



BCRC 2018-2023 Results Report

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CHAIRMAN'S MESSAGE



Craig Lehr, BCRC Chair

Beef research is key to continuous improvements that support producer competitiveness and the Canadian beef industry's ability to meet demand for global food production in a safe, sustainable, and profitable manner.

The increase of the Canadian Beef Cattle Check-Off to \$2.50 per head in most provinces by 2018 and change in allocations to research has opened up opportunities for greater investment by industry to address gaps in knowledge, and to support consumer confidence. The addition of annual research calls, proof of concept projects and establishment of research chairs to support capacity for years to come have all set the stage for a stronger

research community delivering results to industry.

Those investments have yielded returns to the sector of 63:1, according to the 2022 National Check-Off Study. This results report provides stakeholders with a summary of progress in each research priority area and the optimized use of research dollars.

Research has multiple applications including: to maintain or improve production efficiencies; maintain or improve beef demand and consumer confidence; maintain or improve technology transfer; support competitiveness; identify emerging issues and maintain or improve research capacity.

Research chairs were developed for Integrated Forage Management and Utilization at the University of Saskatchewan, Beef Production Systems at the University of Alberta and One Health and Production Limiting Diseases at the University of Saskatchewan.

Technology transfer and knowledge dissemination is an ongoing focus for the BCRC, with continued regular communication to industry, development of new resources and partnerships. During 2018-23, a greater emphasis was placed on promoting and enabling the engagement of champions within industry, such as veterinarians who could disseminate resources directly to producers and the Canadian Beef Technology Transfer Network. As well as ensuring that website resources had national coverage and relevance. The ten-year Knowledge Dissemination and Technology Transfer Plan (2011-2021) was reviewed and updated in the 2023-28 National Beef Research and Technology Transfer Strategy.

The 2018 increased Check-Off has meant that BCRC can leverage government dollars through the Science Cluster program that best serve producers, while still being able to address other topics. It should be noted that, many research activities that reduce greenhouse gas emissions and enhance carbon sequestration also provide productivity benefits to producers.

Craig Lehr, Chair

Beef Cattle Research Council

EXECUTIVE SUMMARY

The Canadian beef industry is highly dynamic, with constantly shifting demands from domestic consumers, international trading partners, producers, and processors. Research sharpens Canada's competitive edge through contributing to industry's ability to innovate, adapt to market pressures, and address consumer issues.

The Beef Cattle Research Council (BCRC) has a vision to be a transparent, competitive, resilient and sustainable Canadian beef industry supported by strategic and effective research, technology transfer and innovation. And a mission to lead the Canadian beef industry as the most prominent supporter of cattle, forage and beef research with a producer-led Council who invest producer funds into research and technology transfer to support growth in beef demand, increase productivity and earn public trust.

The increase of the Canadian Beef Cattle Check-Off to \$2.50 per head in most provinces by 2018 and change in allocations to research has opened up opportunities for greater investment by industry to address gaps in knowledge, drive improvements in productivity, and support consumer confidence. Producer investment into research activities has grown over the last 15 years; from \$6.8 million during 2008-12 to \$11.94 million during 2018-23. A key challenge of evaluating research results is the lag time from when the initial investment is made into base research or development until commercialization and when technology transfer to producers can occur. To address this lag, the Canadian Beef Check-Off Agency conducts an evaluation of producer investments into marketing, promotion and research.

For the 2015-21 time period, the benefit cost ratio to **research was 63.2:1**. This was despite the significant increase in dollars invested, which was expected to result in a decline in the ratio with diminishing marginal returns. While historical studies only evaluated research based on carcass weights, the 2022 study included more indicators which are presented throughout this report.¹ Showcasing the value of producer investment into beef cattle and forage research and extension.

The development of the **Canadian Beef Research and Technology Transfer Strategy 2018-23** was led by the BCRC and the national Beef Value Chain Roundtable (BVCRT), and involved the participation of key stakeholders and major beef research funders across Canada. The Canadian Beef Research and Technology Transfer Strategy coordinates beef research priorities, funding, and technology transfer across Canada. The three core objectives under the 2018-23 Canadian Beef Research and Technology Transfer Strategy were:

- To **enhance industry competitiveness and reduce production costs**
- To **improve beef demand and quality**
- To **improve public confidence** in Canadian beef

This results report includes both Cluster and non-Cluster projects funded by BCRC. The 2018-2023 (Science Cluster III and non-Cluster) invested \$11 million in 137 research projects² across six priority areas: Animal Health and Welfare (41%), Forage and Grassland Productivity (17%), Feed Grains and Feed Efficiency (14%), Environmental Sustainability (11%), Food Safety (11%) and Beef Quality (6%). Research outcomes of Science Cluster III and non-Cluster activities were directly aligned with the objectives of the 2018-23 National Beef Research Strategy.

¹ <https://www.cdnbeefcheckoff.ca/value/>

² Cluster III: 25 research projects plus the 2 BCRC projects, Science Coordination and KTT. Non-cluster: 112 research projects which were running at some point in 2018-2023.

The report focuses on **medium term research indicators** which ask the question “*is the needle moving in the right direction?*”. These are directional indicators that are also impacted by broader market factors such as weather and policy. This means that other things can drive these indicators faster than research can respond. However, they provide an indicator of where advancements are being made and where they are stagnant or in decline. They play a role in identifying research needs and priorities.

Short-term results for individual projects, this examines whether funded projects were successful in producing results or not. Recognizing that answers to research questions are not guaranteed, even with a well-designed project.

Beef Quality (1/4 projects successfully completed; and 2/2 proof of concept projects successfully completed).

Some of the Beef Quality projects were delayed or cancelled due to covid, and the inability to access packing plants when data collection was supported to occur.

AAA and Prime as a percentage of all A grades increased from 63.2% in 2017 to 75% in 2022. At higher prices, improvements in quality grades adds a significant \$82 million to industry. After moving to the five yield grades in 2019, the combination of increased percentage in higher yield grades, and the decline in lower yield grades is estimated to result in an additional value of \$12 million. Dark cutting carcasses as a percentage of total youthful slaughter decreased from 1.6% in 2017 to 1.3% in 2022, marking the lowest level since 2004.

The 2022 NCO study found that the average benefit to beef quality research was 18.7 with a range of 9.6 to 30.6. Improvements in quality grading in particular give significant benefits to industry as it not only provides a return to the producer but also supports consumer demand with a more consistent eating experience.

The tools and knowledge developed through Beef Quality-related research:

- [How cattle feeding diets support quality grading](#)
- [Nutritional Quality of Beef \(topic page\)](#)
- [Dark Cutting Beef \(topic page\)](#)

Food Safety (3/4 projects successfully completed and 1/1 proof of concept project successfully completed).

There were no multi-jurisdictional outbreaks of *E.coli* investigated by PHAC in 2021 or 2022. Since 2008 the Outbreak Management Division has investigated 7 multi-jurisdictional outbreaks of *E. coli* associated with beef (all were *E. coli* O157) out of a total of 37 multi-jurisdictional outbreaks of *E.coli* investigated. While a source other than beef may have been identified for some of these outbreaks, no source was identified for several of these outbreaks.

Addressing concerns about Salmonella, a project was undertaken to examine its presence along with the microbiota in cattle lymph nodes during slaughter. The study involved 80 Canadian slaughter cattle, including both fed cattle and cows, and no Salmonella and STEC were identified in their lymph nodes.

The tools and knowledge developed through Food Safety-related research:

- [E.coli \(topic page\)](#)
- [In plant mitigation of pathogens \(topic page\)](#)

- [On Farm practices to improve food safety \(topic page\)](#)
- [Understanding the 5 W's of Cattle Injections: Who, What, Where, When and Why](#)
- What producers need to know about [Remote Drug Delivery devices \(blog article\)](#). In addition, new questions were added to the 2023 Canaian Cow-Calf Survey to establish a baseline for Remote Drug Delivery device use.

Animal Health and Welfare (9/10 projects successfully completed and 7/8 proof of concept projects successfully completed)

The progress and evolution of research is reflected in projects overtime, that build on each other. For example, Science Cluster III answered questions regarding calf welfare during long distance transportation, resulting in this being excluded in the 2023-28 Research Strategy. After several years of benchmarking cow-calf health and productivity parameters through WC3SN (ANH.23.13) and C3SN (ANH.21.17), future projects are designed to develop regionally appropriate solutions to nation-wide challenges of high economic importance previously identified.

Public interest in transportation regulations continues. Therefore, research such as ANH.06.17 that found rest stops did not provide any clear welfare benefits for weaned calves during long distance transport, is critical for industry communications. Continued diligence maintaining current and relevant research on these topics to inform science-based regulations is necessary to protect animal welfare.

The 2022 NCO study found that the average benefit to cow-calf reproductive efficiency was 6.9 with a range of 2-13.6, cow-calf survival rate was 11.7 (1.5-34.1), feedlot survival was 21 (4.6-47.2), and carcass weights was 16.4 (8.5-24.1). All of these are positive.

The tools and knowledge developed through Animal Health and Welfare-related research:

- Parasites – [Internal \(topic page\)](#) and [External \(topic page\)](#)
- [Lameness \(topic page\)](#)
- [Transport \(topic page\)](#)
- [Mycotoxins \(topic page\)](#)
- [Johne's Disease Control in beef herds \(tool\)](#)

Antimicrobial Use, Resistance and Alternatives (1/1 project successfully completed and 2/2 proof of concept projects successfully completed).

Once CIPARS data is available research indicators will be developed to begin monitoring. Two recent studies have reported on producer attitudes pertaining to antimicrobial use and resistance as well as antimicrobial use practices in Canada. A clear majority of 146 cattle producers from across the country indicated that antimicrobial resistance was a highly important to them personally (67%), most were aware of initiatives to improve antimicrobial stewardship within the beef industry (78%) and the vast majority rely on veterinarians for information on antimicrobial use (99%) and antimicrobial stewardship (88%; Fossen et al. 2023a).

Although medically important antimicrobials had been used in 99% of herds at least once in the past year, the vast majority of operators treated fewer than 5% of the animals within the herd, using predominantly Category III antimicrobials (Medium Importance in human medicine; Fossen et al. 2003b).

The tools and knowledge developed through AMU/AMR-related research:

- [Antimicrobial resistance \(topic page\)](#)
- [Can Tylosin use be reduced?](#)

Feed Grain and Feed Efficiency (5/5 projects successfully completed)

From 2013-17 to 2018-22, the five-year average barley yield declined 6.2% or 4.2 bushel/acre to 64.1 bushel/acre. The decline is attributed to the significant lower yield in 2021 which dropped 60% year-over-year to 43.2 bushel/acre due to drought conditions in western Canada. Despite lower yield, the average harvested area for barley expanded by 17%, from 5.7 million acres in 2013-17 to 6.7 million acres in 2018-22, resulting in a 10% (or 37,550 bushels) increase in average annual production from 389,000 bushels to 427,000 bushels. More feed grain varieties are being registered with 40 barley and 2 triticale varieties registered with CFIA between 2018 and 2022.

The Feed-to-Gain ratio at the feedlot sector increased 5% from 6.28 in 2013-17 to 6.63 in 2018-22 based on meta-analysis of Canadian Journal of Animal Science publications³, representing \$121.9 million in additional feed costs. Average daily gain in feedlots reported by journal articles dropped 2% from 3.92 lb/day to 3.86 lb/day⁴, representing a total of 7.2 million additional days on feed. After seeing improvements in previous periods these results are discouraging and can be impacted by feed quality, weather and research not keeping up with other factors. The 2022 NCO study found that the average benefit to feed efficiency research was 7.2 with a range of 0.6-25.6.

The tools and knowledge developed through Feed Grain and Feed Efficiency-related research:

- [Alternative Feeds \(topic page\)](#)
- [Grazing crops \(topic page\)](#)
- [Optimizing Feedlot Efficiency \(topic page\)](#)

Forage and Grassland Productivity (9/9 successfully completed projects)

Average Canadian tame hay yield increased 2% from 1.84 tons/acre in 2008-12 to 1.88 tons/acre in 2013-17 and decreased by 13% to 1.64 tons/acre in 2018-22. This decline can be attributed to the severe drought conditions experienced in 2021 when the yield hit a mere 1.35 tons per acre, marking a steep 26% drop from the previous 10-year average (2011-2020) and reaching its lowest point since 2003.

In addition to drought, hay prices have negatively impacted cow-calf competitiveness. Alberta hay prices have increased from \$102/ton in 2013-17 to \$176/ton in 2018-22. The Canadian cow-calf sector is unlikely to expand without sufficient feed availability and a more competitively priced source of winter feed.

The 2022 NCO study found that the average benefit to tame hay yield research was 40.1 with a range of 10.1-76.

The tools and knowledge developed through Forage and Grassland Productivity-related research:

- [Cover Crops \(topic page\)](#)

³ Feed to Gain values for control and trial groups from beef feedlot studies in the Canadian Journal of Animal Science were averaged for each year

⁴ Average daily gain values for control and trial groups from beef feedlot studies in the Canadian Journal of Animal Science were averaged for each year

- Drought Management strategies (topic page)
- [Forage U-Pick \(tool\)](#)
- [Grazing Management \(topic page\)](#)
- Carrying Capacity (tool)

Environment Sustainability (4/4 successfully completed projects)

Several research projects between 2018 and 2023 contributed to the updated National Beef Sustainability Assessment (NBSA), filling data and knowledge gaps. According to the Canadian Roundtable for Sustainable Beef's updated NBSA, from 2013/14 to 2021:

- Producing 1 kg of beef, boneless, packed and consumed, now creates **15%** less greenhouse gases.
- Both eastern and western beef production has decreased its water consumption by **177 Litre per kilogram** boneless beef, consumed
- Reduced impact on water quality (Freshwater eutrophication; 3.89 g P eq./kg boneless beef, consumed; 24.6%) due to changes in feed rations.
- Land used for beef production contributes **74% of the wildlife habitat capacity** needed for **reproduction** on crop and pastureland and 55% of the wildlife habitat capacity needed for **feeding** on crop and pastureland.

The tools and knowledge developed through Environmental related research:

- [Environmental Footprint of Beef Production \(topic page\)](#)
- [Hormones and other Growth Promotants in Beef Production \(topic page\)](#)
- [Forested Rangeland grazing \(topic page\)](#)

Benefit Cost Ratios

To track the impact of research on industry and identify where limited research funding can have the largest return Benefit Cost Ratios can be studied. The Canadian Beef Cattle Check-Off Agency conducts an evaluation of the producer funds every five years. An update was published in March 2022, conducted by Dr. Alan Ker of the University of Guelph Department of Food, Agricultural and Resource Economics. Any Benefit Cost Ratio (BCR) above one (1:1) indicates that an additional dollar in expenditures will increase benefits above a dollar and thus suggests increasing expenditures. It is clear with respect to research expenditures, far greater benefits have accrued than costs thereby suggesting increases in investments could be supported while still providing a positive return. When the ratio is one to one (1:1), the investment breaks even. Typically, investments follow diminishing returns where the BCR gets smaller with larger investments.

In the 2022 NCO study, there was interest to recover BCRs for a variety of research metrics not just carcass weights in this study. This significantly altered the way in which the analyses could be undertaken with metrics for both feedlots and cow-calf operations included. Given the fact that more metrics are considered, it is expected that the aggregate BCR will be higher than past studies. The results indicate that BCRs for research expenditures are 63:1. However, the estimated BCR for carcass weight is 16:1 which is lower than both the Cranfield and Rude study. The lower BCR for carcass weights in this study comes from the combination of more dollars invested into research and the change in methodology which separated

it from other metrics. Within the research metrics, none stand out as either performing significantly better or worse than other metrics (when the confidence intervals are taken into account).

Feedlot BCRs	Lower CI	Median	Upper CI
Carcass weight	8.5:1	16.4:1	24.1:1
Survival Rate	4.6:1	21.0:1	47.2:1
Feed Efficiency	0.6:1	7.2:1	25.6:1
Beef Quality	9.6:1	18.7:1	30.6:1
Total Feedlot	23.3:1	63.2:1	127.4:1
Cow-Calf BCRs	Lower CI	Median	Upper CI
Reproductive Efficiency	2.0:1	6.9:1	13.6:1
Survival Rate	1.5:1	11.7:1	34.1:1
Tame Hay Yields	10.1:1	40.1:1	76.0:1
Total Cow-Calf	13.7:1	58.7:1	123.8:1

It should be noted that the values used in the BCR calculations are based on *selected measurable indicators*. These may not reflect the true total value to industry due to the exclusion of factors that are difficult to measure; for example, the effect of improved pain management.

Economies and Policy Research (3/3 successful projects)

One of BCRC’s core industry principles is to “Generate science to inform decision makers, policy and best management practices and to support consumer confidence and public trust.” Over the last five years this included updating the “Economic Impact of the Canadian Cattle Industry” estimates that are used by national and provincial cattle organization when communicating with governments. As well as investing in the development of the Canadian Cow-Calf Cost of Production Network that provided benchmarks from coast to coast using a consistent methodology. This initiative went beyond benchmarking to include future farm scenarios for producers to be able to identify practices that would have a positive economic cost-benefit for their specific production system and environmental situation.

Technology Transfer (8/9 projects were successfully completed)

Technology transfer and knowledge dissemination is an ongoing focus for the BCRC, with continued regular communication to industry, development of new resources and partnerships. During 2018-23, a greater emphasis was placed on promoting and enabling the engagement of champions within industry, such as veterinarians who could disseminate resources directly to producers and the Canadian Beef Technology Transfer Network. As well as ensuring that website resources had national coverage and regional relevance. This included:

- The veterinary industry supports the beef sector both directly with medical procedures and access to medications and vaccinations, and in an ever-increasing advisory and consultative role. Recognizing this, BCRC develops educational materials and decision-making tools for both producers and veterinary teams. The veterinary project developed tools and resources for dissemination (e.g. the Calf911 videos), and CE credit educational materials.
- The Transfer is a quarterly e-newsletter designed to be a platform for extension agents working in the Canadian beef and forage sector to share timely extension resources. The Canadian Beef Technology Transfer Network is open to anyone interested or working in beef and forage extension and knowledge transfer.
- The Eastern project steering committee reviewed topic pages to ensure national representation and relevance for producers. As well as identifying topics unique to producers in Eastern Canada that needed resources developed.

- The Wire, is BCRC's monthly newsletter with a collection of seasonal information, production tips and beef research news.
- Farm managers make decisions every day. The results of these decisions may be obvious in the short term, while other outcomes can take much longer to recognize. Therefore, in May 2023 BCRC launched its first online course to help producers strengthen their farm record skills. This free, six-part email course will help turn information into action, as they learn how to collect and save data so that it can be analyzed and used to make better-informed decisions.
- BCRC has made CowBytes, a ration-balancing software available for purchase (August 2023).

The ten-year Knowledge Dissemination and Technology Transfer Plan (2011-2021) was reviewed and updated in the 2023-28 National Beef Research and Technology Transfer Strategy. The beefresearch.ca website was updated in 2021/22 with improved navigation for new materials that highlight the resources for producers, researchers and veterinary teams.

INTRODUCTION

The Beef Cattle Research Council (BCRC), established in 1997, is Canada's industry-led funding agency for beef, cattle and forage research and extension. The BCRC's mandate is to determine research and development priorities for the Canadian beef cattle industry and to administer Canadian Beef Cattle Check-Off funds allocated to research. BCRC plays a key role in guiding research priorities for the Canadian beef industry and subsequently influencing government investment in beef cattle research.

Continual improvements in industry practices are critical as the Canadian beef industry competes internationally with over 45% of Canadian beef production being exported. Competitiveness is multi-faceted considering both cost of production in every sector, consistent quality supporting demand and informing public discussion around production practices, domestic regulations and trade. Overall, beef research has the potential to impact industry's ability to meet increasing global food demand sustainably and supports the profitability of Canadian beef producers. The BCRC defined three core research objectives under which more specific priorities and research outcomes are established:

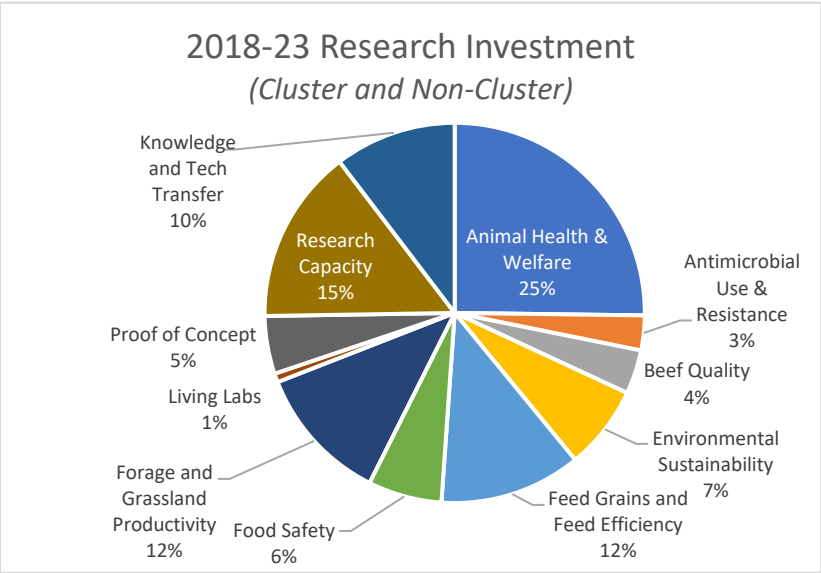
1. To **enhance industry sustainability and improve production efficiencies**, priority outcomes are to enhance feed and forage production, increase feed efficiency and decrease the impact of animal health issues and production limiting diseases.
2. To **improve consumer confidence and beef demand**, priority outcomes are to reduce food safety incidences, define quality and yield benchmarks supporting the Canadian Beef Advantage, and improve beef quality through primary production improvements and the development and application of technologies to optimize cutout values and beef demand.
3. To **improve public confidence in Canadian beef**, outcomes are to improve food safety, strengthen the surveillance of antimicrobial use and resistance, develop effective antimicrobial alternatives, ensure animal care, demonstrate the safety and efficacy of new production technologies, improve environmental sustainability and measure the beef industry's environmental benefits.

BCRC administers the Canadian Beef Cattle Check-Off funds allocated to research. The National Beef Strategy 2015-20 proposed that the national check-off (NCO) be increased from \$1 per head to \$2.50 per head. This occurred in 2018 for most provinces. The additional research dollars allocated to BCRC allowed for new **annual research calls** to be launched. The below table shows how producer investment into research activities has grown over the last 15 years.

In 2018-2023, several new priority areas for research investments were developed, and are included in the table below. The investments presented below are National Check-Off investments only, whereas previous Results Reports for 2008-12 and 2013-17 included match funding and are not comparable.

BCRC Research Project Investments (Million \$) ⁵	2008-12	2013-17	2018-23
Beef Quality	\$0.16	\$0.29	\$0.68
Food Safety	\$0.53	\$0.76	\$1.14
Animal Health and Welfare	\$0.47	\$0.99	\$4.57
Antimicrobial Use and Resistance	\$0.06	\$0.00	\$0.54
Forage and Grassland Productivity	\$0.16	\$0.73	\$2.12
Environmental Sustainability	\$0.32	\$0.02	\$1.29
Feed Grains and Feed Efficiency	\$0.00	\$1.09	\$2.18
Living Labs	N/A	N/A	\$0.14
Proof of Concept	N/A	N/A	\$0.89
Research Capacity	N/A	N/A	\$2.70
Knowledge and Tech Transfer	N/A	\$0.30	\$1.88
Total	\$1.69	\$4.18	\$18.12

From 2018-23, BCRC participated in Science Cluster III through Agriculture and Agri-Food Canada (AAFC). During this period, 27% of NCO research dollars were committed to the Science Cluster and 45% of dollars were allocated to annual calls and 28% to other activities (e.g. Research capacity, KTT). When combining the Science Cluster and non-Cluster investments into research, the chart shows that Animal Health and Welfare receives the majority of funding (25%), followed by Research Capacity (15%).



Maintaining progress in all areas of research is critical to the long-term success of the beef industry. As outside pressures come from all sides – public policy, inflationary costs, and internal competitiveness.

The BCRC has developed three **research chair** positions in partnership with key research institutions and matching industry and government funders. The goal is to ensure long-term research capacity is in place to gain and maintain momentum in priority areas. Research chairs were developed in Integrated Forage Management and Utilization at the University of Saskatchewan, Beef Production Systems at the University of Alberta and One Health and Production Limiting Diseases at the University of Saskatchewan.

In addition, to the annual science calls a new format was developed called the proof of concept projects. The **proof of concept** projects had a limited budget of \$50,000 that allowed researchers to test higher-risk concepts and determine their feasibility prior to pursuing a larger research investment. This was

⁵ The NCO funding shown here includes dollars from Alberta Beef Producers (provincial check-off) in 2008-13 for feed grains and efficiency as well as in 2013-18 for beef quality and environmental sustainability – that were included as part of Beef Science Cluster I and II.

particularly valuable for priority areas where live animal and field research is expensive and a lot can be tested in a lab to determine potential. Started in 2018, there is now a growing list of concepts that have potential to be developed into full projects. This has been very successful in not only identifying concepts that should be pursued, but also minimizing risk of investing in ideas that at first seem very promising but had limited success..

Examples of successful POC projects include one led by Dr. Roopesh Syamaladevi at the University of Alberta. Who explored opportunities of using chemical-free sanitizers to reduce E. coli and biofilm contamination in beef processing plants. The initial POC investment led to a [full-scale research project](#) funded through the Beef Science Cluster IV. Another [project](#), conducted by Dr. Trevor Alexander at AAFC Lethbridge, sought to find more cost- and time-effective strategies to monitor antimicrobial resistance (AMR) in Bovine Respiratory Disease (BRD) pathogens at the feedlot. This team found that sampling water bowls may be a simpler way to evaluate pen-level AMR for BRD specific pathogens rather than swabbing individual animals.

In contrast, a recent [project](#) conducted by Dr. Michael Steele at the University of Guelph investigated increasing the energy beyond recommended levels for 3- and 6-weeks pre-partum cows to improve the quality of colostrum at birth compared to cows given the recommend levels of energy in the diet. This study found no difference in colostrum quality and yield between any of the treatments, showing that current NRC nutrient recommendations are still on target for late gestation cows.

Accessibility of information on practices (both historical and new) that address current issues (e.g. drought, reproductive efficiency challenges, mycotoxins, etc.) is critical for producers. Extension efforts provide recommendations for management that can incrementally improve productivity on individual operations, supporting Canadian beef producers as they make daily decisions. A 2021 review of the BCRC **Technology Transfer** program provided some recommendations, which have been implemented. Partnerships to extend the reach of [beefresearch.ca](#) via veterinarians and be regionally relevant with material has occurred.

PERFORMANCE MEASURES

Evaluating research is something that must be done with a long-term view. The initial investment may take years to provide a result that then needs to be commercialized and/or adopted by industry. Consequently, the industry is currently benefiting from historical investments in research. Evaluation of research funding is broken into long-term performance measures (benefit cost ratios), medium-term research indicators and short-term operational deliverables. It is important to have realistic expectations of when results will appear on the continuum.

Long Term (6-10 years): The Canadian Beef Cattle Check-Off (NCO) evaluation showed that the benefit cost ratio to research were 46:1 in 2010; this was partly due to under-investment. This decreased to \$34.5 in 2016 indicating that while increased investment had been beneficial, further investment was warranted. In 2018 the national levy increased from \$1 to \$2.50 per head in most provinces.

For the 2015-21 time period, the benefit cost ratio to **research was 63.2:1** despite the significant increase in dollars invested which was expected to decline with diminishing marginal returns. While historical studies only evaluated research based on carcass weights, the 2022 study included more indicators which

are presented throughout this report.⁶ Showcasing the value of producer investment into beef cattle and forage research and extension.

Medium Term (4-6 years) in 2012 BCRC identified research indicators to monitor progress in the various priority areas. They asked the question “*is the needle moving in the right direction?*”. These are broad directional indicators that are outside of BCRC’s direct influence and control, with broader market factors, weather and policy being able to drive them faster and to a greater degree than research can respond. However, they provide an indicator of where advancements are being made and where they are stagnant or in decline. They play a role in identifying research needs and priorities.

These research indicators are found in the section titled “*Value - What Does it Mean for Industry*”. Appendix A provides a summary of the calculations and assumptions used in these value sections. It should be noted that due to loss of data without an updated National Beef Quality Audit, many priority areas cannot be compared overtime. Therefore, greater reliance is put on the 2022 NCO study results for each priority area.

Short Term (1-4 years) deliverables are specific measures utilized to evaluate results of specific research projects funded by the BCRC. This looks at internal operations to evaluate whether funded projects are successful in producing results or not and where process changes may be made to improve. Answers to research questions are not guaranteed, even with a well-designed project. In this report each project deliverable is given a designation (✓✗?) indicating if results were achieved. The ✓ designation does not indicate that the results were favourable for the beef industry; only that answers to the questions were found that will inform the industry on how to proceed.

✓ - Solid Results ✗ - Failed ? - Partial Results or Incomplete

Industry has invested in many initiatives that have provided exciting results. The “Findings” section under each priority area summarizes results, but industry has yet to reap the full reward of this work. Discovering that something does not work can still move the industry forward in finding a solution.

Operational effectiveness is a key part of any organization’s success. Over the last five years, streamlining financial reviews, automating accounting processes with electronic systems, and partnerships with institutions have contributed to operational efficiencies. Building relationships with universities that result in reciprocal trust in systems reduces frictions and allows all parties (e.g. researchers, funders and institutional staff) to focus on their responsibilities. AAFC contributed to these efficiencies with the introduction of a standard financial reporting template and annual external financial audit process to replace AAFC’s internal process of sampling each claim.

Basic research is critical to producing the scientific advancements needed to apply the practical outcomes in applied downstream research. Basic research should not be discounted as it provides an important piece of innovation. The success of applied research projects depends heavily upon the work of basic research, which may not have been undertaken with a specific purpose in mind or potentially with a completely different end use in mind. The process of investing into an idea, the basic research required, the development of an application, commercialization and adoption is a long one. Industry invests with the expectation of this process occurring, but not all investments result in successful applications or commercialization.

⁶ <https://www.cdnbeefcheckoff.ca/value/>

BEEF QUALITY

OVERARCHING OBJECTIVE

To support consumer demand, trade and competitiveness with other beef exporters and protein sources in world markets by maintaining and improving the quality of Canadian beef - through production and processing improvements to reduce inconsistencies.

Background: The quality of Canadian beef sets it apart from competitors and enhances Canada's competitiveness both domestically and globally. Recognizing the evolving preferences of consumers and competition, the beef industry acknowledges the need to enhance carcass and meat quality, adapt to changing market demands, and maintain its competitive edge.

Canadian per capita beef consumption has ranged between 17-20 kg since 2010 and was at 17.5 kg in 2022. Despite the decline in per capita consumption since 1980, the Retail Beef Demand Index that measures consumers' willingness to pay for beef based on deflated retail price shows demand surged to historic high in 2020-2022 above 120, comparable to levels seen in the late 1980's.

While beef demand is impacted by multiple factors such as disposable income, economic uncertainty, the price of beef relative to other proteins, health perceptions, and public confidence; high variability in beef quality, particularly in tenderness, poses a significant challenge to beef demand. Therefore, research focused on tenderness genetics, developing technologies to measure tenderness in-plant, and processing interventions to increase tenderness in undervalued cuts is important.

As of January 15, 2019, the three yield grades of the Canadian beef grading standards was replaced with five yield grades. The adoption of five yield grade standards is being implemented to align with the American yield grades and create transparency with the U.S., given its role as the biggest export market for Canadian beef. This change will also allow for the industry to develop management practices for targeted finishing by creating a greater distinction between low and high carcass yields.

OUTCOMES

- OUTCOME #1: Improved Consumer Satisfaction with Canadian Beef
- OUTCOME #2: Validate and support the Canadian Beef Advantage
- OUTCOME #3: Extension, Outreach and Policy

See detailed outcomes in the [Canadian Beef Research and Technology Transfer Strategy 2018-2023](#).

PROJECT FINDINGS

BQU.08.17 - Development of prediction tools to optimize carcass value (2013-18 Beef Science Cluster)


Key Message - This project developed the new carcass ruler and camera grading equations necessary when Canadian moved from three to five yield grades to harmonize with the US.



- Partial Results or Incomplete (COVID-19 prevented testing in commercial packing plants)

BQU.10.17 - Canada's National Beef Quality Audit at retail and processing (2013-18 Beef Science Cluster)

Key Message - Electrically stimulating carcasses using a constant current was more effective than traditional high voltage electrical stimulation in lowering pH, improving color and reducing purge and drip losses in heavy, fat carcasses. Preliminary results also indicated that grading cameras have potential to identify and sort carcasses based on tenderness, lean and fat color.

 - Partial Results or Incomplete (COVID-19 prevented data collection in commercial packing plants; research objectives were revised and successfully achieved)

BQU.02.18 - Nutrient density and nutritional value of Canadian beef products (2018 Annual Call)

Key Message - Beef's high nutrient density, particularly for vital nutrients that are most often inadequate in Canadian diets (iron, vitamin B12 and zinc), makes it an affordable source of all these nutrients for consumers.

 - Solid Results

BQU.09.18 - Developing a Canadian Total Quality Management System for Beef Processing (2018 Annual Call)


Key Message - A portable x-ray camera can achieve adequate image quality for automatic analysis and age verification but would need a mechanism to ensure repeatable placement of the x-ray camera.

 - Failed (many deliverables were not achieved due to COVID-19 and staffing changes)

PROOF OF CONCEPT


POC.02.18 - Exploring the potential of using *Carnobacterium maltaromaticum* A5 as a bioprotective agent in meat plants to improve the safety and shelf life of meat (2018 Proof-of-Concept Call)

Key Message - Low levels of a potential probiotic preservative did not prolong the storage life of vacuum-packaged eye of round steaks.

 - Solid Results

POC.02.19 - Marbling relationship between Canadian and Japanese grade sites (2019 Proof-of-Concept Call)

Key Message - Canadian carcasses that grade AAA and Prime are very similar to high Japanese grade beef (high JMGA 3 / low JMGA 4 and high JMGA 4 / low JMGA 5, respectively).

 - Solid Results

EXTENSION, OUTREACH AND POLICY

Extension materials:

- [How cattle feeding diets support quality grading](#)
- [Nutritional Quality of Beef \(topic page\)](#)
- [Dark Cutting Beef \(topic page\)](#)

VALUE – WHAT DOES IT MEAN FOR INDUSTRY

Beef Quality, 1/4 projects successfully completed; and 2/2 proof of concept projects successfully completed.

AAA and Prime as a percentage of all A grades increased from 63.2% in 2017 to 75% in 2022. This reflects the continuous improvement in carcass quality. However, this upward trend is influenced by other factors, including heavier carcass weights as result of reduced currentness at the feedlot sector due to COVID-related market disruptions, and the impact of drought-induced large placements.

The 2030 industry goal for beef quality is to “Increase the value of AAA and Prime carcasses, to be equivalent with the US, by building demand for all cuts on the carcass”. Recognizing that between 2015-19 the AAA/AA price spread was 18% smaller than the Choice/Select price spread. In order to provide a strong price signal to producers, a higher value needs to be obtained on the entire carcass.

In January 2019, the Canadian Beef Grading Agency started reporting on five yield grades comparable to the US yield grades, which makes it difficult to compare against historical data. Yield grade is an estimation of the percentage of the carcass that is saleable at retail. Yield grade 1 (52.4% or more estimated yield) and yield grade 2 (50.2-52.2%) have the potential to receive a premium compared to YG3 (47.7 or 50.0%), while yield grade 4 (45.2-47.5%) and yield grade 5 (45.0% or less) tend to be discounted.

From 2019 to 2022, there was improvement in yield grade performance. Yield grade 1 increased from 12.7% to 13.5%, yield grade 2 increased from 41.1% to 43.2%, while yield grade 4 decreased from 11.4% to 8.9%, and yield grade 5 decreased from 3.9% to 3.1%. Using an estimated cut price of \$3.33 per pound in 2022, the premiums for yield grade 1 and 2 over yield grade 3 are estimated at \$98 per head and \$66 per head, respectively, while the discounts for yield grade 4 and 5 compared to yield grade 3 are estimated at \$65 per head and \$98 per head.

The combination of increased percentage in higher yield grades, and the decline in lower yield grades is estimated to result in an additional value of \$12 million. Dark cutting carcasses as a percentage of total youthful slaughter decreased from 1.6% in 2017 to 1.3% in 2022, marking the lowest level since 2004.

The 2022 NCO study found that the average benefit to beef quality research was 18.7 with a range of 9.6-30.6. Improvements in quality grading in particular give significant benefits to industry as it not only provides a return to the producer but also supports consumer demand with a more consistent eating experience.

RESEARCH INDICATORS ⁷	FINANCIAL IMPACT TO INDUSTRY [†] (MILLION \$)	
	2013-18 UPDATED	2018-23
<i>Quality Grading</i> AAA and Prime as a percentage of all A grades increased from 51.6% in 2008 to 56.7% in 2012, 63.2% in 2017, and 75% in 2022.	+\$15.3	+\$82.4
<i>Yield Grades</i> The three yield grades of the Canadian beef grading standard was replaced with five yield grades as of January 15, 2019. Financial impact shown is for 2019 vs. 2022. In 2019, YG1 12.7%, YG2 41.1%, YG3 30.9%, YG4 11.4% and YG5 3.9%. In 2022, YG1 13.5%, YG2 43.2%, YG3 31.4%, YG4 8.9% and YG5 3.1%.	-\$38.9	+\$12.5
<i>Dark Cutters</i> B4 incidence increased 0.4 per cent point from 1.2% in youthful slaughter in 2012 to 1.6% in 2017, and decreased 0.3 per cent point to 1.3% in 2022.	-\$3.6	+\$4.1
Total BCRC Investment (Cluster and non-Cluster)	0.29	0.68

[†]For assumption and calculation details, refer to Appendix A.

⁷ The NCO funding shown here includes dollars from Alberta Beef Producers (provincial check-off) in 2008-13 for feed grains and efficiency as well as in 2013-18 for beef quality and environmental sustainability – that were included as part of Beef Science Cluster I and II.

FOOD SAFETY

OVERARCHING OBJECTIVE

Reduce food safety incidences to maintain consumer demand for beef domestically and internationally through the development of improved food safety interventions, methods to quantify the effectiveness of food safety interventions, and the development of food safety intervention strategies that counteract multiple pathogens.

Background: Food safety research holds significance in bolstering consumer confidence and global demand for beef through improved interventions, quantifying their effectiveness, and countering multiple pathogens. Although the Canadian beef industry has made strides in reducing pathogen-related illnesses and recalls through interventions like lactic acid washes and carcass pasteurization, ongoing efforts now focus on preventing recontamination during fabrication by ensuring equipment and tools are adequately cleaned. While some proven interventions lack approval in key international markets, addressing these concerns and regulatory barriers requires further research.

OUTCOMES

- OUTCOME #1: Improved food safety along the beef supply chain
- OUTCOME #2: Improved beef quality and food safety research and training capacity
- OUTCOME #3: Extension, outreach and policy

See detailed outcomes in the [Canadian Beef Research and Technology Transfer Strategy 2018-2023](#).

PROJECT FINDINGS

FOS.01.17 - If E. coli shed by cattle is becoming resistant to antimicrobial interventions in abattoirs, how best to raise the hurdles? (2013-18 Beef Science Cluster)

Key Message - E. coli shows no sign of becoming resistant to the sanitizers or heat-based interventions used in Canadian beef processing facilities.

✓ - Solid Results

FOS.07.17 - Identification of genetic and microbial markers for E. coli O157 super-shedders through longitudinal biopsy and monitoring (2013-18 Beef Science Cluster)

Key Message - STEC may promote colonization through suppression of the host immune system or cattle with compromised intestinal immunity may be more susceptible to STEC colonization.

🔍 - Partial Results or Incomplete (COVID-19 and revised federal lab biosafety requirements prevented the large-scale animal sampling and data collection originally planned).

FOS.04.18 - Shiga-toxigenic E. coli persistence mechanisms and surface biofilm detection using near-infrared spectroscopy on beef processing facilities (2018 Annual Call)

Key Message - Biofilms form more easily on food contact surfaces at 25°C compared to 10°C, and form more easily on polyurethane than on stainless steel. Near-infrared reflectance can help detect biofilms on polyurethane. Some sanitizers remove biofilms much more effectively than others, but scrubbing the surface beforehand improves their effectiveness.

✓ - Solid Results

FOS.01.22 - Exploring Salmonella and the microbiota in lymph nodes of cattle presented for slaughter (2022 Annual Call)

Key Message - No Salmonella or STEC were identified in the lymph nodes of 80 Canadian slaughter cattle (fed cattle and cows).

✓ - Solid Results

PROOF OF CONCEPT

POC.09.19 - Chemical free sanitizers to prevent E. coli contamination and reduce food waste (2019 Proof-of-Concept Call)

Key Message - LED light and atmospheric cold plasma in an activated water mist are promising chemical-free alternatives to combat E. coli biofilms in packing plants.

✓ - Solid Results

EXTENSION, OUTREACH AND POLICY

Extension materials:

- [E.coli \(topic page\)](#)
- [In plant mitigation of pathogens \(topic page\)](#)
- [On Farm practices to improve food safety \(topic page\)](#)
- [Understanding the 5 W's of Cattle Injections: Who, What, Where, When and Why](#)
- What producers need to know about [Remote Drug Delivery devices \(blog article\)](#). In addition, new questions were added to the 2023 Canadian Cow-Calf Survey to establish a baseline for Remote Drug Delivery device use.

VALUE – WHAT DOES IT MEAN FOR INDUSTRY

Food Safety, 3/4 projects successfully completed and 1/1 proof of concept project successfully completed.

Food safety is essential to maintain domestic and international consumer confidence and beef demand. Food safety recalls result in substantial costs due to the potential health risks and economic implications. These recalls involve expenses related to product disposal, production halts, facility sanitation, and damage to consumer trust.

Shiga toxin-producing *E. coli* (STEC) related recalls are typically very extensive and result in high costs to packers, processors, and retailers, which subsequently are transferred to producers. Beyond direct costs, analysts recognize that any food safety incident, whether real or perceived, that causes concern in consumers results in reduced prices and lost sales for 3-6 months or longer. Controlling STEC involves a comprehensive approach from various stakeholders to ensure food safety and reduce risks throughout the beef production and consumption chain.

Addressing concerns about Salmonella, a project was undertaken to examine its presence along with the microbiota in cattle lymph nodes during slaughter. The study involved 80 Canadian slaughter cattle, including both fed cattle and cows, and no Salmonella and STEC were identified in their lymph nodes.

RESEARCH INDICATORS

Incidence of *E. coli* O157 and *E. coli* O157:H7

1. During 2017 to 2021, the annual incidence of *E. coli* O157 in Canada ranged between 0.62 (2020) to 1.15 (2018) per 100,000 people.

Annual incidence of <i>E. coli</i> O157 and <i>E. coli</i> O157:H7 per 100,000 people in Canada, 2017-2021					
	2017	2018	2019	2020	2021
Total <i>E. coli</i> O157 Incidence per 100,000	0.95	1.15	1.06	0.62	0.68
Total <i>E. coli</i> O157:H7 Incidence per 100,000	0.79	1.00	0.80	0.50	0.58

Source: National Enteric Surveillance Program (NESP)

2. In 2021, the national total *E. coli* O157 incidence per 100,000 people was at 0.68. The incidence rate varied across provinces and territories.

2021 Provincial incidence of <i>E. coli</i> O157 per 100,000 people in Canada													
	AB	MB	NB	NS	ON	PEI	QC	SK	BC	YK	NL	NU	NT
Total <i>E. coli</i> O157 Incidence per 100,000	1.51	0.93	0.38	0.30	0.62	1.21	0.58	0.42	0.48	0.00	0.00	0.00	0.00
Total <i>E. coli</i> O157:H7 Incidence per 100,000	1.44	0.07	0.13	0.00	0.55	0.61	0.56	0.25	0.40	0.00	0.00	0.00	0.00

Source: National Enteric Surveillance Program (NESP)

3. There were no multi-jurisdictional outbreaks of *E. coli* investigated by PHAC in 2021 or 2022. Since 2008 the Outbreak Management Division has investigated 7 multi-jurisdictional outbreaks of *E. coli* associated with beef (all were *E. coli* O157) out of a total of 37 multi-jurisdictional outbreaks of *E. coli* investigated. While a source other than beef may have been identified for some of these outbreaks, no source was identified for several of these outbreaks.

	Multi-jurisdictional <i>E. coli</i> O157:H7 outbreaks associated with beef	All multi-jurisdictional <i>E. coli</i> outbreaks
2008		0
2009	1	1
2010		0
2011	1 (suspected)	4
2012	3	7
2013		3
2014		1
2015		2
2016	1 (suspected)	3
2017		2
2018		3
2019		7
2020	1 (suspected)	4
2021		0

2022		0
Total	7	37

*****Note***:** These data only include multi-jurisdictional enteric outbreaks, which are enteric outbreaks that have cases identified in more than one Canadian province or territory or involve ill cases from Canada and another country. In these outbreaks, the Public Health Agency of Canada (PHAC) leads the outbreak response. Many enteric outbreaks occur in Canada each year that are investigated by local and/or provincial/territorial public health authorities. Multi-jurisdictional enteric outbreaks represent only a proportion of all Canadian enteric outbreaks. It is important to note this limitation when interpreting the data provided.

Source: Enteric Outbreak Summaries: Outbreak management Division, Public Health Agency of Canada

ANIMAL HEALTH & WELFARE

OVERARCHING OBJECTIVE:

Reduce on-farm production costs and losses through developments of cost-effective management, diagnostic, and treatment tools. Improve consumer confidence through providing science- and outcome-based information regarding the animal welfare impacts of beef production practices.

Background: Canada is globally recognized for its healthy beef cattle and strong commitment to animal health and welfare. Maintaining animal health and welfare remains crucial for Canada's status as a leader in global animal health, food safety, and production competitiveness. Reproductive success is vital for cow-calf producers' profitability, while feedlots face challenges of early morbidity, predominantly due to respiratory disease, which impacts growth and efficiency. Enhancing animal welfare aligns with animal health goals, helping address both industry practices and public confidence in beef production.

OUTCOMES

- OUTCOME #1: Improved surveillance of production limiting disease and welfare issues
- OUTCOME #2: Improved prevention of animal disease and welfare issues
- Outcome #3: Improved animal health and welfare research and training capacity
- Outcome #4: Extension, outreach and policy

See detailed outcomes in the [Canadian Beef Research and Technology Transfer Strategy 2018-2023](#).

PROJECT FINDINGS

ANH.04.17 - Assessing economic impacts and developing evidence-based decision support systems for sustainable parasitic roundworm control in Canadian beef cattle (2013-18 Beef Science Cluster)

Key Message - Blanket internal parasite control and treatment guidelines are inappropriate because their production impacts vary greatly between herds and are affected by climatic conditions, particularly precipitation.

✓ - Solid Results

ANH.05.17 - Identification of treatment strategies for the most common causes of lameness in feedlot cattle (2013-18 Beef Science Cluster)

Key Message - Factors such as cattle source, feedlot size, and age influence the risk of hoof-related lameness. Improved clarity on which bacteria are active in the microbiome of infected hooves will contribute to diagnostic, preventative and treatment strategies to mitigate hoof-related lameness on-farm.

🔍 - Partial Results or Incomplete (COVID-19 prevented data collection in commercial feedlots; research objectives were revised and successfully achieved)

ANH.06.17 - Effect of rest stop duration and quality on the welfare of cattle transported by road (2013-18 Beef Science Cluster)

Key Message - Rest stops did not provide any clear welfare benefits for weaned calves during long distance transport.

✓ - Solid Results

ANH.13.17 - *Mycoplasma bovis* pneumonia in beef cattle (2013-18 Beef Science Cluster)

Key Message - In healthy calves, *Mycoplasma bovis* does not appear to cause severe disease on its own, but inflammation and respiratory tract damage due to other BRD pathogens and dust will worsen the outcome of a subsequent *Mycoplasma bovis* infection. Controlling stress, dust and other respiratory diseases are important to reduce the risk of *Mycoplasma*.”

✓ - Solid Results

ANH.21.17 - The Canadian Cow-Calf Surveillance Network (2013-18 Beef Science Cluster)

Key Message - A broader understanding of normal productivity and disease levels in Canadian beef herds helps prioritize check-off research investments, extension efforts, manage animal health and welfare risks, and supports public and consumer confidence and international trade of Canadian cattle and beef products.

✓ - Solid Results

ANH.30.17 - Investigating antimicrobial resistance (AMR) and virulence factors of *Mycoplasma bovis* (2013-18 Beef Science Cluster)

Key Message - *M. bovis* isolated from the lung and joint are genetically resemble each other than to the *M. bovis* isolated from the upper respiratory tract. This knowledge will be useful in ongoing efforts to develop an effective *M. bovis* vaccine.

✓ - Solid Results

ANH.07.18 - Effect of feeding ergot alkaloids on ruminal metabolism, growth performance, health and welfare of beef cattle: How much is too much? (2018 Annual Call)

Key Message - Even very low levels of ergot can impair intake, performance and carcass quality. A mycotoxin binder showed promise in artificial rumen studies, but follow-up animal work is needed to confirm its effectiveness in feedlot cattle.

✓ - Solid Results

ANH.22.18 - Determining the effect of stress on the respiratory microbiome of cattle during transportation (2018 Annual Call)

Key Message - Calves that were given an 8-hour rest during long-haul transport had higher numbers of BRD-causing bacteria in the respiratory tract than calves that were not rested during transport.

✓ - Solid Results

ANH.11.19 - Surveillance of antimicrobial use and antimicrobial resistance in Canadian feedlot cattle; expansion of bovine respiratory disease pathogen susceptibility testing (2019 Annual Call)

Key Message - Monitoring trends in feedlot antibiotic use and resistance (on arrival and at rehandling) is important for veterinarians and their clients (to reduce disease risk, reduce morbidity and mortality, and safeguard antibiotic effectiveness), the broader industry (to avoid unrealistic, uneconomic and unnecessary regulatory or trade constraints that negatively impact animal health and welfare), and maintain public and consumer confidence in the beef industry’s social responsibility.

✓ - Solid Results

PROOF OF CONCEPT

POC.06.18 - Enhancing the bovine respiratory microbiome through promoting commensal bacterial growth (2018 Proof-of-Concept Call)

Key Message – An intranasal probiotic altered the microbiota of the respiratory tract and may benefit respiratory health.

✓ - Solid Results

POC.04.18 - Exploring options for BRD diagnostics 2.0 – a point of care metagenomic nanopore sequencing pilot study (2018 Proof-of-Concept Call)

Key Message - The DNA sequencing technology used in this preliminary trial was more sensitive, produced faster results, and could detect both pathogens and antibiotic resistance genes better than traditional approaches. More development and refinement are needed before this test can be used chute-side.

✓ - Solid Results

POC.01.19 - Using genetic algorithms to predict antibiotic resistance levels in Canadian feedlot cattle to promote individual animal diagnosis and prevent unnecessary antibiotic use (2019 Proof-of-Concept Call)

Key Message – This study developed a test to assess *Mycoplasma bovis* susceptibility to nine different antibiotics commonly used in the feedlot. Further development would be needed to develop this into a chute-side diagnostic test.

✓ - Solid Results

POC.02.20 - Safety and Immunogenicity of an Ocular Vaccine Delivery Vehicle (2020 Proof-of-Concept Call)

Key Message – A vaccine delivered as an eyedrop may be a safe and more effective way to protect beef calves against pinkeye.

✓ - Solid Results


POC.15.20 - Development and Evaluation of a Novel Optical Sensor Thermometer for the Measurement of Core Body Temperature in Cattle (2020 Proof-of-Concept Call)

Key Message - The new infrared-based digital thermometer developed in this pilot study was faster but less accurate than the industry standard digital thermometer. This technology is promising but requires further refinement before it could be adopted commercially.

✓ - Solid Results

POC.16.20 - Broad-spectrum immunity to enteric pathogens by training innate intestinal immunity in young calves (2020 Proof-of-Concept Call)

Key Message – An injectable Johne’s vaccine (commercially available in Australia) reduced the intestinal immune response in calves.

 - Partial Results or Incomplete (methodology altered without consultation and failed to answer the primary question of interest).

POC.08.21 - Assessing the viability of real-time pathologist assisted field necropsies to improve diagnostic outcomes of beef cattle cases submitted to UCVM's Diagnostics Services Unit (DSU) (2021 Proof-of-Concept Call)

Key Message – Necropsies conducted by veterinarians while on a video call with a trained pathologist had a 46% higher chance of reaching a diagnosis than unassisted video necropsies. Having this service available to veterinarians would strengthen disease surveillance, support the Vet-Client-Patient-Relationship and allow producers to make more informed and cost-effective choices regarding herd health and welfare.

 - Solid Results

POC.23.21 - Can we "super charge" colostrum using pre-partum supplementation? (2021 Proof-of-Concept Call)

Key Message - If NRC nutrient requirements are already being met, providing pregnant cows with additional energy supplementation in the weeks before calving does not further improve colostrum quantity or quality.

 - Solid Results

EXTENSION, OUTREACH AND POLICY

Extension materials:

- Parasites – [Internal \(topic page\)](#) and [External \(topic page\)](#)
- [Lameness \(topic page\)](#)
- [Transport \(topic page\)](#)
- [Mycotoxins \(topic page\)](#)
- [Johne's Disease Control in beef herds \(tool\)](#)

VALUE – WHAT DOES IT MEAN FOR INDUSTRY

Animal Health and Welfare, 9/10 projects successfully completed and 7/8 proof of concept projects successfully completed.

The progress and evolution of research is reflected in projects over time, that build on each other. For example, Science Cluster III answered questions regarding calf welfare during long distance transportation, resulting in this being excluded in the 2023-28 Research Strategy. After several years of benchmarking cow-calf health and productivity parameters through WC3SN (ANH.23.13) and C3SN (ANH.21.17), future projects are designed to develop regionally appropriate solutions to nation-wide challenges of high economic importance previously identified.

Public interest in transportation regulations continues. Therefore, research such as ANH.06.17 that found rest stops did not provide any clear welfare benefits for weaned calves during long distance transport, is critical for industry communications. Continued diligence maintaining current and relevant research on these topics to inform science-based regulations is necessary to protect animal welfare.

Animal health and welfare directly influence the profitability and sustainability of cow-calf and feedlot production. Over the past decade, the survival rate of calves from birth to weaning has been steady at an

estimated 96-97%. Ongoing investments and research have potentially pushed the boundaries of enhancing calf survival, leaving limited room for further substantial improvement. However, it is crucial to emphasize that even a slight regression in calf survival would inflict substantial losses on the industry. To put this into perspective, using 2022 data, a 1% decline in birth to weaning survival rate would translate to 38,000 fewer weaned calves and a revenue reduction of \$26 million. It should be noted that while survival rates have increased, these gains have been offset somewhat by lower reproductive efficiency. While more calves are being weaned per 100 cows the downward trend in reproductive efficiency is limiting gains.

While survival rates at the cow-calf sector may have reached a plateau, the feedlot sector has seen improvement. In the last five years, the feedlot survival rate surged by an impressive 9% from 2017 to 2022. This development, in conjunction with the current elevated cattle prices, is estimated to contribute an additional \$681 million in revenue.

As the beef quality audit was not conducted under this Cluster, data for liver discounts, liver damage, horns, bruises, and head and tongue condemnations are unavailable. When data is available reporting will be resumed.

With the improvement in feedlot survival rate, the benefit cost ratio of research investment in Animal Health and Welfare was positive. The 2022 NCO study found that the average benefit to cow-calf reproductive efficiency was 6.9 with a range of 2-13.6, cow-calf survival rate was 11.7 (1.5-34.1), feedlot survival was 21 (4.6-47.2), and carcass weights was 16.4 (8.5-24.1).

RESEARCH INDICATORS ⁸	FINANCIAL IMPACT TO INDUSTRY € (MILLION \$)	
	2013-18 UPDATED	2018-23
Reproductive efficiency decreased from 90% in 2012 to 86% in 2017 and to 83% in 2022.	-\$236.5	-\$70.3
Survival rate from birth to weaning increased from 95.7% (2008-11 average) to 96.9% (2012-17 average), and decreased to 95.9% (2018-2021 average)(AgriProfits). The COP Network had calf death loss (after 24 hours) averaging 3.1% (ranging from 1% to 9.2%)	+\$57.0	-\$26.0
Survival rate from weaning to slaughter increased from 82% in 2012 to 91% in 2017 and 97% in 2022. <i>The lower survival in 2017 may have been due to imported dairy calves. With improvements made as a switch to more beef feeder imports occurred in 2022. However, the 97% survival in 2022 seems high.</i>	-\$602.5	+\$374.7
Feedlot survival rate (overlap with above) increased from 90.5% in 2008-12 to 91.4% 2013-17, and 93.5% in 2018-22	+\$46.9	+\$172.9
Total liver discounts: <ul style="list-style-type: none"> • Liver abscesses in fed cattle resulting in condemnation increased from 13% in 1998/99 to 23% in 2010/11 and 22% in 2016/17 • Liver abscesses in fed cattle resulting in livers being discounted to pet food have decreased from 10% in 1998/99 to 8% in 2010/11, and increased to 10% in 2016/17 • Liver condemnations in non-fed cattle increased from 18% in 1998/99 to 26% in 2010/11 and remained steady at 26% in 2016/17 • Liver abscesses in non-fed cattle resulting in livers being discounted to pet food decreased from 33.7% in 1998/99 to 23.9% in 2010/11 to 17.6% in 2016/17 	-\$32.0	0

⁸ The NCO funding shown here includes dollars from Alberta Beef Producers (provincial check-off) in 2008-13 for feed grains and efficiency as well as in 2013-18 for beef quality and environmental sustainability – that were included as part of Beef Science Cluster I and II.

Liver damage resulting in lost weight gain cost \$46.7 million in 2016/17 up from \$20.5 million in 2010/11 and \$2.99 million in 1998/99 as the cost of feed increased and cattle stayed on feed longer to get to finished weight	-26.2	0
Horns - the percentage of hornless cattle increased approximately 20% from 1998/99 in fed and non-fed cattle to 88% in 2010/11, and increased to 91% in 2016/17	\$0	0
Bruises -The percentage of non-fed cattle with bruises increased from 76.4% in 1998/99 to 85.7% in 2010/11, and dropped to 63% in 2017; while the percentage of fed cattle with bruises decreased from 49.2% in 1998/99 to 34.1% in 2010/11 to 32.6% in 2016/17	+\$1.2	0
Heads and tongue condemnations rates decreased from 5% in 1998/99 to 3.8% in 2010/11	-\$32.0	0
Carcass condemnations have decreased from 27.5 per 10,000 head slaughtered in 2012 to 18.9 in 2017, and increased to 20.7 in 2022 (Government of Canada, 2023)	+\$3.7	-\$0.9
Total BCRC Investment (Cluster and non-Cluster)	AHW \$0.99 AMU \$0.00 Total \$0.99	AHW \$4.57 AMU \$0.54 Total \$5.10

†For assumption and calculation details, refer to Appendix A.

ANTIMICROBIAL USE, RESISTANCE AND ALTERNATIVES

OVERARCHING OBJECTIVE:

To maintain access to and effectiveness of veterinary products and improve consumer confidence in Canadian beef production.

Background: Antimicrobial resistance is a shared concern in both livestock and human health. Recent technological advancements have empowered the regular discovery of novel antimicrobial resistance genes and transmission mechanisms, allowing for more precise evaluation of their relationships with bacterial isolates obtained from humans and animals.

However, there is a lack of national on-farm surveillance for beef, dairy cattle, and bob/veal calves by the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS). Antimicrobial use is linked to increased resistance prevalence, with limited data for beef cattle.

Since December 1, 2018, a prescription has been required to purchase any medically important antibiotic for use in cattle.

Various antimicrobial alternatives exist, varying in terms of development, effectiveness, and adoption rates. While some alternatives, such as low-stress weaning, vaccination, and preconditioning, have demonstrated their efficacy in applied research situations, others, like bacteriophage and essential oils, exhibit inconsistent outcomes and require further research and development.

OUTCOMES


- OUTCOME #1: Evidence-based antimicrobial resistance decision making and communication to the veterinary, producer and medical communities
- OUTCOME #2: Develop a broader toolbox for disease management
- Outcome #3: Ensure that Canada's beef industry continues to have access to antimicrobials to protect animal health and welfare by developing a database to quantify and validate responsible antimicrobial use in beef production
- Outcome #4: Extension, outreach and policy

See detailed outcomes in the [Canadian Beef Research and Technology Transfer Strategy 2018-2023](#).

PROJECT FINDINGS

AMR.10.17 - Characterizing the microbiome of beef cattle to identify risk factors that affect respiratory health (2013-18 Beef Science Cluster)

Key Message – This study observed relationships between naturally-occurring and pathogenic bacteria in the upper respiratory tract that may lead to effective probiotics that mitigate BRD in the future.

 - Solid Results

PROOF OF CONCEPT

POC.05.19 - Evaluation of feedlot water bowls for pen-level surveillance of antimicrobial-resistant bovine respiratory pathogens (2019 Proof-of-Concept Call)

Key Message - Sampling water bowls may provide a simpler way to evaluate pen-level antimicrobial resistance in BRD pathogens than collecting nasopharyngeal samples from individual cattle.

✓ - Solid Results

POC.16.21 - Antimicrobial peptides that specifically inhibit the BRD pathogen *Mannheimia haemolytica* (2018 Proof-of-Concept Call)

Key Message – Designing antimicrobial peptides (AMPs) that target specific pathogens is challenging. This team was able to modify AMPs that targeted *M. haemolytica* more effectively than naturally occurring AMPs (e.g., host-defence peptides). The mode of action of designed AMPs still need to be better understood so that their potency can be improved and cytotoxicity reduced before they can be commercialized.

✓ - Solid Results

EXTENSION, OUTREACH AND POLICY

Extension materials:

- [Antimicrobial resistance \(topic page\)](#)
- Remote Drug Delivery Device (RDDD) resources www.beefresearch.ca/RDDD

VALUE – WHAT DOES IT MEAN FOR INDUSTRY

Antimicrobial Use, Resistance and Alternatives, 1/1 project successfully completed and 2/2 proof of concept projects successfully completed.

Once CIPARS data is available research indicators will be developed to begin monitoring.

Two recent studies have reported on producer attitudes pertaining to antimicrobial use and resistance as well as antimicrobial use practices in Canada. A clear majority of 146 cattle producers from across the country indicated that antimicrobial resistance was a highly important to them personally (67%), most were aware of initiatives to improve antimicrobial stewardship within the beef industry (78%) and the vast majority rely on veterinarians for information on antimicrobial use (99%) and antimicrobial stewardship (88%; Fossen et al. 2023a).

Although medically important antimicrobials had been used in 99% of herds at least once in the past year, the vast majority of operators treated fewer than 5% of the animals within the herd, using predominantly Category III antimicrobials (Medium Importance in human medicine; Fossen et al. 2003b).

BCRC Investments in AMU/AMR are incorporated into the Animal Health and Welfare Priority.

FEED GRAINS & FEED EFFICIENCY

OVERARCHING OBJECTIVE

Genetic and management improvements that allow feed to be used more efficiently reduces waste, improves the economic competitiveness of the entire beef industry, and contributes to environmental sustainability.

Background: Feed efficiency research develops and validates cost-effective methods to identify more efficient cattle, feedstuffs and feeding strategies. Feed costs are the largest variable cost for beef operations. Improving production and feed efficiencies is a priority across the beef industry, yet it must be balanced with considerations for cow efficiency and the entire life cycle of cattle, from pre-weaning to the feedlot stage, to ensure cost-effectiveness and industry competitiveness.

OUTCOMES

- OUTCOME 1: Improved feed efficiency through animal breeding
- OUTCOME 2: Improved feed supply and utilization
- OUTCOME 3: Maintained feed grains and feed efficiency research and training capacity
- OUTCOME 4: Extension, outreach and policy

See detailed outcomes in the [Canadian Beef Research and Technology Transfer Strategy 2018-2023](#).

PROJECT FINDINGS

FDE.01.17 - Determining the minimum fibre requirement for feedlot cattle and improving the empirical prediction of ruminal pH (2013-18 Beef Science Cluster)

Key Message – Looking at digestibility and other characteristics of NDF when formulating feedlot diets can help improve rumen pH and help avoid rumen acidosis regardless of grain processing.

✓ - Solid Results

FDE.06.17 - Genetic analyses of feed intake, feed efficiency, female fertility, and cow lifetime productivity in beef cattle raised under two environments (2013-18 Beef Science Cluster)

Key Message – This team found several factors that influence cow performance and developed a heifer selection index. Feed intake, feed efficiency, and pre-breeding backfat were the most economically significant traits when selecting replacement heifers.

✓ - Solid Results

FDE.09.17 - Further strategies to enhance the use of wheat grain in feedlot diets (2013-18 Beef Science Cluster)

Key Message – Tempering wheat helps reduce acidosis risk. High protein, low starch wheat varieties work better for backgrounding. High protein, high starch wheat varieties work better for finishing.

✓ - Solid Results

FDE.13.17 - Identification of causal mutations located in distortion regions in beef cattle genome associated with bull and cow fertility and its links to feed efficiency (2013-18 Beef Science Cluster)

Key Message – This team gained a better understanding of genetic factors that may influence fertility, but more research is needed before this is applicable in breeding programs.

✓ - Solid Results

FDE.14.17 - Evidence-based prebiotic and probiotic solutions for improving gut health and feed efficiency in cattle (2013-18 Beef Science Cluster)

Key Message – Most pre/pro/symbiotics had negligible or highly variable effects, though one class of bacteria (*Bifidobacterium*) may warrant additional study.

✓ - Solid Results

EXTENSION, OUTREACH AND POLICY

Extension materials:

- [Alternative Feeds \(topic page\)](#)
- [Grazing crops \(topic page\)](#)
- [Optimizing Feedlot Efficiency \(topic page\)](#)

VALUE – WHAT DOES IT MEAN FOR INDUSTRY

Feed Grain and Feed Efficiency, 5/5 projects successfully completed.

From 2013-17 to 2018-22, the five-year average barley yield declined 6.2% or 4.2 bushel/acre to 64.1 bushel/acre. The decline is attributed to the significant lower yield in 2021 which dropped 60% year-over-year to 43.2 bushel/acre due to drought conditions in western Canada. Despite lower yield, the average harvested area for barley expanded by 17%, from 5.7 million acres in 2013-17 to 6.7 million acres in 2018-22, resulting in a 10% (or 37,550 bushels) increase in average annual production from 389,000 bushels to 427,000 bushels.

More feed grain varieties are being registered with 40 barley and 2 triticale varieties registered with CFIA between 2018 and 2022.

The Feed-to-Gain ratio at the feedlot sector increased 5% from 6.28 in 2013-17 to 6.63 in 2018-22 based on Meta-analysis of Canadian Journal of Animal Science publications⁹, representing \$121.9 million in additional feed costs. Average daily gain in feedlots reported by journal articles dropped 2% from 3.92 lb/day to 3.86 lb/day¹⁰, representing a total of 7.2 million additional days on feed.

Average weaning weight reported by the AgriProfits program in Alberta dropped 10% from 578.8 lb in 2013-17 to 523 lb in 2018-2021¹¹. This may be partially attributed to the trend towards smaller cows with lower feed requirements. Average mature cow weights were down 4% from 1379 lbs in 2013-17 to 1320 lbs in 2018-2021. Weaning weight as a percentage of mature cow weight dropped from 42% to 39% during the same period. The severe drought experienced in 2021 may have played a role in this decrease. In response to the drought, producers may have chosen to wean their calves earlier than usual to conserve pasture resources, potentially contributing to the lower weaning weights.

Productivity per cow, calculated by dividing total beef production by cow inventories from two years ago, is estimated at 615 lbs/cow in 2022, a significantly 99 lbs increase from 516 lbs/cow in 2017, but aligning more closely with the 561 lbs/cow observed in 2012. The estimated productivity per cow should be

⁹ Feed to Gain values for control and trial groups from beef feedlot studies in the Canadian Journal of Animal Science were averaged for each year

¹⁰ Average daily gain values for control and trial groups from beef feedlot studies in the Canadian Journal of Animal Science were averaged for each year

¹¹ 2022 data was unavailable at the time of writing

interpreted with caution as the increase is partly attributed to larger proportion of cows and heifers in the slaughter mix as the Canadian cow herd continued to shrink.

The calculated benefit cost ratio suggests large returns for research invested in Feed Grain and Feed Efficiency. The 2022 NCO study found that the average benefit to feed efficiency research was 7.2 with a range of 0.6-25.6.

RESEARCH INDICATORS ¹²	FINANCIAL IMPACT TO INDUSTRY [‡] (MILLION \$)	
	2013-18 UPDATED	2018-23
From 2008-12 to 2013-2017, the five-year average barley yield increased 14% (8.3 bu/acre) to 67.8 bu/acre. From 2013-17 to 2018-22, the five-year average barley yield decreased 5.5% (3.8 bu/acre) to 64.1 bu/acre. <i>Barley and Triticale Varieties</i> <ul style="list-style-type: none"> • 4 Triticale varieties were registered (national registration) from 2013 to 2017, 1 triticale varieties between 2018-2023 • 34 barley varieties were registered from 2013 to 2017, 37 Barley varieties between 2018-2023 	+\$94.0	-\$240.2
From 2013-17 to 2018-2022, the Feed:Gain ratio reported by journal articles has increased 5% from 6.29 to 6.63. A 1% higher feedlot feed:gain increases feed costs by \$7/head.	+\$55.6	-\$121.9
From 2013-17 to 2018-22, the average daily gain in feedlots reported by journal articles has decreased 2% from 3.92 lb/day to 3.86 lb/day.	-23.9 million days	+7.2 million days
Steer carcass weights have increased 4.3% (36 lbs) from 843 lbs in 2008 to 879 lbs in 2012, increased 1.8% (16 lbs) to 895 lbs in 2017, and increased 3.9% (35 lbs) to 930 lbs in 2022.	+\$127.8	+\$382.7
Weaning weight increased 16.1 lbs from 562.7 lbs (2008-11 average) to 578.8 lbs (2013-17 average) and declined 55.8 lbs to 523 lbs (2018-21 average)	+\$141.0	-\$527.4
Productivity per cow increased 30 lbs from 564 lbs/cow (2013-17 average) to 594 lbs/cow (2018-22 average). This was influenced by a larger proportion of cows and heifers in the slaughter mix.*	+\$39.8	+\$2,605.5
Total BCRC Investment (Cluster and non-Cluster)	\$1.09	\$2.18

‡For assumption and calculation details, refer to Appendix A. *Model was updated to include net feeder trade

¹² The NCO funding shown here includes dollars from Alberta Beef Producers (provincial check-off) in 2008-13 for feed grains and efficiency as well as in 2013-18 for beef quality and environmental sustainability – that were included as part of Beef Science Cluster I and II.

FORAGE & GRASSLAND PRODUCTIVITY

OVERARCHING OBJECTIVE

Improved grassland management, development of annual and perennial forage varieties, and improved yields and nutritional value contribute to the economic and environmental sustainability of Canada's beef industry.

Background: Forages are a major feed component for the cow-calf and backgrounding sectors of the beef industry. Eighty percent of a beef animal's diet over its lifetime comes from forages. The four western provinces in Canada possess the majority of the nation's natural and tame pasture lands, housing 87% of beef cows. While cereals dominate cultivated lands, forage in the form of hay and silage accounts for 40-60% of the value of feed grain crops. As more marginal land is used for forage production due to expanding annual crop acreage, maintaining yield and productivity becomes challenging. The lengthy development and testing period for new forage varieties, combined with a lack of willingness among producers to grow certified forage seed when grain prices are high, limits the industry's ability to fully exploit emerging forage varieties. To maintain international competitiveness, improving forage yields and beef production on marginal lands is essential. While higher-yield varieties have been developed, they haven't fully compensated for the shift to less productive marginal land. Public investment in forage varieties is necessary because the profitability of such investments for private companies is limited due to extended return on investment timelines.

OUTCOMES

- OUTCOME 1: 15% Improvement in yields and nutritional quality of tame, native and annual species through improved pasture, forage and grazing management and plant breeding
- OUTCOME 2: Maintained forage research and training capacity
- OUTCOME 3: Extension, outreach and policy

See detailed outcomes in the [Canadian Beef Research and Technology Transfer Strategy 2018-2023](#).

PROJECT FINDINGS

FRG.01.17 - Development of native and tame forage varieties and mixtures for improved forage and environmental productivity and resilience (2013-18 Beef Science Cluster)

Key Message – Multispecies mixtures did not establish well under drought conditions and ultimately persisted as tame or native grasses monocultures. Introducing forbs into existing stands did not improve yields and most died out in 2-3 years. Mixed sainfoin/grass pastures yielded equally well at either low or high rates of sainfoin inclusion.

✓ - Solid Results

FRG.02.17 - Novel sainfoin cultivars for enhancing production efficiency of pasture and beef cattle and building capacity in forage breeding (2013-18 Beef Science Cluster)

Key Message – Sainfoin can be compatible with both grass and alfalfa, but the level of compatibility depends on the varieties chosen.

✓ - Solid Results

FRG.06.17 - Improving abiotic stress tolerance in alfalfa through the simultaneous down-regulation and/or genome editing-mediated knockout of multiple genes (2013-18 Beef Science Cluster)

Key Message – This team found genes involved in resistance to both waterlogging and drought. This will help to breed future alfalfa varieties with these traits.

✓ - Solid Results

FRG.09.17 - Sustaining the legume component of grazed pasture mixtures for summer grazing and stockpiling complex mixtures in Eastern Canada (2013-18 Beef Science Cluster)

Key Message – Frost seeding was better than sod seeding with respect to legume content of the sward. Choice of legume species cultivar and fertility will significantly impact the effectiveness of no-till seeding.

✓ - Solid Results

FRG.11.17 - Increasing fall productivity in winter-hardy alfalfa by selecting for reduced fall dormancy (2013-18 Beef Science Cluster)

Key Message – This project has succeeded in advancing forage breeding for improved winter survivability. More research is needed before these varieties will be released to producers.

✓ - Solid Results

FRG.20.17 - Evaluating the potential for increased forage productivity in mid-rotation native forested rangeland sites through an integrated forage, cattle and timber management approach (silvopasture) (2013-18 Beef Science Cluster)

Key Message – Cows and forestry make good partners. Strip-thinning forests increases diversity and abundance of plant species, as well improving biomass yields, with the widest strips showing the greatest improvements for grassland and forest management.

✓ - Solid Results

FRG.08.18 - Assessing the impact of grazing annual forage cover crops in an integrated crop-livestock system (2018 Annual Call)

Key Message – The benefits of using annual forage mixtures depend on region and weather; poor establishment is a challenge in drought-prone areas. Diverse annual mixtures improved soil regardless of whether they were grazed or not.

✓ - Solid Results

FRG.10.21 - Assessment of the transcriptomic response of edited SPL8 alfalfa genotypes to drought stress. (2021 Annual Call)

Key Message - Drought resilience in alfalfa may be affected by changes in their response to oxidative stress, the expression of genes encoding particular transcription factors, and carbohydrate metabolism.

✓ - Solid Results

FRG.11.21 - Virtual Fencing (2021 Annual Call)

Key Message – This is phase 2 in a multi-phase project to develop virtual fencing technology. The team is one step closer to developing virtual fencing collars that work in remote locations, but further revisions will be needed.

✓ - Solid Results

PROOF OF CONCEPT

POC.08.18 - Exploring corn intercropping strategies to increase protein and profitability of beef cattle grazing (2018 Proof-of-Concept Call)

Key Message - Seeding Italian ryegrass, hairy vetch, radish, and clover (on their own or in mixes) between the rows of corn yielded protein levels that met or exceeded the NRC's nutritional requirements for multiple classes of cattle.

✓ - Solid Results

POC.08.20 - Will recurrent selection for improved salt tolerance interact with soil microbe to enhance alfalfa performance, root development and nodule formation under salt stress? (2020 Proof-of-Concept Call)

Key Message - Treating salt-tolerant alfalfa seed with a nitrogen-fixing inoculant improved its performance under saline conditions, but using a salt-tolerant inoculant didn't. This suggests that nitrogen is a limiting nutrient under saline conditions.

✓ - Solid Results

POC.17.21 - Identifying alfalfa varieties best suited to pasture rejuvenation (2021 Proof-of-Concept Call)

Key Message – Soil microbial profiles in older vs. newer pasture stands are noticeably different. These soil microbes will influence the performance of alfalfa, meaning some varieties are better suited to pasture rejuvenation than others.

✓ - Solid Results

EXTENSION, OUTREACH AND POLICY

Extension materials:

- [Cover Crops \(topic page\)](#)
- [Drought Management strategies \(topic page\)](#)
- [Forage U-Pick \(tool\)](#) – made national and bilingual
- [Grazing Management \(topic page\)](#)
- Carrying capacity (tool)

VALUE – WHAT DOES IT MEAN FOR INDUSTRY

Forage and Grassland Productivity, 9/9 projects successfully completed.

Research in forage and grassland productivity plays a crucial and multifaceted role in the competitiveness of the beef cattle industry. Enhancement in forage yield and quality and grassland productivity directly influences cattle performance and profitability of cattle production, particularly in the cow-calf and backgrounding sectors. These improvements also contribute to the industry's environmental stewardship, such as carbon sequestration, climate resilience, biodiversity conservation and water quality.

Continued progress in forage productivity is essential to support Canada's competitive position globally. However, quantifying the value of research in this area is challenging, particularly given its vulnerability to weather-related fluctuations. Another hurdle is measuring and valuing forage, which can result in underinvestment in this critical area. Only a small proportion is traded, where the majority is produced and used on farm, which means a stable market price can be difficult to establish. This is compounded by the fact that costs of forage production are rarely measured and are highly variable across regions.

Average Canadian tame hay yield increased 2% from 1.84 tons/acre in 2008-12 to 1.88 tons/acre in 2013-17 and decreased by 13% to 1.64 tons/acre in 2018-22. This decline can be attributed to the severe drought conditions experienced in 2021 when the yield hit a mere 1.35 tons per acre, marking a steep 26% drop from the previous 10-year average (2011-2020) and reaching its lowest point since 2003.

In addition to drought, hay prices have negatively impacted cow-calf competitiveness. Alberta hay prices have increased from \$102/ton in 2013-17 to \$176/ton in 2018-22. The Canadian cow-calf sector is unlikely to expand without sufficient feed availability and a more competitively priced source of winter feed.

Elevated cash crop prices have increased competition for land for forage production. According to the Census of Agriculture, from 2016 to 2021, natural pasture acres decreased 3.7% or 1.3 million acres to 33.9 million acres, and tame or seeded pasture acres decreased 5% or 625,000 acres to 11.9 million acres. In contrast, land in crops were up 0.2% or 212,570 acres from 93.4 million acres to 93.6 million acres, while hay acres decreased 8.4% or 2.8 million acres from 14.1 million acres to 13 million acres.

The 2022 NCO study found that the average benefit to tame hay yield research was 40.1 with a range of 10.1-76.

RESEARCH INDICATORS ¹³	FINANCIAL IMPACT TO INDUSTRY ¹ (MILLION \$)	
	2013-17	2018-22
The five-year average ¹⁴ tame hay yield increased 8% from 1.69 tons/acre in 2003-07 to 1.84 tons/acre in 2008-12 and increased another 2% to 1.88 tons/acre in 2013-17	+\$0.07	-\$1.30
<i>Newly registered forage varieties</i> (National Registration)		
Alfalfa	61	48
Bird's Foot Trefoil	1	0
Bromegrass, Meadow	1	4
Bromegrass, Smooth	1	1
Clover, Red, Double Cut	8	9
Clover, White, Low-Growing	3	1
Clover, White, Tall-Growing	3	0
Orchardgrass	15	6
Ryegrass, Annual	15	5
Ryegrass, Perennial (Forage Type)	12	3
Timothy	10	8
Wheatgrass, Crested	1	0
AAFC, 2020 reports there are 9 varieties of Sainfoin with the most recent developed by AAFC in 2017.		
Total hay acres		
<ul style="list-style-type: none"> From 2006 to 2011, decreased by 14.0% or 2.7 million acres from 19.7 million to 16.9 million acres. From 2011 to 2016, decreased 16.6% or 2.8 million acres to 14.1 million acres. From 2016 to 2021, decreased 8.4% or 2.8 million acres to 13.0 million acres. 		
Natural pasture acres		
<ul style="list-style-type: none"> From 2006 to 2011, decreased 4.8% or 1.8 million acres to 36.3 million acres. From 2011 to 2016, decreased 3.0% or 1.1 million acres to 35.2 million acres. From 2016 to 2021, decreased 3.7% or 1.3 million acres to 33.9 million acres. 		
Tame or seeded pasture acres		
<ul style="list-style-type: none"> From 2006 to 2011, decreased by 2.4% or 340,000 acres from 14.0 million to 13.7 million acres. From 2011 to 2016, decreased 8.2% or 1.1 million acres to 12.6 million acres. From 2016 to 2021, decreased 5% or 625,000 acres to 11.9 million acres. This decline reflects the reduced cattle inventories and consequently reduced demand for forage. 		
Percentage of Canadian agricultural land in pasture		
<ul style="list-style-type: none"> From 2006 to 2011, decreased by 0.1% from 31.3% to 31.2%. From 2011 to 2016, decreased by 1.1% from 31.2% to 30.1%. From 2016 to 2021, decreased by 0.3 percent point from 30.1% to 29.8%. 		
<i>Best management practices</i>		

¹³ The NCO funding shown here includes dollars from Alberta Beef Producers (provincial check-off) in 2008-13 for feed grains and efficiency as well as in 2013-18 for beef quality and environmental sustainability – that were included as part of Beef Science Cluster I and II.

¹⁴ As annual forage yields can be significantly impacted by weather patterns (drought, flooding). The five-year average is used here.

<ul style="list-style-type: none"> • In 2021, 29,771 (49% of beef farms) reported they use rotational grazing, steady with 29,713 farms (49.7% of beef farms) in 2016. • In 2021, 23,807 farms (39.2% of beef farms) reported they used in-field winter grazing or feeding, up from 21,164 farms (35.4% of beef farms) in 2011. • The number of acres in all farms in Canada that receive fertilizer was up from 38.4% of total farm area 2011 to 44.3% in 2016, and further increased to 47.2% in 2021. 		
Total BCRC Investment (Cluster and non-Cluster)	\$0.73	\$2.12

†For assumption and calculation details, refer to Appendix B.

ENVIRONMENTAL SUSTAINABILITY

OVERARCHING OBJECTIVE

To inform environmental conversations around carbon sequestration, greenhouse gas, environmental impact, biodiversity, water, soil health and ecosystem services with science.

Background: Environmental sustainability research pertaining to beef production has grown in profile, importance and relevance in recent years. Environmental research was previously viewed purely as a “public good”. Although data of direct relevance to environmental sustainability was often collected in the course of production-focused research projects (e.g. methane production, nutrient loss in urine and manure, root growth, soil organic matter, etc.), the focus of these projects was on improving growth rates and efficiency, animal health and reproductive performance, and feed productivity. Simultaneously improving productivity while reducing resource use benefits environmental sustainability, though these impacts have only received more direct attention in recent years.

OUTCOMES

- Outcome 1: Science-based information to inform the development of effective public communication and policy development regarding environmental goods and services provided by the beef industry
- Outcome 2: Extension, outreach and policy

See detailed outcomes in the [Canadian Beef Research and Technology Transfer Strategy 2018-2023](#).

PROJECT FINDINGS

ENV.02.18 - The impact of agricultural land conversion on carbon stocks across Canada, with a focus on grazing lands (2018 Annual Call)

Key Message – Converting perennial forages to annual crops results in decreases in soil organic carbon levels.

✓ - Solid Results

ENV.07.17 - A regionalized life cycle impact assessment model for the quantification of Canadian beef production impacts on biodiversity (2013-18 Beef Science Cluster)

Key Message – Keeping grasslands in grasslands rather than converting to other uses such as annual crops, industrial development or urban expansion preserves wildlife habitat and corridors.

✓ - Solid Results

ENV.09.17 - Assessment of occurrence of synthetic hormones (melengestrol acetate & trenbolone acetate) and the beta-agonist (ractopamine) in cattle operations and associated environments (2013-18 Beef Science Cluster)

Key Message – Hormones used in the feedlot break down quickly and don't enter downstream waterways. Ractopamine breaks down more slowly, but common manure composting strategies speed this process.

✓ - Solid Results

ENV.15.17 - Economic and environmental impacts associated with removal of growth-enhancing technologies in the Canadian beef cattle industry (2013-18 Beef Science Cluster)

Key Message – Removing productivity enhancing technologies (e.g., feed additives and synthetic hormones) would increase the environmental footprint of Canada's beef industry.

✓ - Solid Results

EXTENSION, OUTREACH AND POLICY

Extension materials:

- [Environmental Footprint of Beef Production \(topic page\)](#)
- [Hormones and other Growth Promotants in Beef Production \(topic page\)](#)
- [Forested Rangeland grazing \(topic page\)](#)

VALUE – WHAT DOES IT MEAN FOR INDUSTRY

Environmental Sustainability, 4/4 projects successfully completed.

Several research projects between 2018 and 2023 contributed to the updated National Beef Sustainability Assessment (NBSA), filling data and knowledge gaps. According to the Canadian Roundtable for Sustainable Beef’s updated NBSA, from 2013/14 to 2021:

- Producing 1 kg of beef, boneless, packed and consumed, now creates **15%** less greenhouse gases.
- Both eastern and western beef production has decreased its water consumption by **177 Litre per kilogram** boneless beef, consumed
- Reduced impact on water quality (Freshwater eutrophication; 3.89 g P eq./kg boneless beef, consumed; 24.6%) due to changes in feed rations.
- Cattle in the prairies are raised in areas with water supply risks as this land does not sufficiently meet the water needs to grow crops and is best suited for grazing or forage production.
- Land used for beef cattle production represents 40% of total agricultural land in Canada.
- Pasture makes up 84% of the land used for beef production.
- Cropland (barley and other feed crops) makes up only 9.2% of land used for beef production.
- Land used for beef production contributes **74% of the wildlife habitat capacity** needed for **reproduction** on crop and pastureland.
- Land used for beef production contributes 55% of the wildlife habitat capacity needed for feeding on crop and pastureland.
- The contribution of habitat capacity attributed to land used for beef production increased since 2015, while nationally habitat capacity on cropland and pastureland overall has decreased (for breeding and feeding).
- The contribution of beef production to maintaining natural and semi-natural cover types, which are heavily used for reproduction and feeding of many wildlife species, is vital in maintaining Canada’s wildlife capacity.

RESEARCH INDICATORS ¹⁵	FINANCIAL IMPACT TO INDUSTRY ¹ (MILLION \$)	
	2013-18 UPDATED	2018-23
Total BCRC Investment (Cluster and non-Cluster)	\$0.02	\$1.29

¹⁵ The NCO funding shown here includes dollars from Alberta Beef Producers (provincial check-off) in 2008-13 for feed grains and efficiency as well as in 2013-18 for beef quality and environmental sustainability – that were included as part of Beef Science Cluster I and II.

ECONOMICS AND POLICY RESEARCH

OVERARCHING OBJECTIVE


To inform economic and policy conversations around the economic impact of the beef industry, benchmarking cost of production and demonstrating the potential impact of domestic policies through research.

Background: Research is frequently needed to monitor industry progress, evaluate the potential impact of domestic policy interventions on a diverse range of production systems across the country. Throughout the 2018-23 Beef Research and Technology Transfer Strategy every priority area had an Extension, outreach and policy section. As projects arose throughout the time period, some proposals were deemed valuable to industries broader efforts of resilience and effective communication.

OUTCOMES


ECON.01.20 - Estimation of Economic Impact of the Canadian Cattle Industry (2020 Annual Call)

Key Message - Between 2018 and 2020, the cattle sector contributed \$3.35 to the Canadian GDP for every dollar of farm cash receipts. For every worker employed in the sector, another 3.9 (based on indirect and induced impacts) workers are employed elsewhere in the economy; with an employment multiplier of 4.86 person-years on a full-time equivalent basis. For every \$1 of income received by workers and farm owners, another \$6.22 are created elsewhere – resulting in an income multiplier of 7.22 (up from 5.63 in 2012).

 - Solid Results

SURV.01.18 - The Canadian Cow-Calf Cost of Production Network (2018 Annual Call)

Key Message - More profitable farms tend to have larger herds and lower production costs, but profitability did not appear to relate to a specific production system, farm structure or region. Including depreciation and opportunity costs can help producers better measure farm financial performance, make informed decisions, and set goals due to their significant impact on financial viability. Although a third of network participants were primarily focused on building the operation to pass on to the next generation, over half of participants were primarily motivated by non-economic factors (e.g., stewardship of the land and livestock). Different communication approaches are needed to effectively reach these disparate audiences.

 - Solid Results

MISC.01.20 - Assessment of Data Availability for Eastern Canada Feeder and Calf Price Indices (2020 Annual Call)

Key Message - Feeder and fat cattle sale volume and price data from Ontario and Quebec can provide an effective foundation for a cattle price insurance program for Maritime producers.

 - Solid Results

EXTENSION, OUTREACH AND POLICY

Extension materials included:

- 1 Fact Sheet on the Multiplier study
- Multiple blog posts on results from the COP Network

Economic and policy research, 3/3 projects were successful.

One of BCRC's core industry principles is to "Generate science to inform decision makers, policy and best management practices and to support consumer confidence and public trust." Over the last five years this included updating the "Economic Impact of the Canadian Cattle Industry" estimates that are used by national and provincial cattle organization when communicating with governments. As well as investing in the development of the Canadian Cow-Calf Cost of Production Network that provided benchmarks from coast to coast in a consistent methodology. This initiative went beyond benchmarking to include future farm scenarios for producers to be able to identify practices that would work for their specific production system and environmental situation.

The success is not determined by the research project in and of itself; but what they inform and how the results are utilized by industry to inform further development of a program (such as an Eastern Price Insurance program) or provide a base for further research (such as the Cost of Production Network which is being utilized by the Alberta AgriSystems Living Lab to evaluate the benefit cost of different environmental practices on the variety of production systems represented across the country).

KNOWLEDGE AND TECHNOLOGY DISSEMINATION

OVERARCHING OBJECTIVE

Improve and support research extension strategies to facilitate the rapid adoption of innovation by producers to sharpen industry's competitive advantage.

Background: Knowledge dissemination and technology transfer is a critical component of the research process. Through disseminating relevant applications of new strategies and innovations, the economic, environmental and social benefits of investments in beef research are realized. For industry to adopt and profit from research, clear communication of its benefits and practical implementation to producers is necessary. Not only must there be communication from researchers to industry, there must also be ongoing communication from industry to researchers regarding producer concerns, the shifting marketplace, and industry priorities. Improved communication, collaboration and understanding between researchers and industry result in dissemination of meaningful research results to stakeholders along the production chain, influence management decisions concerning beef production, and improve beef products for all customer segments and markets.

Extension also supports science-based regulations and policies, consumer awareness, and continued investments in research. However, extension efforts from governments and universities have greatly declined over the past two decades, resulting in significant shortfalls in industry adoption of new knowledge and technology. This represents lost opportunities for industry to positively impact profitability and sustainability through improved production efficiencies and beef demand. Having recognized the potential in connecting research and industry, the BCRC has placed greater emphasis on playing a leadership role in Canada to renew knowledge and technology transfer efforts amongst stakeholders in the beef cattle industry.

OUTCOMES

Extension, outreach and policy are key components under a number of the priority areas (Beef Quality, Food Safety, Forage and Grassland Productivity) in the Canadian Beef Research and Technology Transfer Strategy 2018-2023. In order to support those topic specific efforts, broader structural outcomes were also developed.

- Outcome 1: Improved efficiency and effectiveness of technology transfer in the Canadian beef industry through greater collaboration and empowerment of technology transfer agents
- Outcome 2: Increased producer adoption of relevant technologies and production practices through improved information management

See detailed outcomes in the [Canadian Beef Research and Technology Transfer Strategy 2018-2023](#).

PROJECT FINDINGS

TEC.01.17 - Enhancing technology transfer in the Canadian beef industry (2013-18 Beef Science Cluster)

Key Message – This project underpinned the BCRCs ongoing efforts to ensure that relevant research results are made available to Canadian cattle, forage and beef producers as accessible webpages, webinars, videos, decision-making tools and factsheets housed at www.beefresearch.ca.

 - Solid Results

KTT.01.19 - The Value of Record Keeping for Decision-Making on Canadian Cow-Calf Farms and Ranches (2019 Knowledge and Technology Transfer Call)

Key Message – This project improved our understanding of how Canadian cow-calf producers currently keep and utilize records and informed revisions to record-keeping resources for producers with beginner, intermediate or advanced skill levels as well as promotion strategies to increase the use of these resources by more producers.

✓ - Solid Results

KTT.04.19 - Evaluating Premiums for Weaned Calves Marketed with Value-Added Management Characteristics (2019 Knowledge and Technology Transfer Call)

Key Message – Consistent premiums were difficult to determine over multiple years. Some premiums existed for VBP+ and EU certified cattle but these were not consistent. Premiums existed for larger lots of cattle and Charolais influence. Premiums offered outside the market (i.e., CAB, Certified sustainable) were not evaluated in this study.

✓ - Solid Results

KTT.02.20 - The Big Beef Podcast (2020 Knowledge and Technology Transfer Call)

Key Message – The Cows on the Planet brought scientific experts together to bust myths and explain the facts about the role of cattle, rangelands and beef in the environment, economy and society.

✓ - Solid Results

KTT.04.20 - Leveraging the Canadian Beef Improvement Network's (CBIN's) Collaboration and Resources to Advance Genetic Improvement Across the Canadian Beef Industry (2020 Knowledge and Technology Transfer Call)

Key Message – This project explored whether purebred associations would be willing to share data and include commercial data in genetic evaluations. Commercial data strengthens genetic evaluations but requires significant effort to check the validity of the data (lbs vs. kg, Year/Month/Day vs. Month/Day/Year vs. Day/Month/Year date formats, etc.).

❓ - Partial Results or Incomplete (fewer seedstock and commercial producers and cattle were recruited than originally intended.)

KTT.05.20 - Canadian Forage U-Pick: Expanding the Western Canadian Forage U-Pick tool to include Eastern Canada (2020 Knowledge and Technology Transfer Call)

Key Message – The Forage U-Pick tool has been updated to include Eastern Canada soil types, and plant varieties. The tool has also been translated into French. The Canadian Forage U-Pick tool can be found at <http://www.upick.beefresearch.ca>

✓ - Solid Results

KTT.05.21 - Nova Scotia On-Farm Cattle Preconditioning Pilot Project (2021 Knowledge and Technology Transfer Call)

Key Message – This project used a variety of methods to encourage vaccination on farm. Numerous factors were found to affect adoption including service design, equipment selection, technician training, veterinary engagement, producer engagement, service coordination, and veterinary oversight.

✓ - Solid Results

KTT.06.21 - Improving vaccine usage and efficacy in western Canadian beef herds to reduce disease risks (2021 Knowledge and Technology Transfer Call)

Key Message – This project enhanced our understanding of the current use of vaccines in Western Canadian beef herds and developed extension resources for producers including written articles, presentations, infographics, and podcasts on core and risk-based vaccines, fact sheets on 12 common diseases in beef herds in western Canada with specific vaccination guidelines, fact sheets on vaccinating beef cattle with good vaccination techniques.

✓ - Solid Results

KTT.08.21 - Development and Production of a Beef Cattle Animal Health Podcast (2021 Knowledge and Technology Transfer Call)

Key Message – The Beef Cattle Health and Nutrition Podcast features conversations with veterinarians, nutritionists and researchers about topics related to beef cattle production with a Canadian perspective.

✓ - Solid Results

VALUE – WHAT DOES IT MEAN FOR INDUSTRY

Technology Transfer, 8/9 projects were successfully completed.

Technology transfer and knowledge dissemination is an ongoing focus for the BCRC, with continued regular communication to industry, development of new resources and partnerships. During 2018-23, a greater emphasis was placed on promoting and enabling the engagement of champions within industry, such as veterinarians who could disseminate resources directly to producers and the Canadian Beef Technology Transfer Network. As well as ensuring that website resources had national coverage and regional relevance. This included:

- The veterinary industry supports the beef sector both directly with medical procedures and access to medications and vaccinations, and in an ever-increasing advisory and consultative role. Recognizing this, BCRC develops educational materials and decision-making tools for both producers and veterinary teams. The veterinary project developed tools and resources for dissemination (e.g. the Calf911 videos), and CE credit educational materials.
- The Transfer is a quarterly e-newsletter designed to be a platform for extension agents working in the Canadian beef and forage sector to share timely extension resources. The Canadian Beef Technology Transfer Network is open to anyone interested or working in beef and forage extension and knowledge transfer.
- The Eastern project steering committee reviewed topic pages to ensure national representation and relevance for producers. As well as identifying topics unique to producers in Eastern Canada that needed resources developed.
- The Wire, is BCRC's monthly newsletter with a collection of seasonal information, production tips and beef research news.
- Farm managers make decisions every day. The results of these decisions may be obvious in the short term, while other outcomes can take much longer to recognize. Therefore, in May 2023 BCRC launched its first online course to help producers strengthen their farm record skills. This free, six-part email course will help turn information into action, as they learn how to collect and save data so that it can be analyzed and used to make better-informed decisions.
- BCRC has made CowBytes, a ration-balancing software available for purchase (August 2023).

- The beefresearch.ca website was [updated](#) in 2021/22 with improved display on mobile devices, improved navigation and search functionality, and new materials for producers, researchers and veterinary teams.

Extension efforts provide recommendations for management that can incrementally improve productivity on individual operations, keeping Canadian beef producers on the cutting edge of the international market. The ten-year Knowledge Dissemination and Technology Transfer Plan (2011-2021) was reviewed in 2021. The review process included collecting input from internal and external stakeholders using interviews, discussion groups and a survey, reviewing the activities of extension organizations across Canada, analyzing web-based and social media dissemination activities, and developing recommendations based on these inputs. Key findings were:

- Strong support for the BCRC Technology Transfer programs with the quality and accessibility of resources. The online components provided through the website were the most important. However, all components of the program were seen as valuable.
- No specific changes to how the program is managed and operated were proposed in stakeholder consultations. However, some of the broader suggestions raised for future consideration included: i) Clarify the program's target audience, ii) Expand program focus to include more information about established farm practices (not just leading edge practices), iii) Consider accessing research results from other institutions for translation and dissemination.
- The Beef Researcher Mentorship Program, funding of third-party extension projects (see below) and the National Tech Transfer Network were identified as program components where enhancements could be made. Specifically, strengthening producer awareness of existing resources (addressed with greater investment into the National Beef Tech Transfer Network, paid print and digital advertising nationally, veterinary collaboration initiative, and CBIC Demo sessions), ensuring regional/locally relevant content (addressed with Eastern project), and collaboration with other extension organizations (also done through the Eastern project).
- Additional opportunities identified include supporting producer peer-to peer and in-person learning, provincial level collaboration, extension skill development. Although valid, these opportunities are a challenge given current infrastructure and resource constraints.

From 2019-21, annual Technology Transfer (KTT) Call for Proposals were completed. Despite the number of applications received only eight projects were completed. Several issues were identified including limited capacity to deliver technology transfer projects, limitations in accessing matching funds, and a general misunderstanding of what BCRC wanted to accomplish with the call for proposals. Consequently, no further KTT calls have been made. A new funding call for regional extension activities was piloted in 2023/24, and had solid interest and participation.

Overall, BCRC's 'core competence' at synthesizing, translating and communicating research outputs is valued by stakeholders. Many would like to see more translation and communication of complex information into practical solutions and practices relevant to producers. It was noted, that there is a large body of beef research (by others) that would benefit from synthesis, translation and dissemination as practical solutions.

This feedback was incorporated into the 2023-28 National Beef Research and Technology Transfer Strategy.

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APPENDIX A : CALCULATIONS AND ASSUMPTIONS USED IN VALUE SECTIONS

The value sections throughout this document were provided by Canfax Research Services and are based on the Research Indicators set out in "A Historical Evaluation of Research Indicators in BCRC Priority Areas" April 2012.

BEEF QUALITY

Quality grading

Definition: Quality grades are determined by maturity (age), sex, conformation (muscling), fat (colour, texture & cover) and meat characteristics (colour, texture & marbling).

Source: Canadian Beef Grading Agency

- AAA and Prime as a percentage of all A grades increased from 62% in 2017 to 75% in 2022.
- The increase from 2017 to 2022 represents an additional value of \$82.4 million to industry through improvements in grading quality
 - Using 2,744,536 head of A grade cattle in 2022 (federal and provincial slaughter)
 - The difference due to quality is 358,092 head with a steer carcass weight of 930 lbs in 2022 this means 333 million additional pounds of AAA+ product produced
 - While the Canadian boxed beef prices were unavailable, the U.S. Choice/Select spread in Canadian dollar was \$24.73/cwt in 2022
 - A \$24.73/cwt additional value on 33 million pounds results in an addition value of \$82 million

Yield grades

Source: Canadian Beef Grading Agency

The three yield grades of the Canadian beef grading standard was replaced with five yield grades as of January 15, 2019.

- In 2017, YG1 36.2%, YG2 33.5%, YG3 30.3%.
- In 2019, YG1 12.7%, YG2 41.1%, YG3 30.9%, YG4 11.4% and YG5 3.9%.
- In 2022, YG1 13.5%, YG2 43.2%, YG3 31.4%, YG4 8.9% and YG5 3.1%.
- Considering all the yield grades, from 2019 to 2022, this represents a gain of \$12.5 million to industry

Calculation:

- Using YG3 as a base price, premium on YG1 \$98, YG2 \$66 and discounts on YG4 \$65 and YG5 \$98/carcass
- Changes are taken from the 2017 to 2022 data.
- Assuming average carcass weight = 850 lb

Dark cutters

Definition: A dark cutter is removed from Canada's quality A grades and given a designation of B4

Source: Canadian Beef Grading Agency

- The number of dark cutter (B4) decreased from 1.64% of youthful slaughter in 2017 to 1.25% in 2022.
 - Using 2,789,443 head of Maturity 1 cattle slaughtered in 2022 (federal and provincial slaughter)
 - From 2017 to 2022, the 0.4 per cent point decrease in B4 cattle resulted in a difference of 10,952 head
- The 0.4 per cent point increase in B4 represents an additional value of \$4 million to industry
 - Assuming \$372/head discount on dark cutting cattle on the additional 10,952 head of B4 cattle.¹⁶
 - Based on the actual 3,949 head, the additional value to industry was \$1.45 million

ANIMAL HEALTH & WELFARE

Reproductive efficiency

Definition: Calves <1 year old on July 1st divided by total cow inventories (beef and dairy)

¹⁶ Canfax survey for Canadian discount. The following link provides the US discount <http://www.youtube.com/watch?v=0y9NZM985mo&feature=related> see 6:34 minute

Source: Statistics Canada

- Reproductive efficiency decreased from 90% in 2012 to 86% in 2017 and to 83% in 2022.
 - In eastern Canada, reproductive efficiency decreased from 74% in 2012 to 69% in 2017 and held steady at 69% in 2022.
 - In western Canada, reproductive efficiency decreased from 96% in 2012 to 90% in 2017 and 88% in 2022.
- The reduction in reproductive efficiency from 2017 to 2022 represents a loss of \$70.3 million to the industry.
 - 2 less calves were born to every 100 cows
 - Assumes an average \$1,346/head for a 550 lbs steer calf (using 2022 average price = \$245/cwt)

Calculation: If 2 less calves were born to every 100 cows then $2\% \times 3,713,800$ head of beef cows on July 1, 2012 = 52,210 less calves valued at \$1,346/head = \$70.3 million loss

Survival rate from birth to weaning

Definition: Survival rate is the proportion of calves weaned compared to the number of calves born

- Conversely, death loss of calves = # calves died/ live births

Source: Alberta Agriculture, AgriProfit\$ (contact: Manglai)

- Based on AgriProfit\$ data, survival rate from birth to weaning increased from 95.7% (2008-11 average) to 96.9% (2012-17 average), and decreased to 95.9% (2018-21 average)
- The decline in average survival rate from 2012-17 to 2018-21 represents a decrease in value of \$26 million to the industry.
 - Assumes an average \$1,346/head for a 550 lbs steer calf (\$245/cwt)
 - Assumes 2022 calf crop level (3.86 million head)

Calculation: 0.5% decline in survival rate = 19,385 less calves weaned in 2022
Valued at \$1,346/head = \$26 million additional revenue for the cow-calf industry

Survival rate from weaning to slaughter

Definition: Survival rate is the number of calves from July 1st cattle inventory report compared to the number exported as feeders, heifers retained and fed cattle slaughtered and exported the next year. Note this includes death losses in backgrounding and finishing lots.

Source: Statistics Canada

- Survival rate from weaning to slaughter increased from 82% in 2012 to 91% in 2017 and 97% in 2022
- The increase in survival rate from 2017 to 2022 represents \$374.7 million of additional revenue for the industry
 - Calf crop on July 1st 2022 = 3.86 million head
 - 5% increase in survival rate = 209,138 more cattle survived in 2022
 - \$1,792/head value per animal (2022 average of \$211/cwt on 850 lbs)

Calculation: 5% increase in survival rate x 3.86 million head of calves = 209,138 additional cattle survived for export or domestic slaughter in 2022. Valued at \$1,792/head = \$374.7 million additional revenue to the beef industry

Feedlot Survival Rate

Definition: Feedlot survival rate is estimated by the number of cattle being marketed as a percentage of the number of cattle placed into feedlot

Source: Alberta & Saskatchewan Cattle on Feed Report from Canfax

- Feedlot survival rate decreased from 90.5% in 2008-12 to 91.3% in 2012-17, and increased to 93.5% in 2018-22
- The increase in survival rate from 2012-17 to 2018-22 represents \$172.9 million additional revenue for the feedlot industry
 - 2022 Fed cattle marketings = 3.29 million

- 2.2% increase in feedlot survival rate = 72,308 more fed cattle marketed in 2022
- \$2,391/head value per fed animal (2022 average of \$177/cwt on 1350 lbs)

Calculation: 2.2% increase in survival rate = 72,308 more fed cattle marketed in 2022
Valued at \$2,391/head = \$172.9 million increased value for the feedlot industry

Condemnations

Definition: Carcasses or parts of the carcass deemed unfit for human consumption. Condemnation rate is estimated by the percentage of the number of cows condemned as % of cows slaughtered.

Source: Canadian Beef Grading Agency

- The condemnation rate has decreased from 27.5 per 10,000 head slaughtered in 2012 to 18.9 in 2017 and increased to 20.7 in 2022.
- The increase in condemnation rate from 2017 to 2022 represents a loss of \$0.89 million to industry.
 - 2022 total slaughter(Federal and Provincial plants) = 3.48 million head
 - 0.02% increase in condemnation rate = 626 more condemned cattle
 - Assumes an average \$1,176/head for a 1,350 lb cattle (using 2017 average D3 cow price of \$87.14/cwt)
 - Assumes an average \$250/head disposal fee for a condemned animal weighed 1,350 lbs
 - A value of \$1,149/head on D3 cows plus a disposal cost of \$275/head for condemned cattle resulting in a total loss of \$1,424/head
 - 626 more condemned cattle at \$1,424/head = \$0.89 million saved

Calculation: 0.02% increase in condemnation rate x 3.48 million head total slaughter (fed and non-fed) = 626 fewer head cattle being disposed. Value per head of cattle at \$1,149 + disposal fee per head at \$275 = loss per head of cattle at \$1,424. Reduced number of condemned cattle of 626 x loss per condemned cattle = \$0.89 million.

PRODUCTION EFFICIENCY

Steer carcass weight

Definition: Warm carcass weight

Source: Canadian Beef Grading Agency

- Steer carcass weights have increased 4.3% (36 lbs) from 843 lbs in 2008 to 879 lbs in 2012, increased 1.8% (16 lbs) to 895 lbs in 2017, and increased 3.9% (35 lbs) to 930 lbs in 2022.
- The increase in steer carcass weight represents a revenue gain of \$394.6 million to industry
 - Assumes 2022 fed cattle marketings (3.29 million head) and composite cutout value (\$3.33/lb)

Calculation: 35 additional lbs per animal x 3.29 million fed cattle marketed = 115.04 million additional pounds valued at \$3.33/lb (composite cutout weighted for AAA/AA production) = \$382.68 million in additional revenue to the feedlot industry from increased carcass weights

Weaning weight

Definition: Average weight at weaning

Source: Alberta Agriculture, *Agri-Profit\$*, provincial average

- From *Agri-Profit\$*, weaning weight increased 16.1 lbs from 562.7 lbs (2008-12 average) to 578.8 lbs (2013-17 average) and declined 55.8 lb to 523 lb (2018-21 average¹⁷)
 - In comparison, average weaning weight reported by the 2017 Western Canadian Cow-Calf Survey was heavier at 597.5 lbs (611 lbs for steers, 584 lbs for heifers)

¹⁷ 2022 *Agri-Profit\$* unavailable at the time of writing.

- Average weaning weight reported by the Canadian Cow-calf Cost of Production Network was also heavier at 559 lbs
- The decline in weaning weight from 2013-17 to 2018-21 represents a \$527.4 million reduction in revenue for the industry
 - Assumes 3.86 million head calf crop is weaned (July 1, 2022 level)
 - Assume calf price at \$245/cwt (2022 level)

Calculation: 55.8 fewer lbs per calf weaned x 3.86 million calves = 215.5 million fewer pounds
Valued at \$245/cwt = 141.1 million in additional revenue to the cow-calf industry

Productivity per cow

Definition: Productivity per cow is measured by total beef production (including live cattle exports, adjusted by potential beef production from net feeder trade) divided by the total number of cows (beef and dairy) from two years prior.

Source: Statistics Canada, Canadian Beef Grading Agency

- Productivity per cow increased 30 lbs from 564 lbs/cow (2013-17 average) to 594 lbs/cow (2018-22 average).
- The increase in productivity from 2013-17 to 2018-22 represents an additional value of \$474.7 million
 - Assumes composite cutout of \$333/cwt (2022 level)
 - Assumes 4.76 million head of cow (2020 Jul 1st level – the two years prior)

Calculation: 30 lbs of additional beef produced per cow x 4.76 million cows in 2020 = increased beef production of 143 million lbs at \$333/cwt = increased revenue of \$474.7million

Weaning weight as a % of mature cow weight

Source: Alberta Agriculture, AgriProfit\$

- Weaning weight as a % of mature cow weight decreased from 43.2% (2008-11 average) to 42% (2013-17 average) and 39% (2018-21 average)

Steer carcass weight as a % of cow carcass weight

Source: Canadian Beef Grading Agency

- Steer carcass weight as a % of cow carcass weight has decreased from 130% in 2012, and decreased to 122% in 2017, and increased to 128% in 2022

FEED GRAINS & FEED EFFICIENCY

Barley yields

Definition: Bushels per acre

Source: Agriculture and Agri-Food Canada

- The five-year average¹⁸ barley yield has decreased 5.5% (3.76 bu/acre) from 67.8 bu/acre in 2013-17 to 64.1 bu/acre in 2018-22
- This represents a loss of \$240.2 million to industry through increased production
 - Assumes holding harvested area at 6.7 million acres (2018-2022 level)
 - Assumes average barley price = \$9.52/bu¹⁹

Calculation: 5.5% decrease in yield = 3.8 additional bushels per acre; 6.7 million acres x 3.8 bushel/acre = 25.2 fewer bushels of barley produced at \$9.52/bu for a total value of \$240.2 million

- Average harvested area for barley expanded by 17%, from 5.7 million acres in 2013-17 to 6.7 million acres in 2018-22. Barley acreage peaked at 7.4 million acres in 2021, driven by strong export demand from China.

¹⁸ As annual barley yields can be significantly impacted by weather patterns (drought, flooding), the long term trend (5-year average) is used in this discussion

¹⁹ Based on 2022 Lethbridge barley price – source: Canfax

Barley and Triticale Varieties

Definition: Number of varieties registered (National Registration)

Source: Canadian Food Inspection Agency, Database of varieties registered in Canada

- 4 triticale varieties were registered between 2013-17, 1 triticale varieties between 2018-22
- 34 barley varieties were registered between 2013-17, 37 barley varieties between 2018-22

Type	Varieties			
	2007	2012	2017	2022
Spring triticale	8	8	12	13
Winter triticale	2	3	3	3
Total triticale varieties	10	11	15	16
Barley, (Forage Type), six-row, spring	8	8	8	8
Barley, six-row, Spring	100	120	133	144
Barley, six-row, Spring, Hulless	7	7	9	9
Barley, two-row, Spring	60	80	96	122
Barley, two-row, Spring, Hulless	10	17	20	20
Barley, two-row, Waxy, Hulless	4	4	4	4
Barley, Winter	3	4	4	4
Total barley varieties	194	243	277	330

Feed:gain ratio

Definition: The pounds of feed required for one pound of gain averaged over the finishing period

Source: Values reported in the Canadian Journal of Animal Science articles compiled by Canfax Research Services and Feedlot Health Management Services

- From 2013-17 to 2018-2022, the Feed:Gain ratio reported by journal articles has increased 5% from 6.29 to 6.63.
- The increase in Feed:Gain from 2013-17 to 2018-23 represents an additional cost of \$121.9 million to industry
 - 2022 fed cattle marketing = 3.29 million head
 - Assumed 550 lb/head gained in the feedlot (800 lbs in-weight & 1350 lbs out-weight)
 - Assumes \$437/tonne of feed for average ration - Lethbridge barley price 2022

Calculation: 550lb/head weight gain x 3.29 million heads of cattle marketed = total weight gain of 819,969 tonnes. A 0.34 increase in feed:gain ratio = 278,790 more tonnes of feed required at average price of \$437/tonne = additional feed cost of \$121.9 million

Average daily gain

Definition: Total gain over feeding period divided by the number of days on feed

Source: Values reported in the Canadian Journal of Animal Science articles compiled by Canfax Research Services and Feedlot Health Management Services

- From 2013-17 to 2018-22, the average daily gain in feedlots reported by journal articles has decreased 2% from 3.92lb/day to 3.86lb/day.
- The increase in ADG from 2012 to 2017 means 2 more days emitting GHG per head and 7.2 million more days in total.
 - Assumes 550 lbs gained in the feedlot on average (800 lb in-weight and 1350 lb out-weight)
 - 2022 fed cattle marketing = 3.29 million head

Calculation: 550 lbs gained at 3.92 lbs per day is 140 days on feed compared to 550 lbs gained at 3.86 lbs per day is 142 days on feed. Therefore a lower ADG increases days on feed by 2.18 days from 140 days to 142 days. 2.18 days x 3.29 million fed cattle = 7.2 million more days on feed.

FORAGE & GRASSLAND PRODUCTIVITY

Forage Yields

Definition: Tons per acre harvested for hay

Source: Statistics Canada Table 001-0017

- The five-year average²⁰ tame hay yield increased 2% from 1.84 tons/acre in 2008-2012 to 1.88 tons/acre in 2013-2017, and decreased by 13% to 1.64 tons/acre in 2018-2022
- This represents a loss of \$669 million
 - Assumes holding hay harvested area at 12.1 million acres
 - Assumes average hay price = \$234.04/ton (Alberta price, 2022)
 - A 0.24 ton/acre reduction in yield on 12.1 million acres means a reduction of 2.86 million tons in total reduction
 - \$234.04/ton for 2.86 million tons, that a loss value of \$669 million
- This means 1.6 million more acres were needed to produce the same amount of hay at the 2022 level. This land can be put into other production – representing a significant gain of opportunity for producers.
 - Assumes holding forage production steady at 2022 level at 21 million tons.

Registered varieties

Definition: New varieties registered (National Registration)

Source: Canadian Food Inspection Agency, Database of varieties registered in Canada

- 61 alfalfa varieties have been registered from 2013 to 2017, 48 alfalfa varieties between 2018-22
- 2 bromegrass varieties have been registered from 2013 to 2017, 5 bromegrass varieties between 2018-22
- 27 ryegrass varieties have been registered from 2013 to 2017, 8 ryegrass varieties between 2018-22
- 14 clover varieties have been registered from 2013 to 2017, 10 clover varieties between 2018-22
- 1 birdsfoot trefoil varieties have been registered from 2013 to 2017, no new birdsfoot trefoil varieties between 2018-22
- 15 orchardgrass varieties have been registered from 2013 to 2017, 6 orchardgrass varieties between 2018-22
- 10 timothy varieties have been registered from 2013 to 2017, 8 timothy varieties between 2018-22
- 1 crested wheatgrass varieties have been registered from 2013 to 2017, no new timothy varieties between 2018-22

Type	Varieties			
	2007	2012	2017	2022
Alfalfa	169	225	286	334
Alfalfa	168	221	282	330
Alfalfa, Hybrid	1	4	4	4
Bromegrass	16	20	22	27
Bromegrass, Meadow	4	7	8	12
Bromegrass, Smooth	12	13	14	15
Clover	47	56	70	80
Alsike	4	4	4	4
Clover, Red, Double Cut	27	33	41	50
Clover, Red, Single Cut	2	4	4	4
Clover, Sweet, Yellow Blossom	1	1	1	1
Clover, White, Low-Growing	1	1	4	5
Clover, White, Tall-Growing	12	13	16	16
Ryegrass	26	31	58	66
Ryegrass, Annual	14	17	32	37
Ryegrass, Perennial (Forage Type)	12	14	26	29
Orchardgrass	37	45	60	66
Bird's Foot Trefoil	11	11	12	12

²⁰ As annual forage yields can be significantly impacted by weather patterns (drought, flooding). The five year average is used here.

Timothy	53	57	67	75
Crested Wheatgrass	16	17	18	18
Total	375	462	593	678

Grassland productivity

Source: Census of Agriculture, Statistics Canada

- From 2011 to 2016, natural pasture acres decreased 3.0% or 1.1 million acres to 35.24 million acres. From 2016 to 2021, natural pasture acres decreased 3.7% or 1.3 million acres to 33.93 million acres.
- From 2011 to 2016, tame or seeded pasture acres decreased 8.2% or 1.1 million acres to 12.56 million acres. From 2016 to 2021, tame or seeded pasture acres decreased 5% or 625,000 acres. This decline reflects the reduced cattle inventories and consequently reduced demand for forage.
- From 2011 to 2016, percentage of Canadian agricultural land in pasture decreased by 1.1 percent point from 31.2% to 30.1%. From 2016 to 2021, percentage of Canadian agricultural land in pasture decreased by 0.3 percent point from 30.1% to 29.8%.

Best management practices

Source: 2016 Agriculture Census, Statistics Canada

- In 2021, 29,771 (49% of beef farms) reported they use rotational grazing, steady with 29,713 farms (49.7% of beef farms) in 2016.
- In 2021, 23,807 farms (39.2% of beef farms) reported they used in-field winter grazing or feeding, up from 21,164 farms (35.4% of beef farms) in 2011.
- The number of acres in all farms in Canada that receive fertilizer was up from 38.4% of total farm area 2011 to 44.3% in 2016, and further increased to 47.2% in 2021.