



2016/17 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) is Canada's only national industry-led funding agency for beef research. A division of the Canadian Cattlemen's Association (CCA), the BCRC is directed by a committee of beef producers from across the country. It plays an important role in identifying the industry's research priorities and maximizing the value of research to improve the competitiveness of the Canadian beef industry and subsequently influence public sector investment in beef research. The BCRC is funded through a portion of a producer-paid cattle and beef National Check-off, with additional funding provided through the Agriculture and Agri-Food Canada (AAFC) Beef Cattle Industry Science Cluster under Growing Forward 2.

The research allocation of the National Check-off administered by the BCRC averages 18 per cent of the monies collected by the provinces. The Check-off revenue and additional funding from industry and government stakeholders leverages funding through the Beef Cattle Industry Science Cluster on a 1:3 industry:government ratio. The second Science Cluster, covering the period April 1, 2013 to March 31, 2018, is a \$20 million program, with \$5 million from industry including the National Check-off, \$1 million from provincial government, and \$14 million from AAFC.

This report presents the results of BCRC administered research activities during the period April 1, 2016 to March 31, 2017. During this period, 17 projects were funded under the Beef Science Cluster, each aligning with one of the following research priority areas:

- Forage and Grasslands Productivity
- Feed Efficiency
- Animal Health and Production Limiting Diseases
- Food Safety
- Beef Quality
- Environment
- Technology and Knowledge Dissemination.

Section III of this report includes a list of Cluster research projects funded by National Check-off dollars and other industry investments. Although the research continues for many projects to be completed in 2018, several success stories are included under the various project reports in section III.

For example, under the area of Forage and Grassland productivity, long-term breeding programs for grass and legumes have made progress in improving yields of various plant materials, under various soil moisture and nutrient conditions. Research also focused on the most economical extended grazing practices to meet the cow herd's nutritional requirements through the winter. Results indicated that economic and environmental benefits can be realized with various grazing practices, through reduced fuel usage and a reduced carbon footprint.

In the area of feed efficiency, researchers developed a new way to look at interactions between prebiotics (feed ingredients that the animal can't digest but the bacteria can) and probiotics (bacteria that benefit the host) and synbiotics (combination of pre- and probiotics) to assess how they function in the animal. These advances will help to create performance benchmarks to ultimately increase beef production. Research also 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. And three barley and triticale varieties with superior yield and quality that were approved for registration were developed.

Relating to animal health and production limiting disease, researchers identified specific habitat characteristics for ticks which carry and spread the bacteria that cause anaplasmosis in cattle. Data collected, including the distribution and relative density of ticks, will support developing industry recommendations to help avoid anaplasmosis. In the area of food safety, antimicrobial use and resistance are mutual concerns for consumers, the public and beef producers. Research continues to focus on antimicrobial resistance (AMR) bacteria, and the risk of AMR bacteria being transferred from the manure to soil, water and municipal water supplies. Preliminary findings indicate that the bacteria or genes that pose the greatest risk to humans are seldom found in cattle.

The National Beef Quality Audit, measuring production related defects in beef carcasses, indicated that fewer injection site lesions were found in 2016 compared to 1999 and that consumer satisfaction with Canadian retail beef has been steady since 2009 but significantly improved relative to 2001. Providing consumers product and preparation information remains very important, with opportunities to address this through on-package information. Research on the environmental footprint of the Canadian beef industry remained a priority. Considering the varying beef production systems and existing blanket recommendations, a review paper outlining the different methods of quantifying water use in cattle was developed. This will lead to meaningful water use assessments.

The technology and knowledge dissemination program delivered a range of extension tools with a focus on accelerating the uptake of research results and outcomes by industry. Regular communication with producers and other stakeholders was achieved through development and distribution of fact sheets, articles, infographics, and videos that discuss research outcomes or priorities. Bov-Innovation, a modular, interpersonal technology transfer session with producers, was held for the first time at the inaugural Canadian Beef Industry Conference in August 2016. Producer extension events throughout the year included webinars and additional Bov-Innovation sessions. BCRC resources are available at www.BeefResearch.ca, and many BCRC communication tools have proved to be valuable resources for the industry. Website traffic has increased each month, articles and fact sheets have been regularly redistributed by trade magazines and other media, views per video are increasing and social media networks of stakeholders continually grow. Perhaps most significant, follow-up with webinar participants one year later confirms that many producers make changes on their operation following the information and advice presented during a BCRC webinar.

In addition to sponsoring research and knowledge and technology transfer programs in support of the Canadian beef industry, BCRC oversees the Verified Beef Production Plus™ Program (VBP+). Throughout 2016/17 VBP+ launched three additional modules supporting sustainability, specifically focused on animal care, biosecurity, and environmental stewardship. Producers are now being trained and transitioning to VBP+. The enhanced program is well positioned to meet the indicators established under the Canadian Roundtable for Sustainable Beef (CRSB) and provides a credible, cost-effective, producer-led option for

verifying responsible production practices through training, simple record keeping and on-farm validation audits. Over the year, VBP+ expanded its engagement along the beef value chain, from producer to end-user, to ensure that the program delivers the ideal balance of rigour for consumers and usability for producers. A new VBP+ business plan is in the process of implementation, utilizing a national database and website to meet the expectations of the end users and have the capacity to train and audit a large volume of producers across all VBP+ modules, leading to increased efficiencies and less reliance on government funding. The VBP+ program is expected to grow in importance and become 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 fiscal year for BCRC is July 1 to June 30; therefore BCRC audited financial statements are not included in this report and are available upon request after August 31, 2017. National Check-off funding allocated to research programming in 2016/17 is outlined in various sections of this report and is estimated at \$1.36 million.

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 National Check-off and currently receives on average \$0.18 of every \$1.00 of National Check-off collected by the provinces. The BCRC leverages federal government funding under Growing Forward 2 with industry National Check-off dollars on a 1:3 (industry:government) basis through Canada's Beef Cattle Industry Science Cluster. It also collaborates with other funding agencies to maximize the value of all investments in research within the Canadian beef cattle industry.

As the only 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. 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 national Technology Transfer strategy. It is also responsible for the delivery of the Verified Beef Production Plus (VBP+) national on-farm food safety program. The BCRC also leads the ongoing implementation of the National Beef Research 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, and infrastructure priorities are addressed.

The majority of BCRC's current research and extension programming is funded through the Beef Cattle Industry Science Cluster under Growing Forward 2. This second Science Cluster runs for the period April 1, 2013 to March 31, 2018. It is a \$20 million program, with \$5 million from industry including the National Check-off, \$1 million from provincial government, and \$14 million from AAFC.

This report covers the period April 1, 2016 to March 31, 2017. This period is the fourth year of the Growing Forward 2 Beef Science Cluster and research programming under the Cluster is centered around the following areas:

- 1) Maintaining or improving competitiveness in the production of beef cattle
- 2) Supporting science-based policy, regulation and trade
- 3) Supporting science-based public education and advocacy
- 4) Supporting the Canadian Beef Advantage through continual advancements in beef quality and food safety, and
- 5) Accelerating the adoption of new innovations in the Canadian Beef Industry.

III. Key highlights for the 2016/17 activities

A. Beef Science Cluster II projects funded by government, industry and National Check-off and managed by BCRC

This section provides the 2016/17 research results for the projects funded under the Beef Science Cluster. Some results are preliminary as several projects extend to 2018. A summary table, including the project number, title, budget, and projected expenditures, follows the results.

Forage and grasslands 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 is to identify 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. 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 reduces significantly energy use.

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 is a collaboration between researchers in Saskatchewan, Alberta, Manitoba and Quebec. They are using 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: Progress has been made in improving seed yield of rough fescue, earlier maturing seed for purple prairie clover, identification of higher seed yielding green wheatgrass plants and potential of native legumes capable of biomass production equivalent to alfalfa and improved forage value of bluebunch wheatgrass. Western wheatgrass was identified as having allelopathic potential along with drought tolerance. Drought tolerance was also noted for slender milkvetch.

Lines grown in Swift Current were shown to be different for days to heading, plant height, leaf width, plant diameter, biomass at second harvest and fall regrowth than lines grown in other locations. These results will be useful as researcher continue the plant breeding effort.

3. FRG.13.13 - Pasture mixtures and forage legumes for the long-term sustainability of beef production

Key highlights: Commercial forage seed mixtures are usually developed to achieve a particular seed price. This research is focused on identifying combinations of forage seed varieties that optimize forage quality, yield and animal productivity in Eastern Canada.

Success stories: Animal gain per hectare was 40% higher in cattle grazing mixtures containing trefoil than for those grazing mixtures containing alfalfa. This result was unexpected, given that alfalfa-based mixtures had greater forage yield, protein content, and total digestible nutrients. Forage mixtures with timothy and meadow fescue showed a greater average daily gain than those with tall fescue. Some forage species and some cultivars within species were shown to have greater yield and nutritional quality than others. A broader national evaluation comparing species and cultivar combinations under grazing would benefit Canada's beef industry.

4. 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 is evaluating a range of perennial and annual forage varieties for extended winter grazing of mature cows and bred heifers in Manitoba. This research is providing 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.

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

Feed efficiency

5. 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 is 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: In the past year, this breeding program has developed three varieties with superior yield and quality that were approved for registration. The team has also reduced the years of variety testing that are needed prior to entering the co-op network from 5 years to 3-4 years. Beyond simple yield and disease and lodging resistance, this team is also selecting varieties that use fertilizer more efficiently. A line with improved Nitrogen Use Efficiency (NUE) is nearing registration and may be released in 2018.

6. 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 is investigating whether cattle 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.

7. 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 have 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.

8. 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 is divergently selecting different cattle populations for high and low feed efficiency, and looking for impacts on other traits. Keeping in mind that only two to three years of replacements have been selected to date, with few of these replacements having had more than one calf, and none 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.

9. 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 feedlot 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 does produce 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.

Animal health and production limiting diseases

10. ANH.12.13 - Geographic variation in abundance and genetics of *Dermacentor andersoni*, a vector of bovine anaplasmosis

Key highlights: The Rocky Mountain tick (*Dermacentor andersoni*) and American Dog tick (*Dermacentor variabilis*) can carry and spread the bacteria that causes anaplasmosis in cattle. The CFIA no longer treats anaplasmosis as a reportable disease, so the costs of dealing with the disease now falls to individual producers. A better understanding of where these ticks are and are likely to be is essential to developing recommendations to help avoid anaplasmosis. This is the most comprehensive study conducted to determine the abundance of in western Canada. Ticks were monitored at 201 different sites in British Columbia, Alberta, Saskatchewan, and Manitoba in the spring and summer of 2014-2016. Results confirmed that *D. variabilis* is expanding northward in Saskatchewan and Manitoba, and *D. variabilis* is expanding westward, but the chance of encountering ticks and the risk of disease transmission varies greatly during different years and at different locations.

Success stories: Data collected during this study also allowed researchers to identify specific habitat characteristics that ticks are more likely to be present in. This has allowed researchers to develop the first statistical equations for predicting the distribution and the relative density of ticks throughout Western Canada. This is an important step for identifying and monitoring areas of greater risk of encountering ticks and for potential transmission of tick-borne pathogens, such as *Anaplasma marginale*.

11. 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: One experiment compared surgical castration, branding or both, with and without pain medication (meloxicam). A single meloxicam injection immediately prior to castration and/or branding effectively eliminated the physiological and behavioural indicators of pain and distress in calves. A second experiment compared three different commercially available wound healing agents in calves surgically castrated at 5 months of age. None of these products affected scrotal temperatures, swelling, or the speed of scrotal healing. This emphasizes the importance of castrating calves as soon as practically possible.

12. 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. In 2016-17, *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 has been gathered to assess the prevalence and geographic distribution of micronutrient deficiencies in young and mature cows from western Canada. Baseline data has also been 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.

Food safety

13. 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 have taken samples in and around four beef feedlots in Alberta over two years and have found that *E. faecalis* and *E. faecium* that pose 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. However, *Enterococci* are very effective at exchanging DNA with each other bacteria. Consequently, this study is analyzing bacterial DNA from Enterococcal samples collected from various environments including streams, rivers, municipal water and human patients to determine the risk of AMR genes from cattle-adapted *E. hirae* being transmitted to humans via other *Enterococcal* species.

Beef quality

14. BQU.06.13 - Genetics of the eating quality of high connective tissue beef

Key highlights: Inconsistent tenderness is one of the main consumer beef quality concerns. Tenderness is determined by both muscle cell proteins (mainly how quickly they break down during aging), as well as connective tissue. Muscles (like the outside round) that have higher amounts or more extensively linked connective tissue are tougher than those with less. Genetic markers for beef tenderness based on the calpain and calpastatin genes (which are involved in tenderization during aging) have been available for several years, and work well in muscles with low connective tissue content (e.g. ribeye). However, these markers do not identify animals that differ in connective tissue content or cross-linking (e.g. outside round).

Success stories: This project identified six genetic markers associated with collagen levels and solubility. If successfully validated in a genetically-independent population, these markers may provide another avenue

to improve beef quality in seedstock and commercial beef cattle.

15. BQU.07.13 – National beef quality audit

Success stories: The National Beef Quality Audit measures production-related defects in beef carcasses, at wholesale, retail, and consumer levels to inform industry education efforts to improve quality and value at all levels of the production system. Results of the most recent NBQA indicated that fewer injection site lesions were found in the top butt, blade, and eye of round compared to 1999. Consumer satisfaction with Canadian retail beef has held steady since the 2009 audit, and is significantly improved relative to 2001. The national benchmark of the retail meat case provides the sector with an accurate perspective on how much product with different label claims is sold. At retail, the most common consumer-targeted package claims related to traceability (9%). Claims related to hormones (less than 5%), antibiotic use (less than 4%), animal welfare (less than 2%), animal diet (2% or less), halal (less than 2%) or kosher (less than 2%) were generally uncommon and varied considerably among cuts. Fewer than 10% of retail stores had beef recipe cards, fewer than 4% had scannable QR codes on beef packages, and 0.2% of steaks (and no roasts) had a website address. Package information may be an opportunity for the beef industry to meaningfully communicate with consumers at both the point of purchase and at the time of preparation in the home.

Environment

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

Key highlights: Estimates of how much water is used during beef production vary widely. This is partly due to differences in production systems as well as forms of water considered in the analysis. Blanket recommendations that ignore these differences may not only be misleading, but could prove counterproductive to the efforts of accurately assessing water use. Beef appears to use more water than other protein sources. However, it is important to note that:

- Cattle often use feed resources that are unsuitable as food;
- Cattle mainly use water that has zero or small opportunity cost (because grazing land is typically unsuitable for crop production);
- The magnitude of the reported estimates may not always mirror actual impacts, and
- There may be possible trade-offs between water use and other sustainability indicators such as carbon footprint and biodiversity.

Success stories: The research team developed a review paper outlining the different methods of quantifying water use in cattle. The most common methods (Water Footprint Analysis and Life Cycle Assessment) differ fundamentally and make it difficult to arrive at a balance between scientific comprehensiveness and practical simplicity to generate meaningful yet useful water use assessments. The review team included the two scientists who spearhead the Life Cycle Assessment and Water Footprinting approaches, potentially paving the way for future collaboration rather than continued confrontation.

Technology and knowledge dissemination

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

Both government and industry make significant investments to continually find better and more efficient methods of producing high quality beef and cattle, but effective technology transfer is needed to realize the

benefits of research efforts. Governments and universities used to employ many extension specialists and support field days, seminars and other initiatives but these activities have greatly declined in many regions over the past two decades due to decreased funding. This has contributed to shortfalls in industry adoption of beneficial knowledge and technologies.

Key highlights: The purpose of this activity is to improve knowledge dissemination and technology transfer by supporting and delivering a range of extension tools with a clear focus on accelerating the uptake of research results and outcomes by industry. A primary focus is extension of results from research activities completed under the Beef Cattle Industry Science Cluster. This project includes regular communication with industry through the creation and distribution of fact sheets that summarize project findings, articles that discuss research outcomes or priorities and other tools, which are published on www.BeefResearch.ca and various other channels. In 2016/17, eight new fact sheets, four webpages, twelve magazine articles, six press releases, seven radio releases, four infographics, one priority area review and two videos were produced.

Extension events for producers, namely eleven webinars and six Bov-Innovation sessions, were held. Bov-Innovation was held for the first time at the inaugural Canadian Beef Industry Conference in August 2016. Bov-Innovation is modular, interpersonal technology transfer sessions with producers that can be conjoined with industry events. Developed to increase the impact of knowledge and technology transfer efforts, presentations are short, exciting and interactive, followed by distribution of take-home resources. Reviews by Bov-Innovation and webinar participants were very positive. Webinar recordings are available on BeefResearch.ca.

Engagement of researchers with industry is being improved through the Beef Researcher Mentorship program. Four applied researchers were paired with industry experts and cattle producers. Mentors help the researchers build their knowledge, skills and network through ongoing discussions and by initiating various introductions, tours and meetings.

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 successful. Website traffic has increased each month and analytics have indicated that the audience is interested in a variety of topics. Articles and fact sheets have been regularly redistributed by trade magazines and other media, as well as by producers on social media. Views per video are increasing and social media networks of stakeholders continually grow. The number of email subscriptions also continually increases. Perhaps most significant, follow-up with webinar participants one year later confirms that many producers make changes on their operation following the information and advice presented during a BCRC webinar.

Summary of Beef Science Cluster research projects – 2016/17

Project #	Project description	2016/17 budget AAFC, NCO and other industry (at June 2016)	2016/17 projected expenditure AAFC, NCO and other industry	2016/17 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	170,400	170,400	0	798,084
FRG.08.13	Development of native plant material (grasses, legumes) and mixtures for forage production in the Prairie Region	640,833	621,757	120,670	2,227,067
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	96,198	96,198	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	291,468	291,468	18,400	930,571
Total		1,198,899	1,179,823	139,070	4,780,148

Feed Efficiency		2016/17 budget	2016/17 projected expenditure	2016/17 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	300,000	93,164	1,400,000
FDE.07.13	The impact of genomic selection for feed efficiency on the cow-calf sector, performance parameters and	0	0	0	552,874

underlying biology

FDE.09.13	Increased Use of High Energy Forages in Conventional Feedlot Beef Production	86,999	86,999	0	432,591
FDE.15.13	Prebiotic, probiotic, and synbiotic technologies for targeted applications in food safety and ruminant productivity	156,469	156,469	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	147,867	278,867	0	459,267
FDE.19.13	Understanding the physiology behind changes in feed efficiency throughout the finishing period	0	220,609	220,609	716,826
Total		691,335	1,042,944	313,773	4,061,325

Animal Health and Production Limiting Diseases		2016/17 budget	2016/17 projected expenditure	2016/17 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	195,083	195,083	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	414,324	414,324	40,309	1,350,992
ANH.23.13	Implementation of a longitudinal disease surveillance network for cow-calf operations in Western	303,600	303,600	58,410	1,067,405

Canada

ANH.33.13	Improving the barrier function of the gut: an approach to minimize production limiting disease	0	0	0	385,708
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Total		913,700	913,007	98,719	3,854,478
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		2016/17 budget	2016/17 projected expenditure	2016/17 projected NCO funds	2013-2018 budget
Beef Quality and Food Safety					
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	497,942	570,346	203,344	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	33,868	33,868	0	175,088
BQU.07.13	Beef Quality Audit	182,467	111,225	0	770,775
Total		714,277	715,439	203,344	3,567,992
Environment					
		2016/17 budget	2016/17 projected expenditure	2016/17 projected NCO funds	2013-2018 budget
ENV.02.13	Environmental Footprint of the Canadian Beef Industry	75,038	75,038	-	310,788

Technology and Knowledge Dissemination		2016/17 budget	2016/17 projected expenditure	2016/17 projected NCO funds	2013-2018 budget
TEC.01.13	Improving Technology Transfer and Knowledge Dissemination in the Canadian Beef Industry	195,527	250,078	103,771	1,206,615
Total all Cluster projects		3,788,083	4,176,329	858,677	17,781,346*
Cluster Management	Management and administration of all Cluster projects	314,906	314,906	134,936	1,484,414
Total all Cluster projects		4,102,989	4,491,235	993,613	19,265,760*

Expenditures on Cluster II projects in 2016/17 were \$4,491,235, including management and administration for Cluster projects. Unspent 2015/16 funding was deferred to 2016/17, covering 2016/17 project expenses which exceeded the budget.

2016/17 National Check-off funding to Cluster II projects is projected at \$993,613.

** Additional government funding towards the Beef Science Cluster projects totals \$1,184,208.*

B. Projects funded by National Check-off and managed by the BCRC

In addition to Beef Cluster II projects funded with National Check-off dollars, BCRC and industry partners also fund projects outside of the cluster based on identification of specific needs and opportunities. The projects identified below are all managed through BCRC, with funding from various sources.

The non-Cluster projects funded through National Check-off revenues in 2016/17 are highlighted below.

- *MISC.03.12 - Enhancing Barley Straw Digestibility*

This project is expected to be completed June, 2018. As reported in the 2015/16 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. 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.

- *Misc.04.13 Offal Quality*

Using information collected during the National Beef Quality Audit, a pilot epidemiological investigation into individual animal (as opposed to group level) risk factors was conducted along with an analysis of the impact of liver abscesses on feedlot performance and carcass characteristics. Five feedlots with detailed animal health and phenotype data for individual animals had this information linked to liver score information using the Canadian Cattle Identification Agency identification number. Multivariable modeling was performed to identify individual animal risk factors associated with the occurrence of liver abscesses at slaughter. Eight variables were associated with liver abscessation at slaughter: year placed, month placed, days on feed, undifferentiated fever/bovine respiratory disease risk category, gender, arrival weight, treatment for arthritis, and treatment for footrot. These findings can be used to identify animals at high risk of liver abscessation to allow for targeting of liver abscess control strategies in the highest risk animals.

- *National Research Inventory*

An inventory system was established to collect data from major beef research funding agencies and to share the data across agencies to better inform funding directions and decisions. The BCRC has accepted responsibility for developing and maintaining the system, and will continue to actively

engage funders to encourage increased participation and grow the number of projects and funders represented in the database.

- *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, and uncertain industry funding at this point the Council has decided to defer use of these funds and carry them over to ensure adequate industry funding is available to leverage federal funding under the next Science Cluster.

- *EU CETA Scientific Review of Microbial Interventions*

CCA's Technical Director is working to prepare a submission to the European Food Safety Authority (EFSA) to approve the use of the microbial interventions (peroxyacetic acid and citric acid) that Canadian processors consider as most important to ensure food safety. Without approval of these interventions large Canadian processors are unlikely to export to the EU, as they will not forgo the use of these products. The preparation of a submission requires a substantial amount of documentation related to product efficacy, environmental safety, and risk of antimicrobial resistance. Funding of \$25,000 is required to hire the appropriate scientific expertise to prepare the review for the submission and liaise with the EFSA. The total cost of submissions for beef and pork are estimated to be \$100,000 with the pork industry also contributing \$25,000 and the remainder being requested from the Canadian Agricultural Adaptation Program (CAAP).

Project description	2016/17 budget	2016/17 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	375,000	0
MISC.04.13 Offal Quality	2,000	2,000
National Research Inventory	840	840
EU CETA Scientific Review of Microbial Interventions	25,000	25,000
Total	430,340	55,340

2016/17 Check-off and industry funding to non-Cluster projects is projected at \$55,340.

** These projects are aligned with the BCRC fiscal year, July 1 to June 30. Consequently the 2016/17 actual expenditures are to be finalized subject to the close of the year end on June 30th, 2017.

C. Projects funded by industry (not Check-off dollars) and managed by the BCRC

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

Project description	2016/17 budget	2016/17 projected ***
Misc.03.15 Remote Sensing Applications to Insure Individual Farm Forage Production	221,839	221,839
Misc.01.16 Enhancing traceability and management Solutions for the Alberta cattle industry using mobile device technology : Phase II	197,489	197,489
VBP Plus Program Development (GF 2)	140,408	140,408
Enhanced VBP+	1,173,496	1,173,496
Total	1,733,232	1,733,232

*** Funding for some projects is deferred to the next fiscal year aligning with project completion date.

The budget for 2016/17 partner contributions (not Check-off) to research projects = \$1,733,232 and the projected expenditures or deferred amounts total \$1,733,232.

D. Verified Beef Production™

In addition to sponsoring research and technology development in support of the Canadian beef industry, BCRC oversees 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 an on-farm sustainability practices verification to the food safety and beef quality aspects of the program.



VBP+ launched three additional modules supporting sustainability, specifically focused on animal care, biosecurity, and environmental stewardship, in June 2016. Since that time VBP+ has worked towards new producers being trained and registered as well as getting producers who were registered under the old program trained and registered under the new VBP+ program. The process of fully transitioning to VBP+ is not yet complete but is expected to be completed by late March 2018.

End-users are increasingly looking for means to verify production practices related to sustainability, specifically animal care and environment. 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+ has expanded its engagement with end-users

over the past year, largely through the CRSB. VBP+ has also expanded its engagement with all stakeholders along the beef value chain to ensure that the program VBP+ delivers meets the ideal balance of rigour for consumers and usability for producers.

It is recognized that VBP+ must prepare for a reduced federal/provincial funding structure once modules are fully developed in the years to come. Consequently, in 2015/16 a new business plan and strategy was developed for VBP+ that sets out a long-term sustainable funding and delivery model for VBP+. The objective of this process is to ensure the VBP+ program is appropriately structured and resourced to meet the expectations of end-users and have the capacity to train and audit a large volume of producers across all four VBP+ modules. Progress has been made toward the implementation of this business plan in 2016/17. VBP+ is now utilizing a couple of 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 grow in importance, as it begins to deliver 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 2016/17 actual program expenditure will be finalized subject to the close of the year end on June 30th. The 2016/17 Check-off and industry budget for VBP+ was \$123,584, with expenditures projected at \$123,584.

IV. BCRC administration and management

The BCRC is overseen by an operating committee of 12 members, which are appointed by the provincial producer organizations and proportionally represent provincial allocation of the National 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 national beef research 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. In 2012, a five year (2013-18) National Beef Research Strategy was developed following extensive consultation with a very broad group of value chain stakeholders - producers, researchers, government, service providers and funding agencies. The 2012 National Beef Research Strategy has been 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.

Given the benefits and results realized through the first Strategy and the need for the Canadian beef industry to remain innovative and competitive in the world market, BCRC and Agriculture and Agri-food Canada's (AAFC) national Beef Value Chain Roundtable (BVCRT) developed the next five year (2018-23) Canadian Beef Research and Technology Transfer Strategy. This Strategy is fundamental to the Beef Science Cluster III, which covers the period April 1, 2018 through to March 31, 2023. The 2012 and 2018 5-year strategies can be viewed at <http://www.beefresearch.ca/about/national-beef-research-strategy.cfm>.

To ensure the Canadian Beef Research and Technology Transfer Strategy 2018 - 2023 development process remained collaborative and highly focused to target future research priorities and funding, industry input was sought through various means including direct stakeholder consultation, an online survey, and two workshops. Researchers, funders and grassroots producers were engaged throughout the Strategy development process. The online beef research priority survey provided input from 506 industry stakeholders across the beef value chain.

A national research priority workshop was held in Calgary on June 22 and 23, 2016. Over the 1½ days, 103 participants considered the progress on research outcomes of the 2012 National Beef Research Strategy and assessed and defined where continued research is required. Attention was focused on identifying new and emerging research priorities that should be included in the Canadian Beef Research and Technology Transfer Strategy 2018 – 2023. The workshop also provided a forum to review the National Beef Research Inventory (mentioned above) to examine projects that have been funded over the last five years across all funding agencies. The BCRC and the BVCRT engaged provincial and federal government and industry funders in discussions about opportunities to improve funding coordination and delivery of research that clearly aligns with industry's established research priorities and defined research outcomes.

A national beef technology transfer workshop was held in Saskatoon on September 28, 2016. Twenty nine extension specialists from across Canada, representing provincial and national organizations, discussed beef extension priorities. The workshop resulted in increased awareness of and collaboration between extension groups, and identification of innovations that, if adoption rates increased, would have the greatest potential to advance the competitiveness and sustainability of the Canadian beef industry.

BCRC general administration and management expenses, covered by National Check-off funding, is projected at \$191,618 for 2016/17.

V. Ongoing research performance reporting and evaluation

BCRC has taken a leadership role in communicating the value of investments, including the National 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 BCRC research priorities, and tracking the economic benefit of 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 upon the completion of the current 5-year research plan through the Beef Science Cluster, which ends on March 31, 2018.

The 2014 report reveals that the largest financial improvements to industry over the past five years 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 BCRC is July 1 to June 30; therefore 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 2016/17 actual expenditures are to be finalized subject to the close of the year end on June 30th. The 2016/17 financial summary for BCRC will be available upon request after August 2017.

Projected National Check-off funding allocated to research programming in 2016/17 is outlined in various sections of this report and includes the following:

Beef Science Cluster research projects -	\$993,613
Non Cluster research projects –	\$55,340
VBP+ -	\$123,584
BCRC general program management and administration –	\$191,618
Total -	\$1,364,155