimicrobial resistance (AMR) one of the top 10 public health crises and has estimated close to five million human deaths were associated with bacterial AMR in 2019.[4] Resistance to antibiotics, which are often used as first line therapy for severe infections, accounted for more than 70% of human deaths attributable to AMR pathogens.[5]

Because of growing AMR concerns, some governments have passed regulations to restrict antibiotic use in farm animals. In 2022, prophylactic use of antibiotics (with some exceptions) was banned across Europe.[6]

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This photo
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Canadian context

Since the launch of the Canadian Institutes of Health Research (CIHR) in 2000, several programs have been initiated federally to address AMR using the One Health framework.[7]

In October of 2014, the Government of Canada released: "Antibiotic Resistance and Use in Canada: A Federal Framework for Action" which mapped out a collaborative federal approach to responding to the threat of AMR.[7] The Public Health Agency of Canada (PHAC) initiated the Canadian Antimicrobial Resistance Surveillance System (CARSS) and the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) – the latter combining data from human, animal and food sources.[8] CIPARS for farms is a voluntary initiative (and thus not inclusive of all farms) that collects farm use data from a network of sentinel veterinarians and producers in specific livestock sectors across Canada.[9 (pg 2)]

In 2015, the federal government followed up on its Federal Framework for Action, highlighting three pillars - Surveillance, Stewardship and Innovation. It identified concrete actions to reduce the threat and impact of AMR[7,10] including proposed measures to strengthen regulations on farm animal antibiotic use.[11] Canada also enrolled in the World Health Organization's Global Antimicrobial Resistance and Use Surveillance System (GLASS), launched in 2015. However, in response to the 2020 call for data, Canada did not report any AMR data to GLASS and does not appear to have provided any information since 2015.[12]

Then, in 2017, the Pan Canadian Framework for Action was launched, adding Infection Prevention and Control as a fourth pillar[13] and recommending the development of a Pan Canadian Action Plan.

In 2018, Health Canada implemented regulations requiring a veterinary prescription to purchase medically important antimicrobials and medicated feeds that were formerly available over-the-counter, and requiring all growth promotion claims be removed from product labels.[15] While the over-the-counter sales regulation is a step in the right direction, its effectiveness in Canada is not known since data collection at the farm level regarding who makes the treatment decisions, and the reasons for antibiotic use, is limited.

Also initiated in 2018 (under the CIPARS umbrella) is the Veterinary Antimicrobial Sales Reporting (VASR) system. Its purpose is to collect data on the sale of veterinary antimicrobials considered important in human medicine, and to estimate sales by animal species.[9 (pg 2)] However, the mandatory reporting of annual sales data only applies to manufacturers, importers and compounders of these drugs[16], unlike European programs that collect data from veterinarians, farmers and feed mill (medicated feed) sales. Without the farm level data, understanding how antimicrobials are being used limits policy makers in their ability to guide impactful and necessary actions to combat AMR.

In a CARSS 2020 report, data from 2018 indicates Canada distributed the sixth highest quantity of antimicrobials intended for use in animals (using European standard animal weights) compared to data from 31 European countries.[17 (pp79-85)] The report also stated that Canada sold 48 times more antimicrobials than Norway (the country with the lowest sales) and three times less than Cyprus (the country with the highest sales). It is interesting to note that a 1995 decision by Nordic countries prohibits veterinarians from profiting from antibiotic sales.[18 (p7489)] Denmark has been particularly successful with its profit ban and the 2010 implementation of their "yellow card" system, with sector-specific antimicrobial use targets where producers face penalties and fines for non-compliance.[19 (pg466),20]

In 2019, PHAC established the AMR Network – a stakeholder coalition fostering collaboration and knowledge-sharing among existing AMR groups. Its goal was to turn action plans into actions and propose AMU governance models to strengthen Canada's AMR response for human health.[21] Two models were proposed in June of 2021: (1) a decentralized, collaborative approach amongst a network of experts; and (2) a centralized, structured, top-down approach with staff. On June 22, 2023, a decision was announced to proceed with the decentralized "network of networks" approach, and to add a 5th pillar – Leadership – to the Pan Canadian Action Plan.[22]

Complementing all the above initiatives is the Canadian Veterinary Medical Association's Stewardship of Antimicrobials by Veterinarians (SAVI). Formed with funding from and in partnership with the federal government, SAVI's four-year mandate (2019-2023) will support national stewardship and data collection elements to enhance veterinarian decision-making regarding AMU.[23] Since veterinary prescribing and dispensing data are not yet available under the CIPARS VASR system, SAVI will fill this gap through its veterinary practice AMU data collection system.[9(pg 12)]

Photo: Dairy cattle on a farm in Canada.
Credit: Shutterstock

At a provincial level, there are two key animal AMU initiatives. In Quebec, effective February 25, 2019, antibiotics of very high importance to human medicine (Category 1) can only be used in food animals for curative purposes (treating disease that is present) if no lower category option is effective, and are forbidden as a preventative measure in any food animals.[24] Quebec is also developing its own AMU surveillance and data collection program for food animals raised in the province,[9 (p12)] although they have had a passive surveillance program in place since 1993.[24 (pg193)]

In Ontario, a collaboration between the Ontario Veterinary Medical Association, government, academia and industry launched the Farmed Animal Antimicrobial Stewardship Initiative (FAAST).[25] In addition to improving antimicrobial stewardship, FAAST will prepare for upcoming policy and regulatory changes and aims to preserve the efficacy of antimicrobials without compromising animal health or food safety through engagement, collaboration and education.[26]

"While the federal government publicly released its Pan Canadian Framework for Action on AMR in 2017, there has been limited political commitment to fund and act on many of the recommendations. It was not until 2023 that the Pan Canadian Action Plan was launched, and it is still unclear how (or whether) it will be adequately funded and supported. Political will and engagement are needed to drive changes that will truly inform about how antimicrobials are used in Canada through mandatory reporting (collection/submission) of AMU

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(what drugs used, for what purpose and decision to use/administered by whom) in animals, and provisions to monitor, support and, as a last resort, penalize those who continue to use antimicrobials inappropriately" (Dr. S. Weese, DVM, DVSc, Dip ACVIM, oral communication, July 24, 2023). Moreover, addressing the root causes driving the need for AMU on Canada's farms in the first place – sub-optimal animal housing, mixing and management practices – is a necessary step to reducing antibiotic overuse and its impacts.

Antibiotic use as a by-product of poor animal welfare

Poor welfare and the overuse of antibiotics on farms are inextricably linked. Prophylactic antibiotics are used to compensate for the consequences of housing and raising animals in unnatural, stress-inducing conditions which make them vulnerable to illness and infections.

In a review of the scientific literature, several routine on-farm practices across different species have been identified as being associated with high levels of prophylactic and/or therapeutic use of antibiotics and point to opportunities to reduce their use by improving animal welfare on farms. The following table summarizes common disease concerns, along with routine and alternative practices to reduce stress and improve animals' immune systems, to thus facilitate a reduction in AMU.

Photo: Cattle on a feedlot in Canada.
Credit: Shutterstock

Table 1. Summary of preventative antimicrobials used to treat common diseases in cattle, pigs and chickens, and alternative animal management practices to reduce AMU

Species	Diseases	Antimicrobials used	Alternative practices
Dairy cattle			
	Mastitis	Oxytetracycline, Cephapyrin, Cetiofur HCl, Perlimycin, Ampicillin, Chlortetracycline	Frequent floor cleaning, improved milking hygiene (teat dips and sealants), use of robotic automatic milking systems, selective dry cow therapy using gradual dry-off and unrestricted feed with reduced feed energy density, sand and straw bedding, increased stall size
Beef cattle			
	Bovine Respiratory Disease Complex	Chlortetracycline, Oxytetracycline, Florfenicol, Cetiofur HCl, Cetiofur CFA	Two-step weaning process, preconditioning calves prior to feedlot (and postponing transport until older), use online auctions (on-farm) in lieu of auction yard sites, smaller groupings/limit mixing of unfamiliar animals at feedlots, one- or two-dose injections and vaccines vs in-feed antimicrobial additives
	Liver Abscesses	Tetracyclines, Tylosin	Higher levels of roughage/forage, more gradual transition to grains, reduce levels of Tylosin
Pigs			
	Respiratory Diseases	Chlortetracycline, Amoxicillin, Oxytetracycline, Penicillin G procaine, Tilmicosin, Lincomycin, Cetiofur HCl, Cetiofur CFA, Tylosin, Tylvalosin	Enrich environment with straw and novelty items, reduce stocking density, limit stress-inducing physical alterations (e.g. teeth clipping, tail docking, castration)
	Lawsonia intracellularis (causative agent of porcine proliferative enteritis or PPE)	Tylosin, Tetracyclines, Tiamulin, Lincomycin	Vaccines in lieu of antimicrobials, enrich environment with straw and novelty items, reduce stocking density and physical alterations, provide separate dunging areas
	Post-weaning diarrhea in piglets	Tetracyclines, Tylosin	Breed sows for smaller litter sizes, postpone piglet weaning age to a minimum of 28 days
Broiler Chickens			
	Intestinal diseases (Coccidiosis, Necrotic Enteritis)	Bacitracin, Chlortetracycline, Oxytetracycline, Tylosin	Raise slower growing breeds, feed chicks immediately upon placement, reduce stocking density, extend barn turnover time between flocks for proper sanitation, eliminate drafts, improve ventilation and heat sources
All species			
	All contagious diseases		Enhanced hygiene and cleaning, biosecurity improvements, vaccination if available and effective
	All diseases which result partially from stressful conditions or immune system challenges		Housing practices and living conditions more closely resembling natural, non-production settings

Note 1: Table adapted from Laurent, 2018[27] and CgFARAD, 2020[28] for Extra Label Drug Use published data and diseases on Canadian farms.

Note 2: As per Health Canada Drug Class categories found on the Farmed Animal Antimicrobial Stewardship Initiative (FAAST) website amstewardship.ca:
Red font indicates Category I antimicrobials of Very High Importance: Cetiofur – a 3rd and 4th generation cephalosporon.
Orange font indicates Category II antimicrobials of High Importance: Tylosin, and Tylvalosin – macrolides, Cephapyrin – a 1st and 2nd generation cephalosporon.

Photo: Pigs raised on a high welfare farm in Canada.

It is important to note that reducing antibiotic use without commensurate improvements in animal husbandry and housing could result in animal health and welfare challenges. For example, research examining various disease states (eye burns, footpad lesions, and airsacculitis) in broiler chickens by type of antibiotic program – no antibiotics ever, nonmedically important antibiotics, or medically important antibiotics – found animals never given antibiotics had a higher likelihood of disease states, and with greater severity.[29] The finding indicates that the growing trend of raising animals without antibiotics may negatively affect animal welfare unless changes are also made to prevent illness and infection.

Historically, each livestock sector has been responsible for its own animal husbandry standards. However, the main guidelines for animal welfare on Canadian farms are now standardized through the Codes of Practice, which are developed through multi-stakeholder committees overseen by the National Farm Animal Care Council (NFACC).[30] Codes are not legally binding except in six provinces where they are referenced in provincial animal cruelty legislation, which is of limited value since enforcement would come only after an infraction has taken place. Moreover, the codes condone some conventional, low welfare practices linked to high levels of antibiotic use. AMU/AMR issues and their linkages to certain animal management practices are currently not addressed in any of the codes.

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Antibiotics have a place in animal agriculture as they do in human medicine, when used appropriately. If animals are ill, they must be treated with antimicrobials for their health and welfare. However, improvements in animal husbandry practices (stocking density, weaning periods, behavioral and physical enrichment), appropriate feed and diets to support animal health, and one-time or two-dose injections of antibiotics and vaccines in lieu of recurring feed additives, will help to prevent illness and reduce the need for routine, prophylactic antibiotic use.

Solutions and policy recommendations

Driving the intensification of animal agriculture has been the consumer demand for diets heavy in animal-based foods.

Modifications to current animal housing and management practices are a crucial component in reducing the reliance on antibiotic use to prevent illness in animal herds.

However, to adequately address poor animal welfare on farms and overuse of antibiotics, dietary shifts towards more plant-based eating are also necessary. Raising animals with more space and using slower growing breeds can be supported within the earth's limited capacity when animal numbers are reduced. These improved conditions alongside less animals will necessarily result in reduced AMU.[10] Adopting mostly plant-based diets with or without small amounts of meat and dairy are recommended by experts for health benefits and climate change prevention as well.[31,32]

Furthermore, policies directed at monitoring and tracking AMU on farms are essential. First, to better understand where and for what purpose they are being used and, second, to identify where antimicrobial stewardship efforts should be targeted to curb AMR.[33]

Photo: Broiler chickens raised on a high welfare farm in Canada.

Policy and regulatory recommendations

In addition to animal management changes, we recommend industry associations and government authorities enforce the following regulatory and policy changes:

- Require AMU reporting as part of the NFACC Codes of Practice for each species and any other industry monitoring and quality management programs and enforce penalties for non-compliance.
- Place all Codes of Practice into provincial laws and ensure enforcement through supply management boards and industry associations.
- Require video and/or other appropriate surveillance monitoring of farms to ensure compliance with required Codes of Practice.
- Track antibiotic sales and use in animals on farm (including ionophores) by veterinarians, pharmacies, farmers, and feed mills (like EU programs) to fill AMU knowledge gaps (provide data to VASR).
- Record profits from prescription drug sales and cap veterinary monetary profits on antimicrobial sales.
- Submit Canada's AMU/AMR data annually to or as requested by GLASS.
- Require mandatory participation by sentinel farms and vets in CIPARS.
- Institute financial penalties on vets, farmers, and feed mills for misuse of antimicrobials through the same mechanism CFIA uses for infractions of the food safety and other Acts.
- The federal government and all provinces should adopt Quebec's policy of forbidding the use of Level One antimicrobials for preventative purposes in food animals and only use when there is curative need, and if no lower category treatment option is available.
- The federal and provincial governments should promote improved animal welfare practices to reduce AMU, particularly through decreased stocking density and mixing of unfamiliar animals, and through improved ventilation to improve animal health and welfare and to limit and control infection.
- All levels of government and food businesses should promote production and consumption of more humanely produced animal-based proteins and plant-based proteins to reduce consumption of animal-sourced foods overall.

Concluding remarks

Intensive animal agriculture practices are driven by economic and production efficiency but these so-called efficiencies in turn create inefficiencies. The drive for high productivity, cost reduction, and increased profits in animal agriculture has come at the expense of both farm animal welfare and human health.

This report highlights opportunities to improve animal management practices on farms that would facilitate the reduction of prophylactic and, in some cases, therapeutic uses of antibiotics in farm animals. The implementation of these improvements will require buy-in from the agriculture industries with support from government by way of financial and regulatory measures.

Funding could come from the $3.5b Agriculture Canada has earmarked under the Canadian Agricultural Partnership (to be spent 2023-2028)[34,35] and the $1.4b over three years promised to compensate dairy farmers for the impact on market share and revenue resulting from recent concessions on two key international trade agreements.[36]

The consequences of AMR for human health are dire. In 2018, Canadian public health experts concluded that 26% of bacterial infections were resistant to the drugs generally used to treat them, taking 5400 lives in Canada annually.[37] If the rates of AMR to first-line antibiotics continue at 26%, by 2050, Canada could see economic losses in GDP of $13 billion annually. If the rates increase to 40% – a likely scenario according to these experts – a further $21 billion annually will be lost (and 13,700 lives) resulting in a cumulative decline to Canada's GDP of nearly $400 billion by 2050, solely from AMR-related issues.[37]

Photo: Waterway downstream from an industrial pig farm being tested for contaminants and antibiotic resistant genes, the building blocks of superbugs.

The drive for high productivity, cost reduction, and increased profits in animal agriculture has come at the expense of both farm animal welfare and human health.

It is hoped the findings in this report will motivate the federal and provincial governments to develop and enforce stricter regulations and legislation governing animal agriculture practices and AMU on farms in Canada.

If AMR increases gradually from 26% to 40%, by 2050, the **cumulative** cost to Canada is estimated at:

396,000 lives

$120 billion in hospital costs

$388 billion in GDP

Source: Adapted from *When Antibiotics Fail*. The Expert Panel on the Socio-Economic Impacts of Antimicrobial Resistance in Canada (2019).[37]

References

1. Manyi-Loh C, Mamphweli S, Meyer E, Okoh A. Antibiotic Use in Agriculture and Its Consequential Resistance in Environmental Sources: Potential Public Health Implications. *Mol J Synth Chem Nat Prod Chem*. 2018;23(4):795. doi:10.3390/molecules23040795
2. Kirchhelle C. Pharming animals: a global history of antibiotics in food production (1935–2017). *Palgrave Commun*. 2018;4(1):1-13. doi:10.1057/s41599-018-0152-2
3. News · CBC. Livestock superbugs threaten humans: doctor. CBC. Published October 4, 2010. Accessed May 31, 2022. https://www.cbc.ca/news/canada/british-columbia/livestock-superbugs-threaten-humans-doctor-1.931842
4. World Health Organization (WHO). New WHO report highlights progress, but also remaining gaps in ensuring a robust pipeline of antibiotic treatments to combat antimicrobial resistance (AMR). Published May 15, 2023. Accessed May 31, 2023. https://www.who.int/news/item/15-05-2023-new-who-report-highlights-progress-but-also-remaining-gaps-in-ensuring-a-robust-pipeline-of-antibiotic-treatments-to-combat-antimicrobial-resistance-(amr)
5. Murray CJ, Ikuta KS, Sharara F, et al. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *The Lancet*. 2022;399(10325):629-655. doi:10.1016/S0140-6736(21)02724-0
6. *New European Union Rules on Farm Antibiotic Use*.; 2020. Accessed April 19, 2023. https://www.saveourantibiotics.org/media/1842/2022-changes-to-european-law-farm-antibiotics.pdf
7. Health Canada. *Federal Action Plan on Antimicrobial Resistance and Use in Canada: Building on the Federal Framework for Action*.; 2015. Accessed May 10, 2023. https://www.canada.ca/en/health-canada/services/publications/drugs-health-products/federal-action-plan-antimicrobial-resistance-canada.html
8. Tsegaye L, Huston P, Milliken R, Hanniman K, Nesbeth C, Noad L. Public health threat in Canada: AMR. *Can Commun Dis Rep CCDR*. 2016;42(11):223-226. Accessed June 12, 2022. https://doi.org/10.14745/ccdr.v42i11a01
9. Léger DF, Anderson MEC, Bédard FD, et al. Canadian Collaboration to Identify a Minimum Dataset for Antimicrobial Use Surveillance for Policy and Intervention Development across Food Animal Sectors. *Antibiotics*. 2022;11(2):226. doi:10.3390/antibiotics11020226
10. Sriram A, Kalanxhi E, Kapoor G, et al. *The State of the Worlds Antibiotics in 2021: A Global Analysis of Antimicrobial Resistance and Its Drivers*. The Center for Disease Dynamics, Economics & Policy (CDDEP); 2021. Accessed May 10, 2023. https://onehealthtrust.org/wp-content/uploads/2021/02/The-State-of-the-Worlds-Antibiotics-in-2021.pdf
11. Service Canada. Health Canada proposes new measures to address antimicrobial resistance. Published April 17, 2015. Accessed March 22, 2022. https://www.canada.ca/en/news/archive/2015/04/health-canada-proposes-new-measures-address-antimicrobial-resistance.html
12. World Health Organization. *Global Antimicrobial Resistance and Use Surveillance System (GLASS) Report: 2021*. World Health Organization; 2021. Accessed June 8, 2022. https://www.who.int/publications-detail-redirect/9789240027336
13. Public Health Agency of Canada (PHAC). *Tackling Antimicrobial Resistance and Antimicrobial Use: A Pan-Canadian Framework for Action*.; 2017. Accessed June 22, 2022. https://www.canada.ca/en/health-canada/services/publications/drugs-health-products/tackling-antimicrobial-resistance-use-pan-canadian-framework-action.html
14. Canadian Institutes of Health Research. Antimicrobial Resistance – Activities. Canadian Institutes of Health Research. Published November 2, 2021. Accessed June 22, 2022. https://cihr-irsc.gc.ca/e/40453.html
15. Public Health Agency of Canada (PHAC). Responsible use of Medically Important Antimicrobials in Animals. Published October 2, 2017. Accessed May 10, 2023. https://www.canada.ca/en/public-health/services/antibiotic-antimicrobial-resistance/animals/actions/responsible-use-antimicrobials.html
16. Canada PHA of. Veterinary antimicrobial sales reporting. Published May 17, 2017. Accessed May 10, 2023. https://www.canada.ca/en/public-health/services/antibiotic-antimicrobial-resistance/animals/veterinary-antimicrobial-sales-reporting.html
17. Shurgold J, Avery B, Volling DrC, et al. *Canadian Antimicrobial Resistance Surveillance System Report - Update 2020*. Public Health Agency of Canada.; 2020:108. https://www.canada.ca/content/dam/hc-sc/documents/services/drugs-health-products/canadian-antimicrobial-resistance-surveillance-system-2020-report/CARSS-2020-report-2020-eng.pdf
18. Vilar MJ, Hovinen M, Simojoki H, Rajala-Schultz PJ. Short communication: Drying-off practices and use of dry cow therapy in Finnish dairy herds. *J Dairy Sci*. 2018;101(8):7487-7493. doi:10.3168/jds.2018-14742
19. Aarestrup F. Get pigs off antibiotics. *Nature*. 2012;486(7404):465-466. doi:10.1038/486465a
20. Nyegaard-Signori C. The road to low antibiotic use in the pig production. DanBred. Published December 9, 2021. Accessed June 30, 2023. https://danbred.com/the-road-to-low-antibiotic-use-in-the-pig-production/
21. Rudnick W, Mukhi S, Reid-Smith R, et al. Antimicrobial Resistance Network (AMRNet): One Health Approach to Antimicrobial Resistance Surveillance, Can Commun Dis Rep 2022, 48(11/12).; 2022:522-528. Accessed May 25, 2023. https://doi.org/10.14745/ccdr.v48i1112a05
22. Public Health Agency of Canada (PHAC). Pan-Canadian Action Plan on Antimicrobial Resistance. Published June 22, 2023. Accessed July 24, 2023. https://www.canada.ca/en/public-health/services/publications/drugs-health-products/pan-canadian-action-plan-antimicrobial-resistance.html
23. SAVI. Overview of Initiative: Introducing SAVI: The Stewardship of Antimicrobials by Veterinarians Initiative. Introducing SAVI: The Stewardship of Antimicrobials by Veterinarians Initiative. Published 2023. Accessed June 14, 2022. https://savi.canadianveterinarians.net/en/about/
24. Roy JP, Archambault M, Desrochers A, et al. New Quebec regulation on the use of antimicrobials of very high importance in food animals: Implementation and impacts in dairy cattle practice. Can Vet J. 2020;61(2):193-196. Accessed June 24, 2022. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6973201/

25. FAAST. Farmed Animal Antimicrobial Stewardship (FAAST). Farmed Animal Antimicrobial Stewardship Initiative. Published 2023. Accessed June 23, 2022. https://www.amstewardship.ca/

26. FAAST. About the Farmed Animal Antimicrobial Stewardship Initiative. Farmed Animal Antimicrobial Stewardship Initiative. Published 2023. Accessed June 23, 2022. https://www.amstewardship.ca/about/

27. Laurent, JW. *Alternatives to Common Preventive Uses of Antibiotics for Cattle, Swine, and Chickens*. Natural Resources Defense Council (NRDC); 2018. Accessed April 19, 2023. https://www.nrdc.org/sites/default/files/alternatives-to-coommon-preventive-uses-of-antibiotics-for-cattle-swine-and-chickens_2018-06-21.pdf

28. CgFARAD newsletter. 2020;Spring:12. Accessed March 22, 2022. https://cgfarad.usask.ca/documents/cgfarad_newsletter_spring_2020.pdf

29. Karavolias J, Salois MJ, Baker KT, Watkins K. Raised without antibiotics: impact on animal welfare and implications for food policy. *Transl Anim Sci*. 2018;2(4):337-348. Published 2018 Aug 10. doi:10.1093/tas/txy016 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7200433/

30. National Farm Animal Care Council (NFACC). *Advancing Animal Welfare and Public Trust Through Codes of Practice: Project Achievements Report September 2018-March 2021*. NFACC; 2021. Accessed June 24, 2022. https://www.nfacc.ca/pdfs/nfacc/NFACC_AR_2021%2023_04_2021%20english%20final.pdf

31. Poore J, Nemecek T. Reducing food's environmental impacts through producers and consumers. *Science*. 2018;360(6392):987-992. doi:10.1126/science.aaq0216

32. Parlasca MC, Qaim M. Meat Consumption and Sustainability. *Annu Rev Resour Econ*. 2022;14(1):17-41. doi:10.1146/annurev-resource-111820-032340

33. Mulchandani R, Wang Y, Gilbert M, Boeckel TPV. Global trends in antimicrobial use in food-producing animals: 2020 to 2030. *PLOS Glob Public Health*. 2023;3(2):e0001305. doi:10.1371/journal.pgph.0001305

34. Sustainable Canadian Agricultural Partnership. Ontario Ministry of Agriculture, Food and Rural Affairs. Accessed June 22, 2022. http://www.ontario.ca/page/sustainable-canadian-agricultural-partnership

35. Canada A and AF. Canadian Agricultural Partnership. Published May 6, 2016. Accessed May 16, 2023. https://agriculture.canada.ca/en/department/initiatives/canadian-agricultural-partnership

36. *2020-21 DFC Annual Report*. Dairy Farmers of Canada; 2020. Accessed May 16, 2023. https://dairyfarmersofcanada.ca/en/annual-report-2020-21

37. The Council of Canadian Academies. *When Antibiotics Fail: The Expert Panel on the Potential Socio-Economic Impacts of Antimicrobial Resistance in Canada*. The Council of Canadian Academies; 2019. Accessed June 12, 2022. https://cca-reports.ca/reports/the-potential-socio-economic-impacts-of-antimicrobial-resistance-in-canada/

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