BCRC

BEEF CATTLE RESEARCH COUNCIL

2014/15 Results Report

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

operating as Canada Beef

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I. Executive Summary

The Beef Cattle Research Council (BCRC) administers the research allocation of the National check-off collected by the provinces. This report presents the results of research activities during the period April 1, 2014 to March 31, 2015.

In addition to National check-off dollars, the majority of BCRC's research and extension programming in 2014/15 was funded through the Beef Cattle Industry Science Cluster under Growing Forward 2. This is the second Science Cluster and 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. The National check-off dollars are leveraged with federal government funding under the Beef Cattle Industry Science Cluster on a 1:3 ratio (industry:government). BCRC also collaborated with other funding agencies to identify the industry's research priorities, maximize the value of research investment, and influence public sector investment in beef cattle research.

During 2014/15, 26 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
- Environment
- Technology and Knowledge Dissemination.

Section III of this report includes a list of Cluster research projects funded by National check-off dollars in 2014/15. Research findings reported are preliminary as all Cluster projects are on-going and will be completed in either 2016, 2017 or 2018. Although the research continues, several success stories can be reported for 2014/15. Under Food Safety, it was found that High Pressure Processing can extend shelf life of beef with no negative effects on meat quality, nutritional quality, or consumer sensory attributes. A generic model cleaning practice has been developed that allows beef processing facilities to greatly improve the microbiological conditions of the equipment and in turn, that of the beef product. Regarding beef quality, between 1999 and 2014, the incidence of injection site lesions dropped by 36 to 90% in two of the five sub-primals examined. Opportunities to further reduce the incidence of injection site lesions through producer education were identified.

Research in the areas of forage and grassland productivity and feed efficiency will help beef producers manage costs of production and choose appropriate forage varieties for swath-grazing that reduce the costs of maintaining the cow herd in winter. In the course of developing research protocols, it was identified how to successfully manufacture a durable high fiber / high fat pellet, providing opportunities to convert canola hulls and screenings into a value-added beef cattle supplement. A new barley variety released through a breeding program had yielded 29% more forage with 11% more starch than the control

variety. The creation of a forage industry chair, under the Science Cluster, will help ensure that Canada continues to conduct leading-edge forage research.

Specific to animal health, research validated that industry's recommendation to castrate calves as early in life as possible is appropriate from both animal production and animal welfare perspectives. Strategies to avoid or alleviate the animal health and welfare challenges associated with feed restriction and acidosis continue to be identified. The environmental impact of Canadian beef production over the 30 years between 1981 and 2011 is being documented. Early results indicate that each kg of beef produced in Canada required 22% less land and 28% fewer cattle, and produced 17% less methane, 19% less nitrous oxide, and 15% less CO_2 in 2011 than in 1981. The Green House Gas intensity per kg of beef produced has decreased by 16% during this time period.

In addition to funding research, the BCRC plays a leading role in increasing industry uptake of relevant technologies through the delivery of its technology and knowledge dissemination strategy. Visit www.beefresearch.ca to learn more about the resources available, including videos, fact sheets, webinars and decision making tools. The successful development and launch of the Beef Researcher Mentorship Program in 2014 facilitated greater engagement of up-and-coming new applied researchers with Canada's beef industry. Three selected mentees participated, and were provided the opportunity to deepen their understanding of the needs of the beef industry in a practical and meaningful way, preparing them for a productive career in applied beef and forage research, teaching and extension.

BCRC is responsible for the delivery of the Verified Beef Production (VBP) national on-farm food safety program. In 2014/15 significant focus has been placed on the development of new VBP modules for animal care, biosecurity, and environment. 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 partnership with end-users such as McDonalds. Consequently as part of the module development process, the BCRC also initiated a strategic planning process in 2014/15 focused on the development of a long-term business and funding plan.

During the period April 1, 2014 to March 31, 2015, BCRC received approximately $0.15 of every $1.00 of National check-off to fund leading-edge research to advance the competitiveness and sustainability of the Canadian beef cattle industry. The fiscal year for BCRC is July 1 to June 30, therefore BCRC audited financial statements are not included in this report. Various sections of the report highlight National check-off expenditures with the 2014/15 financial summary for BCRC available upon request after August 2015.

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 $0.15 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 (VBP) national on-farm food safety program as well as the incorporation of new VBP modules for animal care, biosecurity, and environment. 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 National Beef Strategy is available at http://www.beefresearch.ca/about/national-beef-research-strategy.cfm.

The majority of BCRC's current research and extension programming is funded through the Beef Cattle Industry Science Cluster under Growing Forward 2. This is the second Science Cluster and 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, 2014 to March 31, 2015. This period is the second 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 2014/15 Activities

Beef Science Cluster II Projects Funded by Government, Industry and National check-off and Managed by BCRC

This section provides 2014/15 research results for the projects funded under the Beef Science Cluster. Included is the project number, title and preliminary results as the projects extend to 2016, 2017 or 2018.

Forage and Grasslands Productivity:

1. *FRG.04.13 - Innovative Swath Grazing/Increasing Forage Research Capacity*

This research is intended to develop agro-economic models that will help cow-calf producers optimize winter feeding practices based on swath-grazed barley and triticale. A series of trials are underway to identify varietal differences in weathering-losses, cereal combinations that will optimize nutrient value, and evaluate fiber digestibility in existing and newly-developed varieties. A new researcher being trained through this project is developing the agro-economic models, and also participated in the BCRC's Researcher Mentorship program. This provided the researcher with an opportunity to discuss the project with cow-calf producers, explain and demonstrate the models to them, and gain valuable experience communicating and interacting with producers.

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

Plots have been established at Lethbridge, Brandon, Swift Current and Saskatoon and field data collection is on schedule. The breeding component is providing a training opportunity for a new Post-Doctoral Fellow and improved collaboration with University of Saskatchewan. A PhD student is working on the forage mixtures component and native legume testing. Native species breeding efforts are focused on blue bunch wheatgrass (Lethbridge), purple prairie clover, northern wheatgrass, side oats grama, white prairie clover, rough fescue, and Canadian milkvetch. Characterization of tannins and digestion characteristics of prairie clovers is proceeding. The genomics component is now progressing with a PhD student at the University of Saskatchewan. The cattle nutrition and grazing component is on track after its move from Brandon to Swift Current. Forage nutritional quality and soil nutrients analyses run in-house at service labs located at SPARC (Swift Current).

3. *FRG.09.13 - Nutritional Evaluation of Barley Forage Varieties for Silage and Swathgrazing*

This project is well underway. Two graduate students have been recruited for the research. Phase One was a survey of the nutritional and neutral detergent fiber digestibility characteristics of barley forage varieties commonly grown for silage in Western Canada. Three barley silage varieties that are low (Xena), intermediate (Copeland) and high (Cowboy) in neutral detergent fibre digestibility were selected. These barley varieties were then seeded and subsequently ensiled for animal performance studies at AAFC Lethbridge and the University of Saskatchewan. Ongoing studies are evaluating ensiling characteristics and lamb performance at AAFC Lethbridge, while at the Uof S the focus is on beef cattle performance and metabolic studies.

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

This research is identifying forage species mixtures that provide the best opportunity to enhance beef productivity both on pasture and with stored forages. This research is how the forage species in seed

mixtures (established under the first Beef Cluster) stabilize in the pasture over several years of grazing pressure. Additional research is investigating stand establishment and productivity of complex mixtures under differing levels of nitrogen fertilization at sites in Nova Scotia, Quebec, and Ontario. Grass cultivar choice influences forage yield in binary mixtures and also affects legume content. To date, binary mixtures with meadow fescue and tall fescue had a greater energy:protein ratio and forage yield in comparison to the average mixture. Binary mixtures of meadow fescue with any legume species provided the best combination of forage quality and forage yield. Over time the frequency of occurrence (a conservative estimate of plant density) of seeded legume showed a linear decline across all sites, and the percentage of both seeded grass and seeded legume declined. Orchardgrass-based binary mixtures showed the most stability in species composition over the 4 years.

With complex mixtures, cattle gains and back fat levels increase when trefoil is the dominant legume. Based on forage quality analysis during the first three post-seeding growing seasons (2011, 2012 and 2013), the complex grass mixture of timothy, meadow fescue, reed canary grass, and Kentucky bluegrass provided the best combination of high readily-available energy to protein ratio (0.87) and high DM yield. The first year of agronomic production data was collected, including dry matter yields, frequency of occurrence, botanical composition, and soil characteristics.

5. *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*

Research is required to identify superior strategies for extended grazing to improve animal performance under the range of soil and weather conditions observed in the prairie provinces. Following consultation with the joint Manitoba-Saskatchewan industry-led steering committee, a variety of perennial and annual forages were selected based on potential suitability for extended grazing, accessibility and cost.

The project has been initiated with the establishment of experimental small plot trials at three locations in Manitoba, namely the Parkland Crop Diversification Foundation at Roblin, the Prairies East Sustainable Agriculture Initiative at Arborg, the Ian N. Morrison Research Farm at Carman, the Western Beef Development Centre at Lanigan, SK and the University of Saskatchewan at Saskatoon, SK. This permits researchers to assess a variety of perennial and annual forages under a range of soil and climatic conditions. Annual crops chosen were oats, barley, corn, soybeans, foxtail millet, fall rye and annual rye. Perennial forages were seeded in pure stands and mixtures with five grasses, three legumes and 15 mixtures established. These included varieties of bromegrass, tall fescue, orchard grass, alfalfa and cicer milkvetch with improved characteristics for extended grazing on the prairies.

Feed Efficiency

6. *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*

Subsequent to a deep review of results, methodologies, and objectives, a more comprehensive Cereals Industry Review has been completed. Several changes have been implemented at the Field Crop Development Center, including:

a. Release of 2 varieties with superior yield and quality – approved for registration at Prairie Grain Development Committee meetings in February 2015. This is following the release of 2 other varieties in 2014 and 3 varieties in 2013, showing the productivity of the program.
b. The size of the breeding programs has been increased by carrying out a higher number of crosses and having higher number of lines in yield testing.
c. The breeding process has been accelerated during the segregating stage and during yield testing within the program (prior to the Co-op stage). Growth rooms, growth chambers and

the winter nursery at El Centro, California were increased to maximum capacity in order to optimize their use and accelerate the inbreeding process to its maximum.

d. Decreased the years of variety testing prior to entering the Coop network from 5 years to 3-4 years.
e. Targeted introductions of germplasm sources from two international centers (International Maize and Wheat Improvement Center, CIMMYT and the International Center for Agricultural Research in the Dry Areas, ICARDA) and other successful programs around the world (Minnesota, North Dakota, California, Mexico, Uruguay, Brazil, etc.) to be used as sources of favorable traits in crosses or tested for possible direct releases.
f. Continued the research supporting the breeding programs (Nitrogen Use Efficiency) and selection of lines with favorable traits included in the variety testing network and crossing block.
g. Testing of all advanced germplasm for multiple disease resistance in Brandon, Mexico, Uruguay, Ecuador, Hermiston (Washington State), Lacombe, Edmonton.
h. Testing germplasm for quality traits in wet labs as well as using near-infrared spectroscopy (NIRS)
i. The FHB nurseries at Ottawa and Charlottetown were successful and provided useful DON data for all plots. The new FHB nursery at Morden looked very promising, although lodging was a problem in 2014. Nearly 47% of the core Brandon nursery was lost to flooding and will delay progress by about a year. Lines with promising FHB resistance were evaluated and advanced, and new crosses were made as appropriate.

7. *FDE.07.13 - The impact of genomic selection for feed efficiency on the cow-calf sector, performance parameters and underlying biology*

Advances were made in the area of assessing and monitoring physiological responses to divergent selection for feed efficiency in cattle. Preliminary results indicate that mean cell hemoglobin concentrations are lower in the blood stream of more feed efficient cattle. Heart function also differs according to feed efficiency. Efficient cattle are more reactive to acute stress. Rumen pH and temperature did not differ between efficient and inefficient cattle. More feed efficient bulls had slightly lower semen motility and morphology parameters that are suggesting a delayed sexual maturity. Further work is underway to access the metabolic and sexual hormone profile of the bulls over the testing period.

8. *FDE.09.13 - Increased Use of High Energy Forages in Conventional Feedlot Beef Production*

Higher forage diets could become more appealing to the cattle feeding sector if the reduced feed conversion efficiency associated with forage-based diets can be offset by a lower cost of gain. Starch-containing forages such as corn and cereal silages could play a greater role in beef cattle production, if the energy content of such forges can be enhanced. High digestibility in these forages is dependent on maximum kernel development and low plant lignification at harvest. These are both affected by maturity and hybrid selection. Short season corn hybrids are available that fit within Prairie maturity zones, but kernel maturity before frost occurrence is an issue.

Corn silage hybrids varying in degree days to maturity were grown in 5 locations: Lethbridge, Vauxhall, Lacombe, Elk River (MB), and Ottawa (ON) in 2013 and 2014. Six hybrids were grown at each location in four replicates, and the material was harvested before and after frost. Whole plant, ear and stover material was dried and ground, and numerous chemical and biological analyses were conducted to determine nutritive quality for ruminants. Samples were also evaluated using near infrared spectroscopy. Corn silage was prepared and cattle were purchased in fall 2014 and the backgrounding period has been initiated. Cattle (160) head were allocated to 16 pens. Sixteen head were ruminally cannulated to provide information on rumen fermentation and acidosis. The cattle are being offered one of four diets (dry matter basis): 60% barley silage, 60%, 75% or 90% corn silage.

Half the cattle will be backgrounded until they weigh 370 kg, the other half will be backgrounded to 430 kg to examine the potential of extending the backgrounding phase.

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

Researchers successfully generated oligosaccharides (i.e. prebiotics) from yeast mannan (MOS) and pectin (POS), using GH76 and GH28 respectively. These preparations are reproducible and scalable and will be used in culture and artificial communities as prebiotics in Years 3 and 4. In addition, researchers developed an efficient labelling protocol, which covalently adds a fluorophore to the reducing end of carbohydrates. This is a major step towards developing probes for analysis of bacteria interactions within batch culture (*in vitro*), and animals (*in vivo*). Researchers are well-positioned for scale-up and progress into model systems in Year 3 (2015/16). To support this upcoming research, a Visiting Fellow has been recruited to the program.

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

Four groups of animals (Kinsella Composite (KC) Efficient and Control, Angus (AN) and Charolais (CH) are being managed and divergently selected in this study. 654 animals were tested for feed efficiency last year. RFI calculations, compilation of phenotype and genotype data, and genomic breeding value predictions are on track. Steers are being sorted into quality groups based on predicted DNA marker breeding values. The first 108 project animals went for slaughter in 2014. These consisted of 62 select animals and 46 controls. While the numbers were low, the results were encouraging, with the select animals averaging nearly 4% more AAA carcasses and 11% more Y1 grade. The within-category for animals selected for quality was numerically even better (+8%).

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

Historically, cattle feeding management practices have not considered how the type of energy substrate influences cattle productivity at different stages of production. This research is demonstrating that the type of energy source provided and the timing for when the specific energy sources are provided influences (positively or negatively, depending on the timing and duration) feed efficiency and carcass characteristics for finishing steers. This has provided initial proof of concept for new practices that can be used to improve carcass yield and minimize the negative impact of using low-cost feed products (such as high lipid pellets) on feed efficiency.

Animal Health and Production Limiting Diseases

12. *ANH.01.13 - Identifying Mycobacterium avium subsp. parathberculosis (MAP) exproteome components recognized early during infection to develop diagnostic and vaccine targets*

A significant knowledge gap related to effective control of Johne's disease (JD) is the lack of diagnostic tests for reliable detection of infected animals in the early and subclinical stage disease. Current JD tests and test kits require greater assay sensitivity, and need to identify infected animals sooner. Progress can only be made through identifying MAP components that elicit pathogen-specific immune responses. The goal of this research is to identify MAP biomarkers that can be used to detect with greater sensitivity and specificity animals with early stage Johne's disease.

Using proteomic tools, recombinant DNA technology, and immunodetection methods a panel of >20 MAP soluble antigens to which antibodies were detected in cattle with subclinical-stage disease were identified. No response was detected in cattle from herds with a history of JD-negative tests. Moreover, using 14 of the identified proteins, research showed a strong MAP-specific antibody response at intestinal mucosal infection sites 1-2 months post-infection of neonatal calves with live

MAP bacteria. Response to the proteins varied among individual animal. To our knowledge the study shows for the first time antibody production at local tissue sites precedes serum IgG responses, and supports the notion that JD diagnostic assays must use multiple MAP-specific epitopes to detect all infected animals and animals at different stages of disease.

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

The Rocky Mountain wood tick (*Dermacentor andersoni*) and the American dog tick (*Dermacentor variabilis*) affect the health of livestock through the transmission of pathogens, such as Anaplasma marginale, which causes bovine anaplasmosis. The wood tick also causes paralysis in livestock. Despite the importance of both species of tick to animal health, the abundance of tick varies, and how tick populations differ genetically throughout their distributions is unknown. These are key factors that determine the risk of tick exposure and the potential for pathogen transmission. The purpose of this study is to acquire information on the distribution, abundance, and genetic diversity of *D. andersoni* and *D. variabilis* in western Canada.

Researchers sampled for ticks at 153 sites throughout western Canada from April to July, 2014. *D. andersoni* was collected at 17 sites (BC, AB & SK), D. variabilis was collected from 84 sites (SK & MB), and both species were found together at 4 sites (SK). In general, the greatest density of dog ticks was 6.9 times greater than the greatest density of wood ticks. Both tick species were collected from 4 sites in southwestern SK. This distributional overlap is a result of the westward migration of the dog tick over the last few decades. The distribution of *D. variabilis* has also expanded to the north in Saskatchewan and Manitoba, where it was collected at least 200 km north of the historical geographic limits. The geographic range of *D. andersoni* in Alberta appears to be consistent with reports from the 1940s, but has likely expanded at the northeastern limits by more than 100 km in Saskatchewan.

The second major objective of this project was to estimate the genetic diversity within and among tick populations throughout western Canada. This can be useful as an indicator of variation in biological and behavioural characteristics that affect the ability of ticks to transmit pathogens. Researchers compared the DNA sequences of a single gene for 236 adult *D. andersoni*. There were 12 different genetic types in 17 different populations from BC, AB and SK. Six of these types are newly described and provide a better description of the variation for the wood tick.

14. ANH.13.13 - Development of a fully-automated DNA microarray chip for multiplex detection of bovine pathogens

Current diagnostic tests for bovine respiratory diseases (BRD) and bovine enteric diseases (BED) are primarily single pathogen tests. The main objective of this project is to develop two fully-automated DNA microarray-chips for multiplex detection of BRD and BED pathogens. Based on the sequence database generated, four panels of PCR primers (i.e. enteric viral, enteric non-viral, respiratory viral, and respiratory bacterial) were designed using a commercially available multiplex PCR design software. Specificity of each set of primers was confirmed by comparing the primer sequences to publicly available sequence databases. The specificity of the primers was confirmed by singleplex PCR using the targeted pathogens, relevant non-target pathogens and clinical samples (nasal swabs, fecal samples etc.) collected from healthy animals. The single-plex assays were combined into multiplex PCR assays: BRD viral, BRD bacterial, BED viral, and BED non-viral multiplex assays. The BRD viral assay was able to amplify the targeted gene segments from all five bovine respiratory viruses. The BRD bacterial assay simultaneously amplified gene segments from the four BRD-associated bacterial pathogens. Similarly, BED viral assay successfully amplified genes from four enteric viral pathogens, and the BED non-viral assay specifically amplified genes from four bacterial and three protozoan species.

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

Researchers determined the optimal age and method of castration by comparing how surgical (SU) and band (BA) castration affected physiological and behavioural welfare indicators in calves less than 1 week of age, 2 months and 4 months of age. Physiological and behavioural parameters were collected before, during and after castration in order to assess pain and distress. Overall, no physiological or behavioural parameters differed significantly for calves castrated at 1 wk of age. Conversely, both physiological and behavioural indicators of pain/distress were clearly observed when calves were castrated at 2 and 4 mo of age regardless of the castration method used. At 2 mo. of age SU calves stood and walked more and lie down less (assessed from 2-4 hours post-castration) than BA and Control (CT) calves; behaviours indicative of pain or discomfort. At 4 mo of age, SU calves tail-flicked more (assessed from 2-4 hours post-castration) and had shorter stride length (immediately post-castration) than BA and CT calves.

Band castrated calves experienced chronic pain as evidenced by prolonged lesion healing; however, this chronic pain was not enough to reduce performance. Overall, band castration resulted in more chronic indicators of pain than surgical and sham methods, especially as calves got older. Based on the results of this trial it was concluded that the most welfare friendly age and method of castration is band castration at 1 wk of age.

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

Cow-calf producers from across Manitoba, Saskatchewan and Alberta are participating in a surveillance network study. They are completing two to three detailed surveys per year on a variety of management topics of importance in the cow-calf industry. To date, 4 surveys have been distributed. The first two of these surveys have been returned and data has been entered and coded into a computer database. Preliminary analysis has begun and manuscripts on these surveys will be submitted for publication in the near future.

a. Herd demographics, annual production survey
b. Survey on antibiotic use and attitudes about antimicrobial resistance
c. Surveys 3 and 4 are still being returned and entered into the computer database.
d. Winter feeding, mineral and vitamin management survey
e. Annual production survey
f. Two additional surveys are in the preparation phase and have been developed or are in the process of being created.
g. Survey on marketing practices and economic issues: In collaboration with Eric Micheels (Agricultural Economics) and Kathy Larson (Western Beef Development Centre)
h. Survey on animal welfare practices: In collaboration with Dr. Claire Windeyer (UCVM)
i. Biological samples have been collected from participating herds during the fall of 2014. Preliminary results show that the majority of cows had adequate measured levels of Vitamin A and Vitamin E (97.7 % and 89.9% respectively). In approximately half of the herds all cows sampled had adequate Se levels. In adequate levels of Cu, Mn and Mo were fairly common. Many herds had less than half of the sampled cows with adequate Cu, Mn and Mb (51%, 27% and 60% of the herds respectively). When analysis is completed on all herds, these results will be examined in relationship to winter feeding and mineral feeding practices as well as geographic differences. Samples are also being collected from breeding bulls on participating herds to determine infection rates of *Tritrichomonas fetus* and *Campylobacter fetus* subspecies *veneralis*, two important venereal diseases of cattle.

17. *ANH.33.13 - Improving the barrier function of the gut: an approach to minimize production limiting disease*

The gut has to absorb nutrients while blocking pathogens. A study was conducted to evaluate whether low feed intake and rumen acidosis affect gastrointestinal barrier function. Low feed intake was used as it represents conditions that calves experience associated with weaning, transportation, marketing, and upon arrival at a feedlot, and for beef cows near parturition. Ruminal acidosis was chosen, as it is the most common digestive disorder affecting feedlot cattle and likely affects grazing beef cattle to a greater extent than predicted.
Calves exposed to low feed intake (75% less than normal *ad libitum* intake) and lost weight and body fat. Acidosis was induced in other calves (ruminal pH below 5.5 for 610 min/d during the induction compared to 11 min/d during baseline). Rumen papillae surface area decreased in calves exposed to low feed intake but not when acidosis was induced. Differences in permeability were only detected for the omasum and distal colon. Mannitol flux across the omasum was greater in steers exposed to rumen acidosis than those exposed to low feed intake. Control steers had intermediate pH. Both rumen acidosis and low feed intake decreased flux of mannitol across the distal colon.
These data indicate that the omasum may be a particularly sensitive region for barrier dysfunction. The type of challenge affects the response. Both low feed intake and rumen acidosis resulted in a less permeable tissue relative to the control.

Food Safety

18. FOS.01.13 - Prevalence, Persistence and Control of Non-O157 Shiga Toxin Producing Escherichia coli
Researchers made seven sampling visits to slaughter houses and screened over 2,000 isolates to evaluate the prevalence of the Top 6 STECs. Despite the high apparent prevalence of the Top 6 STEC associated with beef as determined using rapid molecular based screening techniques, no isolates could be recovered from the samples. From the isolates screened, 74 were found to harbor the set of three virulence genes and produce shiga toxin. However, in the course of sub-culturing only two (O76 and O187:H52) were identified as belonging to the enterohemorrhagic *E. coli* (EHEC) group, neither of which have been previously implicated in foodborne illness outbreaks. The remaining 72 isolates readily lost toxin producing ability upon sub-culturing, suggesting the involvement of mobile genetic elements. From the results of screening hides, carcasses, pens, floors and ground beef it can be concluded the Top 6 STEC serotypes, like that of O157:H7, are rarely encountered in beef processing.
Introducing the US regulation that categorized the Top 6 non-O157 STEC as adulterants was controversial given that no previous foodborne illness outbreaks had been conclusively attributed to the group. Consequently, the results of this research have provided risk assessment data to support the view that the incidence of Top 6 non-O157 STEC associated with cattle has been vastly over-estimated and the true prevalence is equal to or lower than the more widely studied O157:H7 serogroup. This is a significant finding which would support industry view that screening for the Top 6 has limited value with respect to enhancing the microbiological safety of beef.

19. FOS.04.13 - Identification and validation of commercially practicable practices and procedures for improving the microbiological safety stability of beef
Dry chilling: is commonly used in small beef abattoirs in many countries and can improve the microbiological safety of carcasses. However, information on the rate and extent of inactivation of bacteria on carcasses during commercial dry chilling is largely lacking. This study determined how dry chilling affected the microflora of beef carcasses at a Canadian beef packing plant. Carcasses are held in the chiller for 3 days before fabrication. Carcasses selected at random at the beginning of chilling, and after 1, 2, 4, 6, 8, 24 and 67 h in the chiller were sampled for total aerobes, coliforms and *Escherichia coli*. The numbers of aerobes were reduced by 90% after the first hour of cooling, and by a further 90% during the subsequent 23 hour of chilling. Very few coliforms or *E. coli* were recovered after 24 h and none were recovered after 67 h. Thus, the chilling process at the packing plant

involved in the study was very effective for improving the microbiological safety and quality of beef carcasses.

Control over the microbiological contamination of beef in Canada: has improved greatly in recent years. Some plants can produce carcasses carrying very few generic *E. coli* (< 1 CFU/10,000 cm^2). Even so, loss of control still happens. A number of studies have demonstrated that the equipment used in the breaking facility is the main source of *E. coli* on beef and trimmings. A study was conducted to assess the current cleaning practice at the fabrication facility of a federally inspected beef plant. Samples were collected after work (before cleaning) and the next morning (before work), from meat contacting surfaces and non-contacting surfaces of the two conveyor belts at the fabrication facility. Three groups of organisms (total aerobes, coliforms, and lactic acid bacteria) were enumerated. No difference was observed between the numbers of any of the three groups of organisms before and after cleaning. Also, the numbers of some groups on meat non-contacting surfaces were higher than those on meat contacting surfaces. The lack of bacterial reduction could result from several factors: 1) insufficient removal of meat debris from the surfaces of equipment, which in turn could lead to bacterial growth; 2) diluting of the sanitizer; 3) aerosols generated by washing the floor with high pressure water after foaming or sanitation of the belts. A trial of modified cleaning procedures was conducted to determine whether the cleaning could be improved. Removal of meat debris by manual scrubbing, drying of the equipment and control of aerosols generated by high pressure wash produced significant reductions in all three groups of organisms.

The storage life of Canadian vacuum packaged beef: 120-180 days is attainable for Canadian products and may be correlated with the strains of Carnobacteria present on the meat. Studies are on-going to gain insight into whether decontaminating interventions at large packing plants affect the microflora on carcasses. The work has been extended to determine the microflora on beef carcasses at a smaller beef packing plant that does not use any decontaminating treatments. Samples have been collected and total aerobes, Enterobacteriaceae and lactic acid bacteria have been recovered. DNA was extracted from selected colonies of each group of organisms. Work is underway to determine the identities of those isolates by 16S rRNA gene sequencing.

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

The objectives of this research are to determine how antimicrobial use (AMU) in beef cattle potentially contributes to antimicrobial resistance (AMR). AMU records are being collected from four Alberta feedlots designated for fecal and associated environmental sample collection. *E. coli* and enterococci are being isolated from bovine feces, manure drainage/catchment basins at feedlots, downstream surface water and retail beef, and compared to isolates obtained from human clinical samples.

Sampling has commenced for fecal composite, catch basin, surface water, carcass and meat, and collection of clinical isolates. Additional samples have been added, including waste-water treatment, stockpiled manure and soil samples. Resources are being allocated accordingly to process samples for microbial isolations, metagenomic sequencing, antimicrobial residue and hormone analyses and water chemistry. Simultaneously, feedlot data is being compiled and linked with antimicrobial use. 612 samples originating from four cattle feedlot pens enrolled in this project and their associated environments (catchment basins, wetlands) have been collected. From the collected samples fecal indicator bacteria E. coli (n = 3,816) and enterococci (n = 4,329) have been isolated and stored for further analyses along with their metadata.

To determine a deep understanding of the bovine fecal microbial community and to examine the presence and nature of AMR genes and mobile genetic elements, groundwork has commenced on extracting and sequencing fecal composite samples for metagenomic analyses. Currently, a next generation sequencing based pilot study is underway to optimize sequence coverage parameters so that a maximum sequencing depth can be achieved to detect organisms and AMR genes that exist in

very low abundance within complex environmental populations. For this purpose a small set of 8 fecal metagenomic DNA samples originating from the aforementioned four Alberta feedlots have been sequenced using Illumina HiSeq. This endeavour has generated a large sequence data set consisting of 228 billion bases resulting into 1.14 billion paired-end reads. The resulting sequence data will be analyzed to understand the microbial community and for mining AMR genes and their prevalence with a goal of improving future metagenomic sequencing strategies for obtaining maximum information.
All of the samples and isolates resulting from this project have been stored at conditions to maximize their shelf life. Together with historical samples, this collection of samples and pure cultures will not only be useful for the current project but will also provide a valuable resource for establishing future projects and collaborations. These cultures have already identified ways in which antimicrobial use practices in cattle can help to reduce the proportion of antibiotic resistant bacteria entering the food chain. Similarly, these sample collections have revealed that transitioning cattle to a grain based diet appears to favor a bacterial species (*E. hirae*) that does not commonly infect humans.

21. BQU.01.13 - Effect of high pressure processing on quality, sensory attributes and microbial stability of marinated beef stead during refrigerated storage

This research is evaluating whether high pressure processing (HPP) can extend the shelf life of beef steaks without adversely affecting consumer satisfaction or nutrient content. As the pressure applied to the teriyaki and honey garlic marinated beef steaks increases, steaks get lighter in colour. Marination can partially mask the change in steak colour. The pressure used in this experiment (400 MPa/3min, 450 MPa/3min and 450 MPa/3min repeated three times) did not affect the water binding capacity or the instrumental tenderness of the marinated beef steaks.
Based on consumer sensory evaluation, HPP treated teriyaki steaks had lower scores on overall, appearance, flavor, tenderness, juiciness and aftertaste acceptability than the control (marinated but not HPP) samples, but higher scores than the fresh (no margination or HPP) steaks. There were no differences on sensory acceptability scores between 450 MPa/3mins treated samples stored 31 days and 61 days. There were no differences in sensory scores among the 3 HPP treated samples. Interestingly, consumers liked the colour of packaged raw beef steak treated with 400 MPa/3mins stored for 31 days and 450 MPa/3mins stored for 61 days more than control and fresh steaks. As expected, HPP at 450 MPa/3 minutes and up to 3 cycles did not have a negative impact on product nutrients. High pressure treatment achieves a 4 log (99.99%) reduction of pressure-resistant bacteria in beef. Marination or individual ingredients of the marinade mix do not significantly affect the efficacy of pressure treatment.

22. BQU.03.13 - Genetics and Proteomics of dark cutting cattle in Alberta

This study is testing whether live animal or carcass characteristics can predict identify cattle that are predisposed to dark cutting. Production and phenotype data from an existing data set of heifers (n = 467) on study at three different farms were used. Carcasses in the data set graded Canada A (n = 14), AA (n = 296), AAA (n = 196) and B4 (dark cutting; n = 21). Generalized logit modeling with the CATMOD procedure, analysis of variance and logistic regression were used to establish phenotypic relationships with carcass grades and farm of origin. Farm of origin affected the incidence of dark cutting, was confounded with breed and was related to differences in cattle weight. Finishing heavy heifers for a short time appeared to increase the likelihood of dark cutting. Heifers at risk of dark cutting had reduced weaning weight, live weight and carcass weight. The probability of dark cutting declined with increased growth rate and at slaughter weight greater than 550kg.
Sampling of 64 rib sections from normal (Canada AA, n = 24), atypical dark cutting (ribeye pH < 5.9, n = 20) and typical dark cutting (ribeye pH > 5.9, n = 20) carcasses substantiated results from Holdstock et al. (2014). The tenderness of Canada B4 product improved with post-mortem refrigerated storage. Atypical dark cutting cattle have slightly more glucidic potential than typical dark cutting cattle, but insufficient glycogen to produce normal coloured beef. Proteomic analyses results

scheduled for 2015-2016 are anticipated to provide additional perspective on the proteins affecting the rate and extent of post-mortem glycolysis. Genomic testing of the 64 rib sections collected from an Alberta abattoir revealed four candidate regions with single nucleotide polymorphism differences, which will be further investigated in the coming final year of the project.

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

Connective tissue, specifically collagen, defines the use of beef muscles. Low connective tissue muscles are considered to be of high value as they are tender when cooked quickly. The heritability of connective tissue toughness (h^2 = 0.10) is similar to that of Warner-Bratzler shear force (h^2 = 0.11) and increases with connective tissue content (eye of round, h^2 = 0.16) (Bouton and Harris 1972; Robinson et al. 2001). Major muscles of the strip loin (longissimus lumborum), top sirloin (gluteus medius), inside round (semimembranosus) and cross-rib (triceps brachii) were collected from 72 steers from the Livestock Gentec breeding herds at the University of Alberta Kinsella ranch. Twenty-four (24) steers each from the Kinsella composite, purebred Angus and purebred Charolais herds were slaughtered at the Agriculture and Agri-Food Canada Meat Research Laboratory abattoir as they reach a back fat of 8 to 10 mm. Full carcass information was collected on each steer (hot/cold carcass weights, yield, quality, grade fat, muscle score, cutability estimate, ribeye area, and marbling score). DNA was collected from each muscle and frozen. Longissimus lumborum, gluteus medius, semimembranosus and triceps brachii were removed from one or both sides depending upon muscle size and assessed for intramuscular pH, fat, protein, moisture, colour, drip loss, cooking loss, Warner-Bratzler shear force, collagen content and collagen heat solubility. Differences in tenderness identified through phenotypic observations will be related to genotype in the third year of the study.

24. BQU.07.13 - Beef Quality Audit

Over the past 20 years significant efforts have been made by the Canadian cattle industry to reduce lesions resulting from injections of vaccines or medication. The prevalence, severity and economic losses due to injection site lesions can be reduced by ensuring proper injection technique, location and adequate hygiene. The prevalence of injection site lesions in the interior of blade, top butt, inside round, outside round, and eye of round subprimals in Canada was previously assessed in 1998. As a more current benchmark was required to gauge progress, a study using similar methodology was conducted in the spring and fall of 2014. The prevalence of injection site lesions was estimated to be 2% for top butt, 14% for blade, 3.3% for eye of round, 7.4% for inside round and 8.3% for outside round. Preliminary estimates suggest that the cost of injection site lesions in Canadian fed cattle likely exceeded $30 million in 2014. This figure is based on the use of the calculation methodologies employed in the 1996-98 studies for benchmarking purposes, with preliminary adjustments for beef pricing. Given injection lesions are largely preventable, recouping some of this lost revenue is certainly achievable and could be significant. To put the dollar value into some context, losses due to internal injection site lesions are similar to the total annual investment by the Canadian beef industry in research and promotion at the national level.

Environment

25. ENV.02.13 - Environmental Footprint of the Canadian Beef Industry

Canada produces approximately 2% of the world's beef and is the world's 5th largest beef exporter, producing 1.4 million tonnes in 2013. Beef production is also an important component of the Canadian economy contributing an estimated $33 billion worth of sales of goods and services either directly or indirectly to the economy. Traditionally, economic performance has been the primary driver of the beef industry and the subject of considerable research. More recently, however, the environmental impact of agricultural commodities, including beef, has also become increasingly important and attracted public interest and debate. The 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 objective of this project is to document the environmental impact of Canadian beef production over the 30 years between 1981 and 2011. Early results indicate that each kg of beef produced in Canada required 22% less land and 28% fewer cattle, and produced 17% less methane, 19% less nitrous oxide, and 15% less CO_2 in 2011 than in 1981. The Green House Gas intensity per kg of beef produced has decreased by 16% during this time period.

Technology and Knowledge Dissemination

26. *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 beef 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 over the past two decades. This has resulted in significant shortfalls in industry adoption of new knowledge and technology.
The purpose of this project is 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 is extension of results from research projects completed under the first Beef Cattle Industry Science Cluster.
This project includes 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 www.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 www.beefresearch.ca. Engagement of researchers with industry was improved with the development of the Beef Researcher Mentorship pilot program and by supporting the participation of a young researcher in the Cattlemen's Young Leaders Development Program. An economic analysis project completed by Canfax Research Services will continually help to inform BCRC's approach to technology transfer.
While it is difficult to measure or qualify the adoption of innovative knowledge, especially in the short term, 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.

Summary of Beef Science Cluster research projects – 2014-15

Project #	Project description	2014/15 budget	2014/15 actual	2013/14 to 2017/18 5-yr budget
	Forage and Grassland Productivity			
FRG.04.13	Innovative Swath Grazing/Increasing Forage Research Capacity	161,271	161,271	798,084
FRG.08.13	Development of native plant material (grasses, legumes)	316,885	307,238	2,310,118

	and mixtures for forage production in the Prairie Region			
FRG.09.13	Nutritional Evaluation of Barley Forage Varieties for Silage and Swathgrazing	106,433	106,433	212,233
FRG.13.13	Pasture mixtures and forage legumes for the long-term sustainability of beef production	208,668	196,871	623,990
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	206,908	162,225	948,512
	Feed Efficiency			
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	1,400,000
FDE.07.13	The impact of genomic selection for feed efficiency on the cow-calf sector, performance parameters and underlying biology	176,295	176,295	552,874
FDE.09.13	Increased Use of High Energy Forages in Conventional Feedlot Beef Production	126,592	120,842	444,091
FDE.15.13	Prebiotic, probiotic, and synbiotic technologies for targeted applications in food safety and ruminant productivity	58,075	58,075	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	48,461	45,957	461,771
FDE.19.13	Understanding the physiology behind changes in feed efficiency throughout the finishing period	142,404	142,404	657,135
	Animal Health and Production Limiting Diseases			
ANH.01.13	Identifying Mycobacterium avium subsp. parathberculosis (MAP) exproteome components recognized early during infection to develop diagnostic and vaccine targets	77,625	77,625	190,325
ANH.12.13	Geographic variation in abundance and genetics of Dermacentor andersoni, a vector of bovine anaplasmosis	185,800	185,800	570,650
ANH.13.13	Development of a fully-automated DNA microarray chip for multiplex detection of bovine pathogens	108,339	108,227	289,501
ANH.21.13	Effect of age and handling on pain assessment and mitigation of common painful routine management procedures	91,924	78,212	1,364,760

ANH.23.13	Implementation of a longitudinal disease surveillance network for cow-calf operations in Western Canada	387,090	386,885	1,067,405
ANH.33.13	Improving the barrier function of the gut: an approach to minimize production limiting disease	124,901	124,901	385,708
	Food Safety			
FOS.01.13	Prevalence, Persistence and Control of Non-O157 Shiga Toxin Producing Escherichia coli	24,150	24,150	48,300
FOS.04.13	Identification and validation of commercially practicable practices and procedures for improving the microbiological safety stability of beef	172,428	172,428	460,538
FOS.10.13	Surveillance of E. coli, enterococci, antimicrobial resistance (AMR) and Enterococcus species distribution in beef operations-associated environments	241,385	241,320	1,809,625
BQU.01.13	Effect of high pressure processing on quality, sensory attributes and microbial stability of marinated beef stead during refrigerated storage	11,500	11,500	34,500
BQU.03.13	Genetics and Proteomics of dark cutting cattle in Alberta	92,012	92,012	245,794
BQU.06.13	Genetics of the eating quality of high connective tissue beef	70,610	70,610	175,088
BQU.07.13	Beef Quality Audit	40,000	39,639	762,085
	Environment			
ENV.02.13	Environmental Footprint of the Canadian Beef Industry	63,250	62,890	310,788
	Technology and Knowledge Dissemination			
TEC.01.13	Improving Technology Transfer and Knowledge Dissemination in the Canadian Beef Industry	196,450	168,739	931,662

The 2014/15 total BCRC and AAFC budget for Cluster II projects was $3,739,455, with actual expenditures of $3,622,549.

2014/15 budget directed to AAFC researchers and managed by BCRC = $1,327,540, with actual expenditures of $1,327,540.

2014/15 budget directed to non-AAFC researchers and managed by BCRC = $2,411,915, with actual expenditures of $2,295,008.

2014/15 industry funding to Cluster II projects was projected at $1,277,275, with actual expenditures of $1,156,423.

Unspent industry funding of $120,852 in 2014/15 will be deferred to subsequent cluster years (2015/16, 2016/17, 2017/18) and allocated to cluster projects where appropriate for use by researchers to continue and/or add upon cluster research.

Projects Funded by National check-off and Industry and Managed by BCRC

In addition to projects funded under the Beef Science Cluster, BCRC also managed and funded projects outside of the Beef Science Cluster based on identification of specific needs and opportunities. The non-Cluster projects funded through National check-off revenues in 2014/15 are highlighted below.

- *ANH.05.11- Determining the incidence, prevalence, and severity of ruminal acidosis in feedlot cattle*
- *ANH.10.11- Effect of transport conditions on indicators of animal welfare for fat cattle and market cows in Canada*
- *BQU.01.11 -Measuring the Canadian Beef Advantage: Development and validation of a new platform technology for non-invasive carcass fat and lean predictions in beef cattle*
- *MISC.03.12 - Enhancing Barley Straw Digestibility*
- *Canadian Global Food Animal Residue Avoidance Database*
- *Development of TB Diagnostic Tests and Genetic Variances of M.Bovis*
- *National Beef Research Inventory*

  BCRC has accepted the responsibility for the development and implementation of a national beef research inventory system to track research funding on an ongoing basis. The inventory database system has been operational with participating funders for a few years and is tracking information in two key areas. Firstly, participating funders are providing information about the proposals they are receiving and whether they are being funded. This helps track the interest and expertise of researchers, and provides funders with industry's views on the relevance of the research, whether similar work is already ongoing somewhere else, or potential collaborators. The second area tracked is projects that are funded. By comparing the research objectives of each proposal with the target research outcomes in the National Beef Research Strategy, an assessment can be made on how research funding is aligned with the Strategy, which outcomes are being addressed, which research areas are potentially being over funded and which outcomes are not being addressed at all.

  In 2014/15 the inventory system was automated and made web-based to significantly reduce the amount of BCRC staff time required to input funder information and analyze results. The automation allows funders to directly use the system for uploading their information, customizing the outputs they receive, and analyzing results. This is expected to increase funder buy-in and increase the number of projects and funders represented in the database.

- *Beef Research Capacity – Development of a New Research Chair Position*

  With recognition of a significant gap in research capacity in the areas of forage breeding, agronomy, and utilization the BCRC has allocated funding ($500,000 total including $400,000 budgeted in 14/15) to establish a new forage management and utilization chair at the University of Saskatchewan. In collaboration with the University and the Saskatchewan Forage Network, efforts are being made to establish an endowed chair, which requires a total investment of $5 million but ensures a chair position is maintained over the long-term. The BCRC has obtained a commitment in principal by Saskatchewan Cattlemen's Association proposing to match the BCRC's commitment. Discussions are also underway with the Dairy Farmers of Canada and the Saskatchewan Ministry of Agriculture who are both supportive of the initiative and are looking at options to provide funding. Efforts are also underway to engage private investments into the initiative. It is the goal of the BCRC to have a funding plan finalized in 2015/16 such that a chair can be hired to begin their research program shortly thereafter.

Project description	2014/15 budget	2014/15 projected*
ANH.05.11- Determining the incidence, prevalence, and severity of ruminal acidosis in feedlot cattle	34,700	28,456
ANH.10.11- Effect of transport conditions on indicators of animal welfare for fat cattle and market cows in Canada	4,905	4,905
BQU.01.11 -Measuring the Canadian Beef Advantage: Development and validation of a new platform technology for non-invasive carcass fat and lean predictions in beef cattle	108,738	108,378
MISC.03.12 - Enhancing Barley Straw Digestibility	40,000	40,000
Canadian Global Food Animal Residue Avoidance Database	7,500	3,000
Development of TB Diagnostic Tests and Genetic Variances of M.Bovis	32,308	32,308
National Beef Research Inventory	0	25,000
Development of a New Research Chair Position	400,000	0

* These projects are aligned with the BCRC fiscal year, July 1 to June 30. Consequently the 2014/15 actual expenditures are to be finalized subject to the close of the year end on June 30th. The 2014/15 check-off and industry budget to non-Cluster projects was $628,151, including $400,000 placed in reserve for the Research Chair position.

Projects funded by Industry and Managed by BCRC

BCRC manages several projects funded by industry partners and other funding organizations. National check-off dollars are not allocated to these projects therefore research results are not included in this report.

Verified Beef Production™

In addition to sponsoring research and technology development in support of the Canadian beef industry, BCRC oversees the Verified Beef Production™ (VBP). The VBP program grew from its roots in the Quality Starts Here✓® (QSH) program, an educational initiative started by the Canadian Cattlemen's Association (CCA) to help the beef industry move toward the highest beef quality in the world. The VBP program further supports the industry's vision to have high quality Canadian beef products recognized as the most outstanding by Canadian and world customers. Bringing it under the auspices of the BCRC provides a practical means for efficient administration and access to development and implementation resources for the program. It also provides an appropriate forum for policy development to then be taken forward to the CCA Board.

The **VBP** is Canada's on-farm food safety program that identifies practical, industry-sanctioned practices to enhance confidence in Canadian beef. Efforts are underway to add auditable modules for animal care, biosecurity and environmental stewardship. A risk-based approach with stakeholders has identified priority areas which will be tested at the farm and feedlot level. Credibility and practicality are utmost in mind, and short outcome-based chapters will be added to the VBP Producer Manual. Producers care about what they do, and continue to show leadership in actively demonstrating their role in responsible production. VBP provides an opportunity to do so, through training, simple record keeping and the optional on-farm validation audit.

Progress has been steady, with nearly 19,000 beef cattle operations trained and representing 70-72% of Canadian cattle production using a weighted average. The number of Registered (audited) operations is reaching 1,100 with about 20-23% of Canadian beef cattle production. Over 3,000 producers have participated in the online training which is an additional option, geared for long-distance learning. Several webinars, tele-workshops and video conference workshops were also held as another option to reaching the 68,000 beef operations in Canada.

VBP looks forward to adapting the additional modules as they become ready, and streamlining it with the efforts of the McDonald's beef sustainability pilot and principles developed by the Canadian Roundtable for Sustainable Beef. Existing VBP materials are available at www.verifiedbeef.org with regionally adapted programming at provincial websites listed under "VBP across Canada". Look for a revised website once additional modules are available.

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 partnership with end-users such as McDonalds. Consequently as part of the module development process, the BCRC also initiated in 2014/15 a strategic planning process focused on the development of a long-term business and funding plan. 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.

The VBP project budget is aligned with the BCRC fiscal year, July 1 to June 30. Consequently the 2014/15 actual program expenditure will be finalized subject to the close of the year end on June 30th. The 2014/15 check-off and industry budget for VBP Plus was $128,048, with actual expenditures projected at $128,048.

IV. 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 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.

In 2012, BCRC committed to completing a series of Priority Area Reviews. These take an in depth look at the different areas of research within each priority area and assesses progress, availability of research and technology transfer resources domestically and internationally, identifies gaps and emerging issues that need to be addressed moving forward. These reports will inform the next round of priority setting sessions by providing more in-depth background for the participants. The first review was completed in October 2013 by Dr. John Cranfield on "The Value of Research in Beef Quality & Food Safety". The Forage & Grassland Productivity Priority Area Review was completed in 2014/15.

V. Financial Note

The fiscal year for BCRC is July 1 to June 30, therefore BCRC audited financial statements are not included in this report. The 2014/15 financial summary for BCRC will be available upon request after August 2015. National check-off funding allocated to research programs is outlined in various sections of this report.