



2017/18 Results Report

Submitted to the Canadian Beef Cattle Research, Market
Development and Promotion Agency

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I. Executive summary

The Beef Cattle Research Council (BCRC) plays a leadership role in identifying research priorities and maximizing the value of research to improve the competitiveness of the Canadian beef industry. A national industry-led funding agency, the BCRC works closely with other industry and government funding agencies to increase coordination, reduce duplication and ensure priority research outcomes are addressed for the benefit of Canadian beef and cattle producers.

A division of the Canadian Cattlemen's Association (CCA), the BCRC is directed by a committee of 12 beef producers from across the country. The BCRC is funded in part through a portion of a producer-paid national levy, the Canadian Beef Cattle Check-Off. In 2017/18, the BCRC received on average 19 percent of every Canadian Beef Cattle Check-Off dollar. Additional 2017/18 funding was provided through the Agriculture and Agri-Food Canada (AAFC) Beef Cattle Industry Science Cluster under Growing Forward 2 (GF2). The Canadian Beef Cattle Check-Off revenue and additional funding from industry stakeholders leveraged government funding through the Beef Cattle Industry Science Cluster on a 1:3 industry:government ratio. The Science Cluster covering the period April 1, 2013 to March 31, 2018, was a \$20 million program, with \$5 million from industry including the Canadian Beef Cattle Check-Off, \$1 million from provincial government, and \$14 million from AAFC.

This report presents the results of the BCRC-administered research activities during the period April 1, 2017 to March 31, 2018, the final year of funding under the AAFC Growing Forward 2 program. During this period, 14 projects were funded under the Beef Cattle Industry Science Cluster, each aligning with one or more of the following research priority areas:

- Forage and Grassland Productivity
- Feed Grains and Feed Efficiency
- Animal Health, Welfare and Production Limiting Diseases
- Food Safety and Beef Quality
- Environment
- Technology and Knowledge Dissemination

Section III of this report includes a list of all research projects funded by Canadian Beef Cattle Check-Off dollars and other industry investments, as well as key highlights for each project. More detailed project reports and/or fact sheets will be available on the BCRC website at www.BeefResearch.ca. An overview of the 2017/18 research results follows.

Specific to the priority area of Forage and Grassland Productivity, research identified optimal combinations of annual crops, agronomic practices and regional variation that provide the most economical extended grazing practices to meet the cow herd's nutritional requirements through the winter feeding period. Researchers showed that there was good potential to extend the grazing season using stockpiled forages, and that corn significantly alters grazing behaviour of cattle during adverse weather, enabling them to graze for longer periods of time without the need to seek shelter. Breeding programs for native plant materials, legumes and grasses, produced several potential lines for commercialization. These were aided by new genomic tools developed in the program for grasses as well as new selection techniques specifically for alfalfa.

It was also identified that adding native plant materials to mixtures resulted in benefits such as improved stability and production under extreme climatic situation that will result in decreased production risks.

In the area of Feed Grains and Feed Efficiency, over the course of the 5-year funding period 10 barley varieties with superior yield and quality were approved for registration. For triticale, progress has been achieved in yield and other characteristics, and three new varieties were released in 2018 with two of them undergoing commercialization. Research also highlighted the variability in corn silage and why it is critical for producers to do a feed test on corn silage before incorporating it into a diet, so performance is not compromised. In an effort to improve feed efficiency, research evaluated interactions between prebiotics (feed ingredients that the animal can't digest but bacteria can) and probiotics (bacteria that benefit the host) and synbiotics (combination of pre- and probiotics) to assess how they function in the animal. Relating to consistent beef quality, one project showed that molecular breeding value (MBV) for carcass traits can be used to sort feeder cattle into uniform carcass endpoint groups during the feedlot stage of production.

The National Beef Quality Audit (NBQA) represented a very comprehensive benchmark of beef quality in Canada. Retail elements included a Customer Satisfaction Survey, Beef Tenderness Survey, Shelf Life Microbiology Survey, Injection Site Lesion Survey, and Meat Case Survey and at the processing plant the Carcass Cooler Audit and Processing Floor Audit. In addition, a stakeholder survey focused on current perceptions and quality priorities was completed with input from processors, retailers, foodservice, distributors, feedlot and cow-calf producers. The NBQA findings indicate that beef quality and consumer satisfaction attributes are most often slightly improved or stable relative to the NBQA completed five years prior. In terms of carcass defects while there are some items showing improvement, there are also a significant number of areas where there is an opportunity for improvement. The overall cost of quality defects at the carcass level is estimated at \$84.49/head for fed cattle and \$47.27 for non-fed animals. On a cumulative basis the total losses due to carcass quality defects approach \$200 million for the Canadian cattle sector.

Specific to Animal Health, Welfare and Production Limiting Disease research looked at cost-effective ways to manage the pain associated with branding and castration in beef calves. A project also established a veterinary and producer network to gather information on the prevalence of production limiting diseases as part of a long-term effort to re-establish a surveillance system. It was also shown that producers are following the Code of Practice for the Care and Handling of Beef Cattle, and that cow-calf producers are using antimicrobials judiciously. Information gathered on disease prevalence will inform future animal health research priorities for the cow-calf sector as well as productivity benchmarks for western Canadian management practices, identifying opportunities for improvement.

Specific to the environmental impact of agricultural commodities, a project summarized what the environmental greenhouse gas, water and ammonia footprint of Canada's beef industry actually is, and how it has changed over the years. The project also established frameworks for assessing the water footprint, impact on biodiversity and ecosystem services provided by the livestock sector. Research showed that producing the same amount of Canadian beef in 2011 required 29% less breeding stock, 27% fewer slaughter cattle and 24% less land, and produced 15% less greenhouse gases than in 1981. Overall, it took 17% less water to produce a kilogram of Canadian beef in 2011 than in 1981.

A comprehensive study of antibiotic use and resistance conducted at commercial feedlots following antibiotic-free and conventional production (with samples collected from pen floors, stockpiled and

composted manure, runoff containment ponds, cropland to which manure had been applied, watercourses, beef processing facilities, hospital patients and urban sewage) found no evidence of any link between antibiotic resistance in feedlot and human environments. Manure composting is an effective way to reduce antibiotic residues. Antibiotic use records from over 2.5 million feedlot cattle confirmed that the antibiotics used in feedlot production belong primarily to the category of "Medium Importance" in human health.

The BCRC's knowledge dissemination technology transfer programs focused on accelerating the uptake of research outcomes by industry. Various mechanisms were used to communicate the findings with industry in useful and meaningful ways. A primary focus was extension of results from research activities completed under the Beef Cattle Industry Science Cluster. Fact sheets summarizing project findings, articles discussing research outcomes or priorities, and new webpages, videos, and cost of production decision tools for producers were created and are available through www.BeefResearch.ca. Engagement of researchers with industry continued to improve over the past year through the Beef Researcher Mentorship program. An economic analysis project and a literature review of adoption levels of various best practices and innovations, both completed by Canfax Research Services, will continually help to inform the BCRC's approach to technology transfer.

While it is difficult to measure or qualify the adoption of innovative knowledge, especially in the short term, the BCRC's technology transfer efforts appear to be very successful. Website traffic and redistribution levels of articles and fact sheets has increased, analytics show that the audience is interested in a variety of topics, views per video are increasing, social media networks of stakeholders continually grow.

The Canadian Beef Cattle Check-Off also supported research projects outside the Beef Cattle Industry Science Cluster. An overview of these projects, including research on barley straw digestibility, are also highlighted in Section III of this report.

In addition to sponsoring research and technology transfer programs in support of the Canadian beef industry, the BCRC continues to oversee the Verified Beef Production Plus™ Program (VBP+). Throughout 2017/18 VBP+ focused on completing its transition from VBP to VBP+, offering a complete sustainability focused program for Canadian beef producers. With the addition of the new modules VBP+ is well positioned to meet the indicators established under the Canadian Roundtable for Sustainable Beef (CRSB) and provide a credible, cost-effective, producer-led option for verifying responsible production practices through training, simple record keeping and on-farm validation audits. VBP+ continued to expand its engagement with end-users over the past year, largely through the CRSB. VBP+ teamed up with BIXS and Cargill to launch the Canadian Beef Sustainability Acceleration pilot, testing the CRSB framework to ensure it will be functional in the commercial beef industry. VBP+ is continuing its effort to prepare for a reduced federal/provincial funding structure, as new programs are unveiled across the country. VBP+ is fully utilizing a national database and national website - one of the first steps in synchronizing and streamlining the VBP+ program and making operations more efficient and less reliant on government funding.

The fiscal year for the BCRC is July 1 to June 30, therefore the BCRC audited financial statements are not included in this report and are available upon request after August 31, 2018. The Canadian Beef Cattle Check-Off funding allocated to research programming in 2017/18 is discussed in various sections of this report and is estimated at \$1,176,681.

II. Background

The Beef Cattle Research Council (BCRC) funds leading-edge research to advance the competitiveness and sustainability of the Canadian beef cattle industry. The BCRC administers the research allocation of the producer paid beef and cattle levy, the Canadian Beef Cattle Check-Off and prior to 2018 received on average \$0.19 of every \$1.00 of Canadian Beef Cattle Check-Off collected by the provinces. The BCRC leverages government (primarily AAFC) funding under Growing Forward 2 with industry dollars, primarily Canadian Beef Cattle Check-Off, on a 1:3 (industry:government) basis through Canada's Beef Cattle Industry Science Cluster. The BCRC also collaborates with other funding agencies to maximize the value of all investments in research within the Canadian beef cattle industry.

As a national beef cattle industry research agency, the BCRC plays an important role in identifying the industry's research and development priorities and subsequently influencing public sector investment in beef cattle research. The BCRC facilitates and encourages collaboration and coordination among researchers, other funding agencies and industry in order to maximize the benefits obtained from all investments in beef cattle research.

In addition to funding research, the BCRC plays a leading role in increasing industry uptake of relevant technologies through the delivery of its knowledge dissemination and technology transfer strategy. It is also responsible for the delivery of the Verified Beef Production Plus (VBP+) program. The BCRC also leads the ongoing implementation of the *Canadian Beef Research Strategy and Technology Transfer Strategy*, working in partnership with industry and government beef research funding agencies across Canada, to be more efficient with limited funding and ensure key research, capacity, infrastructure and extension priorities are addressed.

The majority of the BCRC's 2017/18 research and extension programming was funded through the Beef Cattle Industry Science Cluster under Growing Forward 2. This second Science Cluster covered the period April 1, 2013 to March 31, 2018. It was a \$20 million program - \$5 million from industry including the Canadian Beef Cattle Check-Off, \$1 million from provincial government, and \$14 million from AAFC.

This report covers the period April 1, 2017 to March 31, 2018, the fifth and final year of the Growing Forward 2 Beef Cattle Industry Science Cluster. Research programming under this Cluster was centered around the following areas:

- Maintaining or improving competitiveness in the production of beef cattle – animal health, feed efficiency and feed production
- Supporting science-based policy, regulation and trade
- Supporting science-based public education and advocacy
- Supporting the Canadian Beef Advantage through continual advancements in beef quality and food safety, and
- Accelerating the adoption of new innovations in the Canadian Beef Industry.

The following sections provide an overview of the projects funded throughout 2017-18, including key highlights and success stories for the various research projects.

III. Key highlights for the 2017/18 activities

A. Beef Science Cluster II projects managed by the BCRC and funded by government, industry and Canadian Beef Cattle Check-Off

This section provides the 2017/18 research results for the projects funded under the Beef Science Cluster. A summary table, including the project number, title, budget, and expenditures, follows the results.

Forage and grassland productivity:

I. FRG.04.13 - Innovative swath grazing/increasing forage research capacity

Key highlights: Winter feed costs are the largest variable production cost facing cow-calf producers in Canada. The focus of this research was to identify optimal combinations of annual crops, agronomic practices and regional considerations that provide the most economical extended grazing practices to meet the cow herd's nutritional requirements through the winter feeding period. Although economically friendly, these approaches have environmental benefits as well. Because less fuel is needed for baling, feed transport, feed processing, feed delivery, pen cleaning and manure spreading, extended winter grazing significantly reduces energy use. Forage quality throughout the grazing period was found to be extremely variable but corn was found to better maintain its nutrient quality. This suggests that producers may want to graze cereals early on in the grazing season and save corn grazing for later.

Success stories: Through this project researchers calculated that on average, swath grazing 100 cows for 100 days reduces diesel fuel use by 2,534 L. Researchers were also able to show that one cow winter grazed for 100 days reduces her carbon foot print by 18.27 kg of carbon.

2. FRG.08.13 - Development of native plant material (grasses, legumes) and mixtures for forage production in the Prairie Region

Key highlights: This long-term breeding program has been a collaboration between researchers in Saskatchewan, Alberta, Manitoba and Quebec. They have used both traditional and genomic breeding approaches to characterize differences in the ability of a variety of native grasses (nodding brome, rough fescue, prairie sand reed, northern wheatgrass, bluebunch wheatgrass), native legumes (purple prairie clover, white prairie clover, slender milkvetch, Canadian milkvetch, ascending milkvetch), tame grasses (hybrid brome, crested wheatgrass, green wheatgrass, meadow brome) and tame legumes (alfalfa, sainfoin) to establish, persist in the stand, resist weeds, and produce high yields of forage and seed yields under a range of soil moisture and nutrient conditions.

Success stories: Breeding efforts have produced several potential lines for commercialization. These were aided by new genomic tools developed in the program for grasses as well as new selection techniques specifically for alfalfa.

It was identified that there were benefits to adding native plant materials to mixtures such as improved stability and production under extreme climatic situation that will result in decreased production risks.

It was found that inclusion of sainfoin with grass at a 30:70 will improve productivity.

3. FRG.14.13 - Building long-term capacity for resilient cow-calf production systems through creation of a forage industry chair supporting training and research in evaluation and utilization

Key highlights: Crop selection and winter grazing management recommendations need to be developed on a regional basis to ensure that they appropriately reflect and consider regional variations in the length and severity of both growing seasons and winter temperatures. This project evaluated a range of perennial and annual forage varieties for extended winter grazing of mature cows and bred heifers in Manitoba. This research provided valuable information regarding the ability of alternative extended winter feeding systems to meet the nutritional needs of younger animals that have higher nutrient demands to accommodate continued animal growth as well as maintain pregnancy and body condition score.

Success stories: Researchers in Manitoba showed that there was good potential to extend the grazing season using stockpiled forages. Corn offers the highest potential based on yield, total digestible nutrients and relative feed value but protein supplementation may be needed depending on the maturity of animals grazing and stage of gestation.

Through the use of grazing collars, researchers were able to demonstrate that corn significantly alters grazing behaviour of cattle during adverse weather, enabling them to graze for longer periods of time without the need to seek shelter.

A collaborator in Saskatchewan showed that stockpiling perennial grass and legume species can produce greater than 3.0 tonnes/ha of forage from July to mid-October. Meadow brome grass produced the highest stockpiled and seasonal yields in both pure stands and when it was in a mixture with legumes.

Feed efficiency

4. FDE.04.13 - Germplasm and variety development of barley and triticale for animal feed with a focus on feed quality, yield and disease resistance of both grain and annual forage production

Key highlights: The goal of this project was to create barley and triticale varieties with higher yield and better quality. Using the latest technologies, this project has been able to increase yield in a constant basis and obtain varieties that have better quality and are less susceptibility to diseases.

Success stories: During the duration of this project, 10 barley varieties were approved for registration: one two-row covered malting or dual-purpose variety ('Lowe') released in 2016, two two-row covered malt / dual-purpose varieties (TR13606 and TR14617), five six-row covered (BT596, BT598, SR15507, SR16511 and 'AB CattleLac') and two six-row hulless (HB623, HB542) barley varieties with superior yield and quality. For triticale, progress has been achieved in yield and other characteristics, and three new varieties were released in 2018, two of them already undergoing commercialization.

5. FDE.09.13 - Increased use of high energy forages in conventional feedlot beef production

Key highlights: Corn has higher biomass yields and whole-plant energy content than many other annual crops. This research investigated whether diets containing higher levels of corn silage could potentially reduce both cost of gain and barley grain levels in backgrounding and finishing diets for feedlot steers. There were no statistically significant differences in growth rate, feed efficiency or days on feed for steers backgrounded on 60% barley silage compared to those fed 40, 75 or 90% corn silage. Numerical differences in terms of growth rate, feed efficiency and days on feed faster favored steers backgrounded on barley silage.

Success stories: This research highlighted the variability in corn silage and why it is critical for producers to do a feed test on corn silage before incorporating it into a diet. This research also showed that with high energy corn silage it is possible to increase the level of forage in backgrounding diets without compromising performance. It is also possible to decrease grain use by substituting some grain for high energy corn silage, or by extending the backgrounding phase without compromising performance.

6. FDE.15.13 - Prebiotic, probiotic, and synbiotic technologies for targeted applications in food safety and ruminant productivity

Key highlights: Prebiotics (feed ingredients that the animal can't digest but that bacteria can), probiotics (bacteria that benefit the host) and synbiotics (combinations of pre- and probiotics) are actively being used in diverse livestock sectors and hold promise to increase overall cattle performance and beef production. However, commercially available pre- and probiotics have been plagued by variable composition, challenges with on-farm application, and highly variable performance outcomes.

Success stories: Researchers developed a new way to look at interactions between prebiotics, probiotics, or synbiotics and how they interact with microbial communities in the host animal. This approach is a breakthrough for understanding how prebiotics, probiotics, and synbiotics function in the animal, promote gut health, and improve feed efficiency. These advances will set the stage for determining how prebiotics function in cattle and help create performance benchmarks for evaluating their outcomes in production.

7. FDE.17.13 - Improvement of cow feed efficiency and the production of consistent quality beef using molecular breeding values for RFI and carcass traits

Key highlights: Feed costs are a leading production cost in both cow-calf and feedlot operations. Identifying cattle with the genetic potential to use feed more efficiently would be of tremendous value, provided there are no negative consequences on other economically important traits, particularly reproductive performance. This project divergently selected different cattle populations for high and low feed efficiency, and, looked for impacts on other traits. Keeping in mind that only three to four years of replacements have been selected to date (with few reaching maturity or culling yet), it appears that incorporating feed efficiency in a selection index has not had an immediate adverse effect on maternal traits in a cow-calf operation.

Success stories: Cows subjected to selection were able to repeat their maternal performance as selection progressed. Despite the short-term selection program and the limited sample size used in this study, it appears that a genetic improvement program that incorporates RFI in a selection index will have no adverse effect on maternal traits in a cow-calf operation.

This study showed that molecular breeding value (MBV) for carcass traits can be used to sort feeder cattle into uniform carcass endpoint groups during the feedlot stage of production. Less variability and more

uniform carcass values were observed for steers sorted into MBV-Quality and MBV-Lean groups. For most of the slaughtered steers, MBV-Quality had heavier carcasses with more marbling while MBV-Lean had leaner carcasses. Also, the accuracy of predicting future carcass outcome based on MBV scores ranged from 64-81%.

8. FDE.19.13 - Understanding the physiology behind changes in feed efficiency throughout the finishing period

Key highlights: The efficiency of feed conversion declines the longer cattle are on feed. This is traditionally thought to be because they are getting fatter, and more feed energy is required to deposit fat than to grow muscle. However, some of this decline in efficiency may be related to digestive physiology and nutrient metabolism (e.g. insulin resistance), and, may be overcome by changing the dietary energy source from starch to fat.

Success stories: This research showed that partial substitution of barley or corn grain with a high-lipid high-fibre by-product pellet can be an effective dietary strategy for finishing beef cattle, with added benefits for rumen health. The high lipid pellet produces less efficient gains than barley or corn grain, so the decision to use this strategy will depend heavily on the relative costs of oilseed byproducts and cereal grains. Some of this loss in efficiency may be prevented by switching to a high lipid pellet only during the final stages of finishing.

Animal health and production limiting diseases

9. ANH.21.13 - Effect of age and handling on pain assessment and mitigation of common painful routine management procedures

Key highlights: Public concerns with beef cattle welfare often focus on painful procedures like castration, dehorning and branding. Castration and branding are particularly challenging because of the large numbers of animals affected, and because of legal requirements for branding in some cases. This study is looking for cost-effective ways to manage the pain associated with branding and castration in beef calves.

Success stories: The project provides producers with science-based evidence that to minimize pain in the animal, castration should occur in calves as young as possible. Researchers also showed that meloxicam reduced some physiological and behavioural pain responses in calves regardless of age of castration, with greater benefits seen in older age groups. Meloxicam administered at the time of castration was as beneficial as meloxicam administered up to six hours before castration.

10. ANH.23.13 - Implementation of a longitudinal disease surveillance network for cow-calf operations in Western Canada

Key highlights: A gradual and long-term decline in provincial and federal government animal health surveillance means that Canada's beef industry has little knowledge of the prevalence or economic impact of many production limiting diseases. This project established a veterinary and producer network to gather some of this information as part of a long-term effort to re-establish a surveillance system. *Neospora caninum* seroprevalence was determined to be 6.7%, with 68% of herds having at least one positive cow. Bovine leukosis virus seroprevalence was determined to be 2.3%, with 15% herds having at least one positive cow. Evidence-based guidelines for interpreting PCR tests suitable for use under field conditions for *T. foetus* and

C. fetus spp. *venerealis* in beef bulls from western Canada were developed and shared with veterinarians. Data was gathered to assess the prevalence and geographic distribution of micronutrient deficiencies in young and mature cows from western Canada. Baseline data was collected to evaluate reproductive performance and calf loss. This baseline data will inform productivity benchmarks for Western Canadian management practices and identify opportunities for improvement. Animal welfare practices have been documented along with information on producer's perceptions of painful procedures. Data on antibiotic use in the cow-calf sector was also recorded and used to develop an app to enhance on farm recording of antibiotic use. Estimates of gastro-intestinal parasite levels and parasite control efforts were recorded and provided valuable information about parasite levels as well as potential resistance.

Success stories: Updated information on disease prevalence will inform future animal health research priorities for the cow-calf sector. Data from this project showed that producers are following the Code of Practice for the Care and Handling of Beef Cattle. Data also showed that cow-calf producers in Saskatchewan are using antimicrobials judiciously. Benchmarking data will be extremely valuable in assessing disease trends across the Canadian prairies.

Food safety

11. FOS.10.13 - Surveillance of *E. coli*, enterococci, antimicrobial resistance (AMR) and *Enterococcus* species distribution in beef operations-associated environments

Key highlights: Antimicrobial use and resistance are mutual concerns for consumers, the public, and beef producers. Ongoing surveillance programs are largely focused on the risk of AMR transmission through the food chain, with relatively little attention being paid to the likelihood of AMR bacteria or genes being transferred from manure to soil, water, and municipal water supplies.

Enterococcus are found in a range of habitats, being associated with soil, plants, fresh and salt water, sewage and the gastrointestinal tract of including mammals, birds, fish, reptiles, insects and humans. Although enterococci are usually harmless, *Enterococcus faecalis* and *Enterococcus faecium* are associated with a variety of clinical infections in humans including urinary tract infections, hepatobiliary sepsis, endocarditis, surgical wound infections, bacteraemia and neonatal sepsis. *Enterococci* readily acquire resistance to many antibiotics, most notably vancomycin. As a result, the ability to successfully treat clinical infections has been reduced.

Success stories: Researchers took samples in and around four beef feedlots in Alberta over two years and found that *E. faecalis* and *E. faecium* posing the greatest risk to humans are seldom found in cattle. At the same time, the *E. hirae* that predominates in cattle do not survive well outside the animal, and, are quickly outcompeted by other *Enterococci* that are better adapted to specific environments

Resistance to category I antibiotics including β -lactams and quinolones was found in 4 and 5% of beef production isolates, respectively compared to 15 and 25% in human clinical sterile and non-sterile site isolates.

Soil samples originating from the agricultural fields adjacent to the feedlot had a small and unique resistome and did not overlap with the feedlot resistome.

Composting of feedlot manure can be used to reduce the flow of AMR genes into the environment. The results of the experimental study demonstrated that composting is still a preferred method over manure

stockpiling to prevent the spread of veterinary antibiotic residues and transmission of antimicrobial resistance during land-application of manure.

In the world's largest study of its kind, records from over 2.6 million commercial feedlot cattle quantified what antibiotics are being used in feedlot production, when they are used, what they used for, what category of importance in human medicine these antibiotics belong to, and developed scientifically sound metrics for measuring and reporting antibiotic use in cattle.

Beef quality

11. BQU.07.13 – National Beef Quality Audit

Key Highlights: The results of the current National Beef Quality Audit have highlighted areas where overall improvement has occurred in industry practices, translating to measurable differences in beef quality and food safety in processing plants and at retail. Importantly, success is also measured by identifying areas where concerns are developing such that strategies can be developed to mitigate them.

At the plant level, incremental progress has been made in the reduction of prevalence of horns, bruising, and condemnations, indicating industry adoption of welfare-friendly practices is occurring. However, the NBQA also identified increases in fed-cattle brands which may be related to protection against theft due to record high prices since 2014. At the same time, there has been an increase in injection site lesions, and an increase in the severity of liver abscesses. The cooler audit also clearly indicated a shift towards higher quality grades (increased marbling) with a decrease in yield grade (decreased lean meat yield). Overall the cost of these defects has increased by 15% for fed cattle and 5% for non-fed cattle.

At retail, progress has been made at improving the quality of the more economical cross-rib and inside round cuts, with smaller improvements for the higher priced strip loin and top sirloin cuts. Evaluation against competitors' product entering Canada (Mexican beef strip loins) demonstrated measurable quality advantages for Canadian product. Results of this audit have indicated an upper limit for tenderness may have been reached for the higher value cuts. In addition, continued increase in carcass weights and rib-eye areas necessitate thinner retail steak fabrication to meet ideal portion sizes, which continues to impact top sirloin and inside round cuts. Consumer satisfaction scores obtained following preparation of steaks at home (79%) are essentially equivalent to the levels found in the previous audit (80%).

Success Stories - To our knowledge the 2014-2018 National Beef Quality Audit represents the most comprehensive benchmark of beef quality ever performed in Canada. Retail elements included a Customer Satisfaction Survey, Beef Tenderness Survey, Shelf Life Microbiology Survey, Injection Site Lesion Survey, and Meat Case Survey and at the processing plant the Cooler Carcass Audit and Processing Floor Audit. In addition, a stakeholder survey focused on current perceptions and quality priorities was completed with input from processors, retailers, foodservice, distributors, feedlot and cow-calf producers.

The 2014-18 NBQA findings indicate that beef quality and consumer satisfaction attributes are most often slightly improved or stable relative to the NBQA completed five years prior. In terms of carcass defects while there are some items showing improvement, there are also a significant number of areas where there is an opportunity for improvement. The overall cost of quality defects at the carcass level is estimated at

\$84.49/head for fed cattle and \$47.27 for non-fed animals. On a cumulative basis the total losses due to carcass quality defects approach \$200 million for the Canadian cattle sector.

Environment

12. ENV.02.13 - Environmental footprint of the Canadian beef industry

Key highlights: The environmental impact (footprint) of agricultural commodities, including beef, has become increasingly important and is attracting public interest and debate. The environmental footprint of the beef industry is complex with implications for greenhouse gas emissions, nutrient cycling, water and air quality, carbon storage, and grassland and wetland ecosystems.

The beef industry's potential environmental impacts (both negative and positive) are understood in a general sense as many individual impacts have been studied in research projects over the years. This project is the first time the available data has been pulled together into a reliable summary of what the environmental greenhouse gas, water and ammonia footprint of Canada's beef industry actually is, and, how it has changed over the years. The project also established frameworks for assessing the water footprint, impact on biodiversity and ecosystem services provided by the livestock sector, laying the groundwork for subsequent quantitative analyses for these two important aspects of a holistic environmental footprint assessment.

Success stories: The analysis of greenhouse gas emissions from Canadian beef production between 1981 and 2011 showed that producing the same amount of beef in 2011 required 29% less breeding stock, 27% fewer slaughter cattle and 24% less land, with a 15% reduction in greenhouse gas emissions compared to 1981.

The water use intensity of Canadian beef production (liters per kg beef) declined by 17% over the 30-year period between 1981 and 2011. Since feed production accounted for 99% of water use in beef production, further reductions in water use intensity will need to focus on improved feed production and feed efficiency.

Comparing ammonia emissions showed that ammonia losses per kilogram of beef decreased by 20% from 1981 to 2011. This reduction in emission intensity was mainly attributed to increases in reproductive efficiency, average daily gain and slaughter weight, and an overall improvement in productivity per breeding herd over the study period.

Technology and knowledge dissemination

13. TEC.01.13 - Improving technology transfer and knowledge dissemination in the Canadian beef industry

Key highlights: The purpose of this project was to improve knowledge dissemination by supporting and delivering a range of technology transfer mechanisms with a clear focus on accelerating the uptake of research results and outcomes by industry. A primary focus of the initiative was extension of results from research activities completed under the Beef Cattle Industry Science Cluster.

The project included regular communication with industry through the creation and distribution of fact sheets that summarize project findings and articles that discuss research outcomes or priorities which are published on BeefResearch.ca and various other channels. New resources, such as new webpages, videos, and cost of production decision tools for producers have been created and made available through BeefResearch.ca.

Engagement of researchers with industry was and continues to be improved through the Beef Researcher Mentorship program, and by recognizing highly engaged researchers with the Canadian Beef Industry Award for Outstanding Research and Innovation. An economic analysis project and a literature review of adoption levels of various best practices and innovations, both completed by Canfax Research Services, will continually help to inform the BCRC's approach to technology transfer.

The project was enhanced in 2017 with two supplemental activities. One enhanced Bov-innovation programming through collaboration with provincial and national organizations to increase the impact of knowledge and technology transfer. Bov-innovation programming expanded upon the tools developed and advanced them to the next level of adoption through modular technology transfer sessions that were conjoined with a national industry event.

The other activity improved beef production economic knowledge in the Canadian beef industry via three sub-activities: understanding the production practices and disease prevalence among Ontario cow-calf herds; a proof-of-concept software tool for Canadian beef producers to estimate economic impact from selecting among various gastrointestinal nematodes (parasites) (GIN) management options; and studying factors affecting the adoption and exploitation of data management systems in the Canadian beef industry.

Success stories: While it is difficult to measure or qualify the adoption of innovative knowledge, especially in the short term, the BCRC's technology transfer efforts appear to be very successful. Website traffic has increased each year and analytics have indicated that the audience is interested in a variety of topics. Articles and fact sheets have been regularly shared by producers on social media and redistributed by trade magazines and other media; redistribution levels have increased year over year. Views per video are increasing and social media networks of stakeholders continually grow. The number of email subscriptions also continually increases.

Summary of Beef Science Cluster research projects – 2017/18

Project #	Project description	2017/18 budget AAFC, NCO and other industry (at June 2017)	2017/18 projected expenditure AAFC, NCO and other industry	2017/18 projected NCO funds	2013/14 to 2017/18 5-yr budget
Forage and Grassland Productivity					
FRG.04.13	Innovative Swath Grazing/Increasing Forage Research Capacity	152,454	152,454	0	798,084
FRG.08.13	Development of native plant material (grasses, legumes) and mixtures for forage production in the Prairie Region	512,295	491,251	74,808	2,246,143
FRG.09.13	Nutritional Evaluation of Barley Forage Varieties for Silage and Swathgrazing	0	0	0	212,233
FRG.13.13	Pasture mixtures and forage legumes for the long-term sustainability of beef production	0	0	0	612,193
FRG.14.13	Building long-term capacity for resilient cow-calf production systems through creation of a forage industry chair supporting training and research in evaluation and utilization	103,500	103,500	4,600	930,571
Total		768,249	747,205	79,408	4,799,224

Feed Efficiency		2017/18 budget	2017/18 projected expenditure	2017/18 projected NCO funds	2013-2018 budget
FDE.04.13	Germplasm and variety development of barley and triticale for animal feed with a focus on feed quality, yield and disease resistance of both grain and annual forage production	300,000	299,168	95,018	1,400,000
FDE.07.13	The impact of genomic selection for feed efficiency on the cow-calf	0	0	0	552,874

sector, performance parameters and underlying biology

FDE.09.13	Increased Use of High Energy Forages in Conventional Feedlot Beef Production	71,000	71,000	0	432,591
FDE.15.13	Prebiotic, probiotic, and synbiotic technologies for targeted applications in food safety and ruminant productivity	102,724	102,724	0	499,767
FDE.17.13	Improvement of cow feed efficiency and the production of consistent quality beef using molecular breeding values for RFI and carcass traits	166,865	166,865	0	459,267
FDE.19.13	Understanding the physiology behind changes in feed efficiency throughout the finishing period	41,688	41,688	41,688	716,826
Total		682,277	681,445	136,706	4,061,325

	Animal Health and Production Limiting Diseases	2017/18 budget	2017/18 projected expenditure	2017/18 projected NCO funds	2013-2018 budget
ANH.01.13	Identifying Mycobacterium avium subsp. parathberculosis (MAP) exproteome components recognized early during infection to develop diagnostic and vaccine targets	0	0	0	190,325
ANH.12.13	Geographic variation in abundance and genetics of Dermacentor andersoni, a vector of bovine anaplasmosis	0	0	0	570,650
ANH.13.13	Development of a fully-automated DNA microarray chip for multiplex detection of bovine pathogens	0	0	0	289,398
ANH.21.13	Effect of age and handling on pain assessment and mitigation of common painful routine management procedures	479,380	479,380	87,550	1,350,992
ANH.23.13	Implementation of a longitudinal disease surveillance network for	131,100	131,100	88,490	1,067,405

cow-calf operations in Western
Canada

ANH.33.13	Improving the barrier function of the gut: an approach to minimize production limiting disease	0	0	0	385,708
Total		610,480	610,480	176,040	3,854,478

Beef Quality and Food Safety		2017/18 budget	2017/18 projected expenditure	2017/18 projected NCO funds	2013-2018 budget
FOS.01.13	Prevalence, Persistence and Control of Non-O157 Shiga Toxin Producing Escherichia coli	0	0	0	48,300
FOS.04.13	Identification and validation of commercially practicable practices and procedures for improving the microbiological safety stability of beef	0	0	0	460,538
FOS.10.13	Surveillance of E. coli, enterococci, antimicrobial resistance (AMR) and Enterococcus species distribution in beef operations-associated environments	482,992	479,368	99,434	1,834,625
BQU.01.13	Effect of high pressure processing on quality, sensory attributes and microbial stability of marinated beef stead during refrigerated storage	0	0	0	32,872
BQU.03.13	Genetics and Proteomics of dark cutting cattle in Alberta	0	0	0	245,794
BQU.06.13	Genetics of the eating quality of high connective tissue beef	0	0	0	175,088
BQU.07.13	Beef Quality Audit	115,233	94,628	0	770,775
Total		598,225	573,996	99,434	3,567,992
Environment		2017/18 budget	2017/18 17 projected expenditure	2017/18 projected NCO funds	2013-2018 budget
ENV.02.13	Environmental Footprint of the Canadian Beef Industry	92,000	92,000	0	310,788

	Technology and Knowledge Dissemination	2017/18 budget	2017/18 projected expenditure	2017/18 projected NCO funds	2013-2018 budget
TEC.01.13	Improving Technology Transfer and Knowledge Dissemination in the Canadian Beef Industry	399,883	346,483	74,993	1,206,615
	Total all Cluster projects	3,151,114	3,051,611	566,581	17,781,346*
Cluster Management	Management and administration of all Cluster projects	320,716	320,716	135,996	1,484,414
	Total all Cluster projects	3,471,830	3,372,327	702,578	19,265,760

Expenditures on Cluster II projects in 2017/18 totaled \$3,471,830, including management and administration for Cluster projects.

2017/18 Canadian Beef Cattle Check-Off funding to Cluster II projects is projected at \$702,578.

B. Non-cluster projects funded by the BCRC and industry

In addition to research projects funded within the GF2 Beef Science Cluster program, the BCRC and industry partners also fund projects based on identification of specific needs and opportunities. The projects identified below are not within the Cluster and are all managed through the BCRC with funding from the Canadian Beef Cattle Check-Off and various other industry sources.

- a) The non-Cluster projects funded through Canadian Beef Cattle Check-Off revenues in 2017/18 include:

- *MISC.03.12 - Enhancing Barley Straw Digestibility*

This project is expected to be completed June, 2018 with the final report pending. As reported in the previous Results Report, on a pound-for-pound basis, there is as much energy in barley straw as there is in the grain. The problem is that cattle can't access the energy in barley straw because even rumen microbes have a hard time digesting it. This research is studying a wide range of microorganisms from ruminants that are said to thrive on rely on higher fiber diets (e.g. bison) as well as fungi that decompose wood. This research aims to identify genes coding for enzymes capable of breaking down complex fibers, potentially leading to feed treatment or dietary additives enabling cattle to cost-effectively extract more energy from high fiber feeds.

- *Canadian Global Food Animal Residue Avoidance Database – CgFarad*

The Canadian global Food Animal Residue Avoidance Database (CgFARAD) plays an important role in the prevention of drug and chemical residues in foods of animal origin. Based at the Western College of Veterinary Medicine, University of Saskatchewan and the Ontario Veterinary College, University of Guelph, the CgFARAD service provides technical information and advice to Canadian veterinarians and government regulators on withdrawal issues relating to extra-label drug use and exposure to toxic chemicals in food animals. The clinical pharmacologists responsible for the CgFARAD are uniquely positioned to provide expertise to meet industry needs. The BCRC contributed \$7,500 to reflect the beef industry's contribution to maintaining this important capacity. Additional support is provided by other protein sectors and provincial and federal governments.

- *Research Program Development*

These funds were budgeted for further research program development via direct project funding or a call for proposals with identified research priorities. All proposals considered to use these funds are reviewed and approved by the Council. In preparation for the next Science Cluster which will start in 2018/19, and uncertain industry funding during 2017/18 the Council decided to defer use of these funds and carry them over to ensure adequate industry funding is available to leverage federal funding under the 2018-2023 Science Cluster.

Project description	2017/18 budget	2017/18 Projected Check-Off dollars**
MISC.03.12 - Enhancing Barley Straw Digestibility	20,000	20,000
Canadian Global Food Animal Residue Avoidance Database-CgFarad	7,500	7,500
Research Program Development	200,000	0
Total	227,500	27,500

2017/18 Check-Off and industry funding to non-Cluster projects is projected at \$27,500.

** These projects are aligned with the BCRC fiscal year, July 1 to June 30. Consequently the 2017/18 actual expenditures are to be finalized subject to the close of the year end on June 30th, 2018.

- b) The following projects, outside of Beef Cluster II, were funded by industry partners and other funding organizations and managed by the BCRC. Canadian Beef Cattle Check-Off dollars were not allocated to these projects. Reports on these projects are available upon request.

Project description	2017/18 budget	2017/18 projected ***
Misc.03.15 Remote Sensing Applications to Insure Individual Farm Forage Production	369,537	369,537
Misc.01.16 Enhancing traceability and management Solutions for the Alberta cattle industry using mobile device technology : Phase II (project extension resulted in revised budget)	75,321	75,321
VBP Plus Program Development (GF 2)	42,059	42,059
Enhanced VBP Plus	613,825	613,825
Total	1,100,742	1,100,742

*****The budget for 2017/18 partner contributions (not Check-Off) to research projects = \$1,100,742 and the projected expenditures or deferred amounts total \$1,100,742.**

- c) Verified Beef Production Plus

In addition to sponsoring research and technology development in support of the Canadian beef industry, the BCRC continues to oversee the Verified Beef Production Plus (VBP+) program. The VBP+ program grew from its roots in the Quality Starts Here (QSH) program, an educational initiative started to help the beef industry move toward the highest beef quality in the world through on-farm verification of practices relating to food safety and beef quality. The VBP+ program builds on the QSH program by adding three more modules for on-farm sustainability practices related to biosecurity, environmental stewardship and animal welfare.



Over the course of the past year VBP+ has been focusing on completing its transition from VBP to VBP+. VBP+ now offers a complete sustainability focused program for Canadian beef producers.

End-users continue to look for means to verify production practices related to sustainability, specifically animal care and environmental sustainability. With the addition of the new modules VBP+ is well positioned to meet the indicators established under the Canadian Roundtable for Sustainable Beef (CRSB) and provide a credible, cost-effective, producer-led option for verifying responsible production practices through training, simple record keeping and on-farm validation audits. VBP+ continued to expand its engagement with end-users over the past year, largely through the CRSB.

Specifically, VBP+ has teamed up with BIXS and Cargill to launch the Canadian Beef Sustainability Acceleration pilot. The pilot is testing the CRSB framework to ensure it is functional in the commercial beef industry when it is implemented. The pilot, which has been operational since October 2017, has returned financial incentives to producers, and has been successful in gaining interest of producers across the country. VBP+ has also began plans to reinvigorate its training program with the goal of bringing it into alignment with training programs being sought out by packing plants and other industry stakeholders across North America.

VBP+ is continuing its effort to prepare for a reduced federal/provincial funding structure. This is starting to become more and more apparent as new programs are unveiled across the country. VBP+ is fully utilizing two key national tools (being a national database and national website) which is one of the first steps in synchronizing and streamlining the VBP+ program, ultimately making operations more efficient and less reliant on government funding.

The VBP program is expected to continue to grow in importance, as it delivers on all four modules and becomes a core pillar in verifying sustainable beef production in alignment with the CRSB, Canada Beef, and end-users looking for options to communicate what is happening at the farm level through verification and reporting.

The VBP+ project budget is aligned with the BCRC fiscal year, July 1 to June 30. Consequently the 2017/18 actual program expenditure will be finalized subject to the close of the year end on June 30th. The 2017/18 Check-Off and industry budget for VBP+ was \$237,500, with expenditures projected at \$237,500.

IV. BCRC administration and management

The BCRC is overseen by an operating committee of 12 cattle producers, which are appointed by the provincial producer organizations and proportionally represent the provincial allocation of the Canadian Beef Cattle Check-Off to research. Lead by an Executive Director, the BCRC oversees research program development and implementation, playing a key role in establishing and refining industry research priorities in consultation with other stakeholders. The Executive Director acts as a liaison and facilitation link among the BCRC committee and BCRC staff, CCA, Canada Beef, Canadian Beef Cattle Research, Market Development and Promotion Agency, technical advisors, and national and provincial interest groups with similar research objectives. The Executive Director encourages coordination of priorities and funding allocations between agencies in alignment with the *Canadian Beef Research and Technology Transfer Strategy*.

A Science Advisory Panel supports the research program development process within the Cluster to ensure the delivery of research plans that are directed towards industry's research objectives and achieve the outcomes desired by industry. The Panel also assists with the technology transfer and knowledge dissemination process and identification of commercialization opportunities. Over the past decade, two five-year National Beef Research Strategies were developed following extensive consultation with a very broad group of value chain stakeholders - producers, researchers, government, service providers and funding agencies. The 2012-2018 *National Beef Research Strategy* was instrumental in guiding industry and government research investments at both a national and provincial level across multiple funding agencies, particularly for the Beef Science Cluster II, 2013 to 2018. The subsequent 2018-2023 *Canadian Beef Research and Technology Transfer Strategy* was instrumental in guiding the development of the third Beef Science Cluster, effective April 1, 2018.

Canadian Beef Cattle Check-Off funding directed to the BCRC general administration and management expenses for 2017/18 is projected at \$209,103.

V. Ongoing research performance reporting and evaluation

The BCRC has taken a leadership role in communicating the value of investments, including the Canadian Beef Cattle Check-Off, made in beef, cattle and forage research. The BCRC partnered with Canfax Research Services to develop and monitor a series of research indicators that aid in assessing the economic returns to beef research in Canada, developing the BCRC research priorities, and tracking the economic benefit of the BCRC funded research over the long term. An inaugural results report was developed and released in February 2014. The report outlines how dollars were invested between 2009 and 2013, and how that research is contributing to advancements in production efficiencies, quality and demand for Canadian beef. In many cases the financial impacts of deliverables to the industry were calculated; some impacts may not be fully apparent for several years. The intent is to complete a similar evaluation in 2018/19 upon the completion of the current 5-year research plan through the Beef Science Cluster, which ended on March 31, 2018. Research reports are now under review.

The 2014 report reveals that the largest financial improvements to industry between 2009 and 2013 were in the priority areas of 'animal health and welfare' and 'feed grains and feed efficiency,' as research in these areas allow for almost immediate adoption of new technology and have a high level of private investment. View the full report at: http://www.beefresearch.ca/files/pdf/BCRC_results_report_jan2014.pdf.

VI. Financial note

The fiscal year for the BCRC is July 1 to June 30 and therefore the BCRC audited financial statements are not included in this report. In most instances, the projected expenditures in this report reflect the July to June fiscal period. Consequently the 2017/18 actual expenditures are to be finalized subject to the close of the year end on June 30th. The 2017/18 financial summary for the BCRC will be available upon request after August 2018.

Projected Canadian Beef Cattle Check-Off funding allocated to research programming in 2017/18 is outlined in various sections of this report and includes the following:

Beef Science Cluster research projects -	\$702,578
Non-Cluster research projects –	\$27,500
Verified Beef Production Plus -	\$237,500
BCRC general program management and administration –	\$209,103
Total -	\$1,176,681