
# BCRC (2009-2013)
# Results Report

January 2014

180, 6815 8th St. NE
Calgary, Alberta T2E 7H7
Phone: 403.275.8558

## CONTENTS

## CHAIRMAN'S MESSAGE

Tim Oleksyn
BCRC Chair

The Beef Cattle Research Council (BCRC) has a responsibility to report back to stakeholders (both industry and government) on how National Check-off dollars are invested in research and how they are contributing to advancements in the beef industry. It is important to measure progress in research to evaluate how to be most effective with limited dollars. The Council is proud to present this inaugural results report summarizing funding activities over the last five years.

Research has multiple applications including: improving productivity; supporting the Canadian Beef Advantage; providing data to inform policy, regulations and trade disputes; and educating the public on how beef is produced in Canada.

The development and publication of the National Beef Research Strategy in 2012 has allowed the BCRC to ensure that all areas of research critical to the long term success of the beef industry receive appropriate funding. These priority areas include animal health and welfare, feed grains and feed efficiency, forage and grassland productivity, specified risk material (SRM) disposal, beef quality and food safety. Balancing funding across all these areas with industry partners is a priority for BCRC. Placing excessive funding emphasis on one priority area is detrimental to industry as it risks the loss of research facilities and expertise in other areas. BCRC is currently collecting and analyzing data voluntarily submitted by other beef research funding agencies into a National Research Funding Inventory. This database will allow funding agencies to better communicate about funding decisions and will enhance collaboration to prevent unnecessary overfunding or unintentional neglect of critical long-term research priorities.

The success of applied research projects depends heavily upon the work of basic research. Because of the uncertainty of its outcome, basic research is typically considered higher risk and therefore has historically been funded by governments. As government funding for basic research is reduced, this will eventually impact applied research. There is a critical balance between basic research, applied research, and technology transfer that needs to be maintained as much as ensuring that research in all areas of the beef industry are supported.

The Government of Canada's development of the Science Clusters in 2009 was welcomed by the beef industry as it increased dialog on the importance of continued support for basic research and focused use of limited dollars on areas of industry priority. The science cluster program has leveraged resources and accelerated performance through a systems approach which encourages collaboration between researchers across the country. The development of the National Beef Research Strategy has provided all partners with clear industry priorities, giving direction to move forward.

An increased investment into technology transfer has ensured that this research will be communicated to industry. Encouraging adoption of new technology and providing recommendations for management changes can incrementally improve productivity on individual operations, driving industry competitiveness. This step completes the circle of growth and re-investment in research, as it provides value back to producers.

Tim Oleksyn, Chair
Beef Cattle Research Council

## EXECUTIVE SUMMARY

Research supports the Canadian beef industry by addressing arising issues in a rapidly changing marketplace. This is key to driving competitiveness and innovation.

The 2009-2013 Canadian Beef Cattle Industry Science Cluster (Beef Cluster I) brought together Canada's leading federal government (Agriculture and Agri-Food Canada - AAFC), and industry research funders (Beef Cattle Research Council - BCRC and Alberta Beef Producers - ABP) to provide $10.5 million in applied cattle, beef and forage research. Beef Cluster I funded 32 research activities that involved 51 lead researchers at seven federal sites and five universities in six provinces, in addition to several provincial government institutions and industry facilities.

The funding available through Beef Cluster I enabled industry to successfully encourage the development of effective teams of researchers spanning multiple AAFC and non-AAFC researchers and institutions across Canada on multiple research activities. In addition to strengthening research results and reducing duplicated research efforts, this collaboration ensured trained research expertise in key areas is maintained to facilitate future research. It also encouraged improved technology transfer and knowledge dissemination efforts aimed at the successful development and adoption of priority outcomes by Canada's beef industry.

BCRC's work to increase communication and collaboration between researchers and across industry partners is aimed at:

1. Increasing the percentage of successful research projects that meet industry needs
2. Reducing the lag from development to adoption
3. Increasing the proportion of producers adopting new technology

The success of applied research projects depends heavily upon the work of basic research. In some situations, necessary basic research may not have been undertaken with a specific purpose in mind or was potentially undertaken with a different end use in mind. Basic research is typically considered higher risk and its indirect benefits are more difficult to measure; therefore basic research has historically been funded by governments.

Reduced government funding for basic research impacts the effectiveness of applied research for which funds are easier to obtain because applied research projects have more clear benefits to industry. *There is a critical balance between basic research, applied research, and technology transfer that needs to be maintained as much as ensuring that research in all areas of the beef industry are supported.*

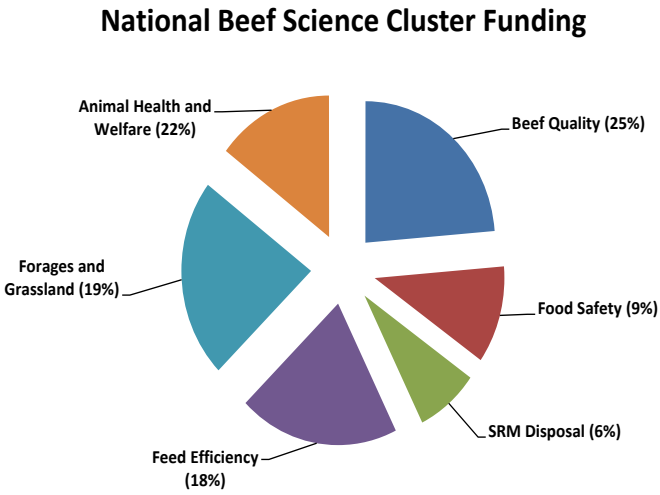
Areas of basic research that will provide the most benefit to the beef industry in the future include rumen biology, understanding the physiology of the cow, soil science, plant physiology and genetics. Basic research continues to occur primarily through government (but to a lesser degree than before) and at universities. Industry needs to clearly communicate the importance of this basic research and may need to fund portions of it in order to maintain capacity in Canada.

This inaugural Beef Cluster I Results Report evaluates the effectiveness of research activities funded through the BCRC[1]. The BCRC recognizes its responsibility to report back to stakeholders with measured progress in each research area in order to be most effective with limited research dollars. Evaluating research activities is challenging because there is a significant lag between the initial investment,

[1] Results presented in this report only include those projects that had funding start after 2009 and were completed in 2013.

commercialization, and a measurable impact following adoption by industry. Even when this lag is taken into account, many research activities are still difficult to evaluate. Funding for applied or near-market projects is easier to assess.

The largest financial improvements to industry over the past five years were in the priority areas of Animal Health & Welfare and Feed Grains & Feed Efficiency as these applied areas allow for almost immediate adoption of new technology and have a high level of private research investment.




**Animal Health and Welfare**

(5/11 successfully completed deliverables)

Minimizing the costs of animal health issues and production limiting diseases is critical to the economics of cow-calf and feedlot production. A 2% improvement in reproductive efficiency decreases the cost of cow-calf production by $16.50 per head, and a 1% decrease in pre-weaning death loss reduces cost of production by $7.45 per head. It is recognized that changes in management may require investment in order to achieve these results.

Beef Cluster I research developed more cost-effective diagnostic tests for two diseases that can seriously impair the reproductive performance in cow-calf operations, vibriosis and trichomoniasis. These tests are now moving towards further validation and commercialization. Mineral supplementation strategies for the cow herd in the pre-natal and early post-natal period were evaluated and approaches were identified that improved the health and growth performance of calves. The health risks associated with feeding industry standard levels of dried distillers' grains with solubles (DDGS) to feedlot cattle were assessed and found to be negligible.

The National Beef Quality Audit quantified the degree to which animal management has improved since 1999 through the prevalence of horns (58% reduction), brands (82% reduction) and bruises (31% reduction). These results indicate quantifiable improvements in animal welfare through less frequent use of painful procedures and widespread adoption of improved facility design, animal handling and transportation practices. Liver discounts were identified as a significant opportunity for improvement. The effect of transportation practices on the health and welfare of weaned beef calves and market cows is being evaluated in collaboration with commercial truckers and feedlots, and will help inform efforts to develop science- and outcome-based transportation regulations and practices that contribute to the welfare of cattle.

The risk of transmission of two diseases that are being deregulated in Canada (no longer federally reportable) was evaluated. The biology, ecology and behavior of the ticks and biting fly vectors that transmit anaplasmosis and bluetongue were studied. Trapping methods to monitor the populations of these vectors were compared, and the distribution of these vectors suggests that the risk of disease spread appears to be minimal in Western Canada.

The tools and knowledge developed through this research:

- have been incorporated into industry practice (in the case of DDGS feeding recommendations),
- are being further developed into commercially available diagnostic tests (in the case of vibriosis and trichomoniasis),

- will help industry develop producer recommendations to manage the risk of exposure to vectors of a de-regulated disease (tick-borne anaplasmosis), and
- inform the development of science-based cattle transport regulations.

Three projects (6 deliverables) were unable to achieve their stated objectives due to:

(1) challenges obtaining MAP strains from the CFIA and U.S.,
(2) errors in previous published work and unrelated health problems, and
(3) an extension provided for one year so results are not available at this time.

**Feed Grains and Feed Efficiency** (13/15 successfully completed deliverables)

Feed is the single largest variable input cost in both cow-calf and feedlot production. For the feedlot sector, a 5% improvement in feed efficiency could reduce feed costs by over $50 million annually, dramatically reducing feed grain usage. For the cow-calf sector, a 5% improvement in feed efficiency would reduce winter feeding costs by close to $30 million annually.

Research quantified the influence of grain type, source, and processing on the nutritional value of DDGS for beef cattle. Four protein ingredients were tested and found that they can be used effectively in diets fed to backgrounded cattle. This study helped feedlots to appropriately price these alternative feeds relative to traditional feed grains, based on their effects on animal backgrounding and finishing performance, carcass value, beef quality and manure nutrient levels. Strategies effectively incorporating DDGS into backgrounding and finishing diets were developed and widely adopted by industry.

The impact of feeding DDGS was extended to assess manure composition, *E. coli* shedding and shelf life of beef (see the Food Safety and Beef Quality sections for those results). Composted manure contains less dry matter, moisture, and more nitrogen (N), phosphorus (P), sulfur (S) and salt than raw manure. Soil salt, P and S increased as manure from DDGS-fed cattle was applied at higher rates, particularly for composted manure. The increased P in the composted manures has the potential for P loading in soil and would require reduced rates to avoid excessive buildup of $PO_4$-P in the soil. P-based applications of manure would better match crop demand than N-based manure applications.

Genetic and physiological indicators of feed efficiency were also evaluated. This led to a better understanding of the interactions between selections for feedlot feed efficiency and other economically relevant traits (primarily fertility). Marker assisted expected progeny differences (EPDs) and indexes to assist in the identification and selection of breeding stock that are genetically superior for economically relevant traits were not completed through the Beef Cluster I, but a number of individual cattle breed associations are in the process of developing these tools.

The beneficial effect of improved feed efficiency on environmental indicators like methane and manure production was measured. Improving feedlot feed efficiency will have measurable environmental benefits; a 20% improvement in feed efficiency translates to a 30% decrease in manure production, as well as a 30% reduction in methane production.

Two deliverables were not met due to:

- Feed efficiency markers identified not working across different breeds, hindering the development of viable marker panels for commercial feedlots
- A reliable value for heritability could not be developed because phenotype data was not collected in multiple locations. Related research by the team is underway to determine this

Due to substantial investments by other industry partners, the BCRC elected not to invest in feed grain variety development through Beef Cluster I. As those investments come to an end, BCRC will invest in feed grain breeding research in Beef Cluster II (2013-2018).

**Forage and Grassland Productivity** (15/15 successfully completed deliverables)

Canada's forage industry is the single largest crop with 80% of production going to livestock feed. As a critical input for the cow-calf and backgrounding sector, Canada's forage productivity must continually improve to support Canada's international competitiveness.

Beef Cluster I research identified native grass and legume cultivars suitable for semi-arid rangelands, developed a new variety of a non-bloating legume, and discovered genetic markers that are significantly associated with barley silage digestibility. Appropriate forage and legume mixtures can provide an optimal ratio of forage quality and yield in Central and Eastern Canada.

Seeding dates and alternative annual forages were compared for swath grazing to reduce winter feeding costs of the cow herd. Research suggests that swath grazing triticale can reduce winter feeding costs by over $100 per cow compared to wintering cows for 100 days in a corral. Savings were lower for swath grazed barley ($89) due to lower yields, and for corn ($83) due to higher input costs. This has significant implications for Canada's beef industry as reducing total winter feeding costs by as little as 1% would save Canada's cow-calf sector an estimated $6 million annually. Triticale had the lowest production cost, higher yields, and a lower daily feeding cost compared to barley and corn. High-yielding crops which utilize a greater portion of the season than barley have the potential to reduce the cost of wintering cows further than previously envisioned.

Lower fertilizer costs improved returns for alfalfa-grass mixed pastures. Economic simulation indicated substantial benefit to alfalfa inclusion and small detriments to rested grazing, though these may be overcome if cow-calf performance on early-seeded and early-swathed annuals could be improved.

These results will contribute to improved soil health, pasture longevity and productivity, and reduce production costs in the cow-calf sector.

**Beef Quality** (7/12 successfully completed deliverables)

The National Beef Quality Audit showed consumer ratings of the flavour, juiciness and tenderness of a variety of steaks (top sirloin, strip loin, boneless cross rib, inside round) improved 8-12% from 1999 to 2009. Improved satisfaction with the eating quality of Canadian beef will contribute to improved consumer confidence. Another National Beef Quality Audit will be conducted under Beef Cluster II (2013-2018).

Over the last five years the proportion of carcasses grading AAA or higher increased from 51.6% in 2008 to 56.7% in 2012, while the proportion of yield grade 1 carcasses decreased from 60.8% in 2008 to 48.8% in 2012. Dark cutting beef (B4 grade) prevalence in youthful cattle decreased from 1.4% in 2008 to 1.2% in 2012.

The dark cutting phenomena is more complex than previously suspected. Dark cutting in beef carcasses was not affected by slightly lower chilling temperatures, indicating that the incidence of atypical or borderline dark cutting is not likely related to the number of carcasses in the cooler. Three distinct subcategories of dark cutters were observed (classical, atypical, and borderline).

Optimal feeding strategies to enhance omega-3 levels in mature and youthful cattle were researched but not developed. A fatty acid workshop held in the fall of 2009, clarified that the omega-3 fatty acids predominant in beef have no known human health benefits.

Four plant enzymes were found to increase the heat solubility of perimysium, and are therefore potentially useful for the tenderization of meat. The flavours imparted by kachri and ginger were acceptable to a trained taste test panel and if a method of injecting a more concentrated solution of

these enzymes was devised, both tenderness and flavour may be improved. The DNA panel was able to explain 40% of the genetic variation in beef tenderness in the population it was developed in.

While promising DNA markers were found within each population, very few markers had predictive value across populations. This suggests that breed-specific marker panels are likely the most appropriate approach to follow until the actual functional mutations responsible for differences in tenderness and eating quality are identified.

Beef demand has stabilized over the past 15 years after declining throughout the 1980s and into the first part of the 1990s. While gains were seen in AAA grading production, there were fewer yield grade 1 cattle and more yield grade 3. By focusing all market signals on AAA production, the industry is actually seeing a net loss as costs from additional fat deposition on the animal are accrued by the feedlot which is then trimmed by the packer.

Five deliverables were not met due to:

- Communication efforts are still underway
- Breed specific markers were identified but few work across breeds or populations. Within breed panels are being pursued by purebred associations

**Food Safety** (9/12 successfully completed deliverables)

Research evaluated the effectiveness of various food safety interventions applied to cattle, whole carcasses, beef cuts and trim routinely applied at commercial beef processing facilities. Modern beef packing plants using multiple interventions can produce dressed carcasses carrying as few as four (4) viable *E. coli* cells per carcass. However, beef can be contaminated with pathogens during carcass breaking. Contamination from personal equipment can be wholly avoided by ensuring that hands, cotton gloves, steel mesh gloves and knives are thoroughly and regularly cleaned, and by wearing disposable rubber gloves between cotton gloves and steel mesh gloves.

While lactic acid sprays and washes are very beneficial for reducing microbial contamination on dressed carcasses, they had limited benefit on beef trim. E-beam treatment achieves more comprehensive pathogen control on trim. Treatment with a 1kGy e-beam eliminated more than 99.99% of the VTEC and 99% of the *Salmonella.* A trained panel observed no effects of irradiation on the colour, aroma, texture, juiciness or flavour of beef patties made with a variety of treated and non-treated ground beef mixtures, even with patties made entirely with beef that had been e-beam treated.

The results of these research activities will contribute to further improve food safety practices in the beef industry, and continued efforts to achieve the regulatory approval of e-beam irradiation for beef. Success in these efforts will reduce the risk of future beef recalls and improve consumer confidence in the safety of Canadian beef in both domestic and export markets. While reductions in the incidence of *E. coli* in beef have occurred over the past decade, this does not reduce the negative impact to industry when a recall occurs. Measuring the benefit of this reduction is difficult as the benefit is from avoiding a recall. Although the cost of a recall incident can be calculated after the fact, it is difficult to estimate the costs that were *not* incurred by an event that *did not* happen.

Cranfield (2013) found that simulations from 1998:Q3 to 2010:Q3 showed that on average one additional beef recall in Canada would lead to a 2,260 tonne reduction in beef consumption per quarter (with a range of 710-5,740 tonnes), valued around $C26.5 million at the retail level (with a range of $8-67 million); this is equivalent to a one percent drop in consumer beef expenditures.

Three deliverables were not met due to:

- Research was redirected to focus on *E. coli* versus *Salmonella* and *Listeria*
- Only one DDGS inclusion rate was used in the study (representative of industry practices)

**Specified Risk Material** (2/2 successfully completed deliverables)

Research found that 99.9% of BSE prions are destroyed after 28 days of composting in beef manure. These results can inform the review of Canada's Enhanced Feed Ban, which currently prohibits the movement of composted manure that may contain deadstock among farms. If legalized, the ability for producers to use fertilizer from composted SRM will offset some of the costs accrued by industry, particularly for feedlots looking to sell manure to farmers in their area and are currently paying for deadstock removal.

**Technology transfer** activities were significantly enhanced through Beef Cluster I. A 10-year Technology Transfer and Knowledge Dissemination Strategy was developed and led to the hiring of a Beef Extension Coordinator. Consequently, the Canadian beef industry's communication regarding the value and results of applied cattle, beef and forage research has reached unprecedented levels. Much of this communication has occurred through the beefresearch.ca website developed in 2012, with continued communication through the Canadian Cattlemen's Association's (CCA) Action News e-newsletter, regular articles in Canadian Cattlemen – the Beef Magazine, a Beef Research School video series developed in collaboration with realagriculture.com, as well as more traditional communication through the Verified Beef Production program, agricultural print media and speaking engagements at various industry events. Increased investment into technology transfer ensures that research results from Beef Cluster I will be communicated to industry and its partners, with the enhanced opportunity for greater and faster uptake of innovation.

**Building Capacity** - Highly skilled personnel specializing in food safety, beef quality, forage and grassland productivity and feed efficiency were trained through Beef Cluster I. One of these individuals has been hired as a food safety researcher at AAFC Lacombe, one of the forage researchers trained has become a Forage Management Specialist with the Saskatchewan Ministry of Agriculture, and one feed efficiency researcher was hired at the Nova Scotia Agricultural College of Dalhousie University. Maintaining and enhancing current research capacity in Canada to ensure all priority areas are covered is needed, so that Canadian specific issues and regional conditions can be addressed directly instead of relying on US research and extrapolating for the Canadian situation. This is critical to the long term vitality of the beef industry. Unfortunately, industry efforts to get several of these scientists hired into permanent positions to reinforce federal carcass composition and forage research capacity at AAFC Lacombe and AAFC Swift Current have not yet been successful. Preventing further reductions in federal research capacity is a high priority for BCRC.

Improved **industry recognition** of the value of applied research has led to an increased allocation of the National Check-off dollar to research. Since 2010, four provinces (Saskatchewan, Alberta, B.C. and Nova Scotia) have doubled their percentage allocation to national research through the National Check-off, while only one province (Ontario) has decreased its allocation.

Several important findings resulted from Beef Cluster I, particularly around the value of coordinated research funds. There is potential for improved effectiveness through additional collaboration and cooperation between funders.

With few exceptions, Beef Cluster I has been a notable success and has laid a solid foundation to build upon in future Beef Clusters. Beef Cluster II (2013-2018) builds on Beef Cluster I research to move towards the beef industry's long term objectives as set out in the National Beef Research Strategy.

## INTRODUCTION

The Beef Cattle Research Council (BCRC) was established in 1997 and is Canada's industry-led funding agency for beef research. The BCRC is funded through a portion of a producer-paid National Check-off ($1 collected when an animal is sold). On average the BCRC receives 15 cents of every National Check-off dollar. 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.

In 2011, the BCRC began the process of more formally developing and reporting on performance measures and research indicators that can be monitored on an ongoing basis to evaluate research progress and its contribution to the beef cattle industry. This inaugural results report is designed to provide a summary of research initiatives funded through BCRC, what was delivered and the value provided. It also identifies how those successes can be built upon in the future in order to meet industry's long-term objectives of increasing beef demand and enhancing industry sustainability.

The Canadian beef industry depends on export markets for over 40% of its production. The industry as a whole needs to be competitive in the international marketplace to provide a cost competitive product that meets the standards and quality expectations of both domestic and international customers. There are many areas to consider when looking at a country's competitive standing including the demand for product, profitability of the industry, and having the latest technologies available to maintain the competitiveness of all sectors from animal production and meat processing, all the way to the consumer.

The Canadian beef industry has defined its desired position in domestic and international markets through the articulation of an **industry value proposition**:

*Worldwide Leadership in Animal Health and Beef Safety*

The **vision** of the National Beef Research Strategy from the Beef Value Chain Round Table and the BCRC is:

*Be recognized globally for beef research that delivers innovations contributing significantly to the profitability and sustainability of the Canadian beef cattle and meat industry.*

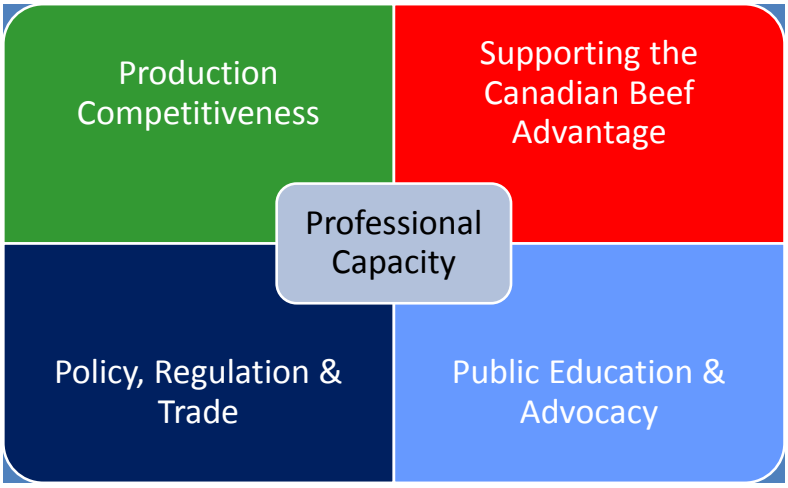
The overarching ***research objectives*** are to reduce costs of production and improve production competitiveness relative to global competitors, and to increase Canadian beef demand, domestically and globally, and improve carcass values.

To ***reduce costs of production***, research is focused on priority areas to enhance feed, forage and grassland productivity, increase feed efficiency, decrease the impact of animal health issues and production limiting diseases, improve utilization of specified risk materials, and a continued focus on environmental management and animal care.

To ***improve beef demand and quality***, research is focused on priority areas to reduce food safety incidences, define quality and yield benchmarks supporting the Canadian Beef Advantage (CBA), improve beef quality through an audit program and primary production improvements, and the development and application of post processing technologies to optimize cutout values.

These priority areas transcend the objectives of reducing costs and improving efficiency for competitiveness by supporting the attributes that can increase demand and market share for beef and thereby improve carcass values. Research can be quantitative (advancing production competitiveness, supporting the CBA) or qualitative (informing policy, regulation and trade, explaining the reasons for production practices to consumers) or both. An example is work done on animal transport showing that animals come off trucks after short and long-haul trips in a healthy and non-stressed condition. This

research helps avoid the implementation of ineffective or counter-productive prescriptive regulations, informs the public of the outcome of current production practices and provides proof of animal welfare in Canada, which supports the CBA. None of these objectives can be reached if research capacity in Canada is lost.




In recent decades, the private sector has increased its investment in agriculture and food innovations (ERS, 2012[2]). The most rapid increases were seen in crop breeding/biotechnology, followed by farm machinery and food manufacturing. At the same time, research and development (R&D) spending in real dollars for crop protection chemicals and animal nutrition declined. It has been found that generally the four to eight largest firms in a sector accounted for around 75% of the R&D, with large firms investing more as a percentage of product sales than small firms. Consequently, sectors dominated by small firms (i.e. cow-calf sector) invest a smaller percentage than sectors dominated by large firms (i.e. feedlot sector). This is partly also a function of specialization of expertise and a single focus versus a diversified operation with multiple farm enterprises and potentially off-farm income. This leaves a large role for industry and public investment in agricultural research and development.

The 2009-2013 Beef Cattle Industry Science Cluster (Beef Cluster I) brought Canada's leading federal government (Agriculture and Agri-Food Canada - AAFC) and industry funders (Beef Cattle Research Council - BCRC and Alberta Beef Producers - ABP) together to provide $10.5 million in applied cattle, beef and forage research. The Beef Cluster I funded 32 research activities that involved 51 lead researchers at seven federal sites and five universities in six provinces, in addition to several provincial government institutions and industry facilities. The funding available through the Beef Cluster I enabled industry to successfully encourage the development of effective collaborative teams of researchers spanning multiple AAFC and non-AAFC researchers and institutions across Canada on multiple research activities. This ensures that research expertise in key areas is trained and maintained to facilitate future research. It has also improved technology transfer and knowledge dissemination efforts aimed at encouraging the successful adoption of promising innovations by Canada's beef industry.

The Beef Cluster I provided the opportunity to create a more strategic approach to investing in research programs and making progress on important industry objectives. The Beef Cluster I supports the industry's BSE recovery-marketing strategy by funding projects that accelerate development of the industry's value proposition to expand domestic and export markets and establish Canada as a worldwide leader in animal health and beef safety.

[2] Research Investments and Market Structure in the Food Processing, Agricultural Input and Biofuel Industries Worldwide. Economic Information Bulletin No. EIB-90 p.34. http://www.ers.usda.gov/publications/eib-economic-information-bulletin/eib90.aspx#.UtlqNRDn9QI

Since 2009 considerable success has been achieved in improving communication and coordination among funders. A National Beef Research Review was conducted in 2008 preceding the development of a National Beef Research Strategy in 2012, which identified specific short-, medium- and long-term target research outcomes that are of priority to Canada's beef industry. These target research outcomes formed the basis of Beef Cluster II (2013-2018).

The National Beef Research Review revealed a stark illustration of how the historical lack of communication and coordination among funders has led to significant duplication of funding and effort in some areas of research, and corresponding underfunding in other areas. While these problems may never be entirely overcome, significant efforts have been made, and success achieved, in encouraging a number of significant beef and forage research funders to share information about funding proposals received and funding decisions made. These funding decisions are tracked against the target research outcomes in the National Beef Research Strategy to assess alignment and buy-in with the strategy. This alignment also helps funders identify which target research outcomes are already being adequately addressed by other funders, and which are worth targeting in upcoming calls for proposals. Over time, the realized benefits of improved communication and coordination will naturally lead to more open discussion of the benefits of reducing the disparate administrative and reporting requirements imposed on Canada's cattle, beef and forage researchers. The precedent established by the Beef Cluster I will provide a clear example of the long-term administrative and efficiency benefits of matching research funds.

Maintaining progress in all areas of research critical to the long term success of the beef industry will support the industry in addressing issues as they arise in a rapidly changing marketplace. However, the BCRC's role is not to address all objectives in the National Beef Research Strategy; but rather the BCRC is dependent upon other industry and government dollars to be strategically aligned so that all areas in the National Beef Research Strategy are covered. Beef Cluster II builds on this current research to move towards the beef industry's long term objectives as set out in the National Beef Research Strategy. Improved industry recognition of the value of applied research has led to an increased allocation of the National Check-off dollar to research. Since 2010, four provinces (Saskatchewan, Alberta, B.C. and Nova Scotia) have doubled their allocation to research through the National Check-off.

## PERFORMANCE MEASURES

One of the challenges in evaluating research is that progress is made over a long period of time. The initial investment may take years to provide a result that then needs to be commercialized and adopted by industry. Consequently the industry is currently benefiting from historical investments in research. It is well recognized that any evaluation of research funding must reflect the time frame of the task undertaken. This is broken into long-term performance measures, medium-term research indicators and short-term deliverables reflecting the appropriate evaluation period for each goal and activity.

**Long Term** (6-10 years) performance measures are overarching and provide an indication of how investment in research from all parties, both private and public, have contributed to advancements in priority areas. The National Check-off Study from 2010 showed that returns on investment (ROI) in research were high at 46:1. This is partly due to under-investment, but also highlights the value of research and importance of future investment. It is recommended that future ROI work evaluating the returns to National Check-off investments in research be completed every five years.

**Medium Term** (4-6 years) research indicators monitor progress in the various priority areas. The BCRC commissioned a "Historical Evaluation of Research in BCRC Priority Areas" that reviewed various medium term research indicators. These indicators are expected to be impacted over the medium term as research is directed to addressing various challenges the industry is facing. These medium term indicators will be influenced by both private and public research and therefore cannot be considered an appropriate evaluation of BCRC managed funds in isolation. Medium term indicators do play an important role in assisting in identifying research needs and priorities moving forward.

In this report *Research Indicators,* are medium term indicators provided for each priority area under the section titled "*Value - What Does it Mean for Industry",* give an overview of advancements since 2008. These are not directly attributable to BCRC projects as they are outside of BCRC's direct influence and are impacted by all (private and public) research success of commercialization and producer adoption of new technology, as well as outside environmental influences (which frequently impact animal health and death loss) making them difficult to interpret over the short term. However, they provide an indicator of where advancements are being made and where they are stagnant or in decline. Appendix A provides a summary of the calculations and assumptions used in these value sections.

These research indicators should not be confused with short term deliverables which are more specific measures utilized to evaluate results of specific research projects funded by the Council. It is important to have realistic expectations of when results in these indicators will appear.

**Short Term** (1-4 years) deliverables for BCRC are directly related to projects funded. This in-depth look at BCRC operations allows for an internal evaluation of whether objectives are being met or not and where changes may be made to improve. In order to evaluate the five years of funding, focus is placed on the short term goals outlined under the Beef Cluster I (2009-2013).

Answers to research questions are not guaranteed, even with a well-designed project. In this report each project deliverable is given a designation (✓ ✗ ?) indicating if results were achieved. The ✓ designation does not indicate that the results were favourable for the beef industry; only that answers to the questions were found that will inform the industry on how to proceed.

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

Not all research goals have a direct impact that can be measured or even seen indirectly by producers. Basic research may not achieve applied outcomes on its own, but is critical to producing the scientific advancements needed to apply the practical outcomes in applied downstream research. Many of the research goals work together like building blocks where the value of the whole is greater than the individual studies/projects.

Research can take many years before paying off. The process of investing into an idea, the basic research required, the development of an application, commercialization and adoption is a long one. Industry invests with the expectation of this process occurring, but not all investments result in successful applications or commercialization. Industry has invested in a number of initiatives that have provided exciting results. The "Findings" section under each priority area summarizes results although industry has yet to reap the full reward of this work. Even discovering that something does not work moves the industry forward in finding a solution. An example of this is genetic research which spans across many of the priority areas. In 2001, initial investments were put towards the development of a Bovine Genomics program at the University of Alberta. While investment towards genetic advancements has been numerous, the genetic markers identified through the mapping of the *Bovine Genome* are just now starting to be validated and incorporated into breeding tools for the seedstock sector. Genomics is a long-term investment with potentially 10-20 years before a commercialized tool may be available to industry.

Other work calculating ROI on research has noted that applied research tends to have very positive return on investment, while basic research tends to be close to zero. Basic research is typically funded by government with high risk and uncertainty of future reward as once the research is complete it is available to everyone and considered a "public good". This basic research should not be discounted as it provides an important piece of innovation. Without the underlying foundation of basic research, applied research cannot occur.

The success of applied research projects depends heavily upon the work of basic (pure) research which may not have been undertaken with a specific purpose in mind or potentially with a completely different end use in mind. As government funding for basic research is reduced, this will eventually impact applied research. There is a critical balance between basic research, applied research, and technology transfer that needs to be maintained as much as ensuring that research in all areas of the beef industry are supported.

A benefit:cost ratio is not provided in the "Return on Investment" section, as benefits from the 2008 to 2013 investment period will not be realized for several years. This lag recognizes the time it takes for successful research to be commercialized and adopted by industry.

## ANIMAL HEALTH & WELFARE

**OVERARCHING OBJECTIVE:**

Reduce costs and losses incurred as a result of major production limiting diseases and animal health issues that affect primary production sectors through the development of effective and economical management practices, diagnostic, and treatment tools.

**Background**: Productivity (i.e. reproductive performance, death loss, average daily gain) is a major determinant of profitability in the cow-calf sector. Strategies to address infectious diseases or nutritional disorders that impair fertility or pre-weaning calf survival greatly impact the rancher's bottom line and resilience in down cycles. Moving through the supply chain, increased mineral concentrations in distillers' grains may affect the health of weaned calves when incorporated into feedlot diets. Mortality and morbidity represent an economic cost to producers who are also under increased scrutiny from consumers to show how they are providing the highest degree of animal care and welfare practices proven by sound science.

### FINDINGS

**RESEARCH GOAL #1:** Improve diagnostic tools and accelerate vaccine development *for Mycobacterium avium* spp. *paratuberculosis* (Johne's Disease)

Mycobacterium avium spp. paratuberculosis (MAP), the bacterium that causes Johne's disease, is a concern to the beef sector because of its potential (unproven) link with Crone's disease in humans. Diagnostic test and vaccines for Johne's disease already exist. However, current diagnostic tests are unreliable until the animal is in advanced stages of the disease, at which time the animal has spread the disease to countless other herd-mates. Currently available vaccines reduce the shedding and spread of the disease, but do not prevent it. Unfortunately, the research funded under Beef Cluster I did not overcome these challenges. One project aimed at vaccinating calves (using a neonatal disease challenge) and developing an early diagnostic test (a skin fold test similar to that traditionally used for bovine tuberculosis) was unsuccessful. This project was seriously impaired by regulatory delays in obtaining necessary experimental MAP strains from the US, and the necessary research agreements with the CFIA. A second project did identify a phage with potential as a MAP diagnostic, but it is questionable whether this test is robust enough to identify the full range of MAP strains that may be present in cattle.

**RESEARCH GOAL #2:** Examine the effects of alternative nutritional strategies on animal health

Feeding 22.5% corn or wheat dried distillers' grains with solubles (DDGS) did not affect the overall morbidity or mortality rate of feedlot steers, the prevalence of ruminitis, or the incidence of polioenchephalomalacia (PEM or more commonly known as "polio") although wheat and corn DDGS resulted in the highest serum sulfate concentrations. Thiamine demand was higher in animals consuming high dietary sulfur, but dietary sulfur inhibited the conversion of free thiamine into thiamine pyrophosphate in the brain of cows affected with polioencephalitis.

**RESEARCH GOAL #3:** Develop strategies to control emerging vector borne, zoonotic, and foreign animal diseases

Recent moves to re-classify anaplasmosis and bluetongue (moving them from the reportable to notifiable disease list) is likely to lead to reduced federal surveillance and disease response activities. This may impact animal productivity, so practical means of reducing the risk of disease transmission would be of value. Applying semiochemicals to animal's backs may limit tick movement among animals, and could aid in preventing spread of anaplasmosis within a herd. Cattle do not develop an immune

response to protect against late season tick infestations. Overall overwintering survival of ticks is relatively high, but is reduced by cold weather. Montane ticks begin and end questing earlier during the year compared to prairie ticks. Black light and $CO_2$ traps were roughly equivalent in attracting *Culicoides* species in an area, but black light traps operated for a week would be almost as sensitive at detecting *C. sonorensis* as $CO_2$ traps operated for 24 hours. The *A. bovis*-like bacterium was not found within *D. variabilis.* An *A. bovis*-like bacterium was found in questing *D. andersoni* adults from four localities in Alberta, and is likely to occur elsewhere in the Canadian prairies. Errors in the published literature impeded development of the new PCR test (Polymerase Chain Reaction), so it is unclear whether current diagnostic tests used to detect *A. marginale* cross-react with *A. bovis*-like bacteria.

In terms of reproductive diseases, the PCR-based vibrio test had relatively high (85%) sensitivity and specificity, and the trichomoniasis test had 94% sensitivity and 100% specificity. These two diseases can each reduce reproductive efficiency by well over 50% with a significant impact on cow-calf profitability. Calves with inadequate copper levels at birth were more likely to receive treatment due to common newborn diseases such as navel infection, scours or pneumonia. Prenatal copper supplementation using a total-mixed ration reduced the incidence of neonatal disease and reduced the calving-rebreeding interval, and free-choice copper supplementation post-calving led to higher weaning weights. Mineral supplementation practices were identified that reduced pre-weaning morbidity by 85%. Healthier cattle have less need for antimicrobial treatments.

**RESEARCH GOAL #4:** Monitoring and management of key animal health and welfare issues

Significant research has been done in recent years to inform government around animal welfare when cattle are transported. Consumers most commonly see cattle when they are being transported and often raise questions or concerns because of a lack of familiarity with farming. Compared to other countries with much smaller geographical regions, Canada transports cattle much longer distances. This raised the question whether regulations were needed to mandate rest stops. Research was able to show that the additional handling of unloading and re-loading cattle at rest stops did not result in more cattle unloaded at the final destination in better condition. In fact, straight through trips resulted in cattle coming off the truck in a healthy and non-stressed condition (i.e. not sweated, lame, etc.). This study, which was the largest of its kind done globally under industry conditions, found that at least 99.95% of cattle reach their destination with no identifiable problems of any sort, regardless of the duration of the trip.

Preliminary results of the transport study indicate that when ambient temperatures exceeded 15$^{o}$C the Temperature-Humidity Index (THI) was slightly higher in the back and doghouse compartments, at the higher loading density. Loading cattle at a lower density did not appear to effectively reduce the THI in the larger deck and belly compartments at these high temperatures.

The role of research to inform policy and regulation is important and must continue. In Beef Cluster II work will be done to evaluate current practices to ensure that best management practices are done with the least stress to cattle as possible. This is important not only for informing animal care practices but also when communicating about industry practices to consumers.

Research is examining ventilation management strategies and stocking density during transport to show how transportation management practices affect the incidence of respiratory disease in feedlot calves. Respiratory disease is a leading cause of death and treatment costs at feedlots. Reducing the death loss in feeder calves from 2% to 1.5% would save the Canadian beef industry more than $10 million annually in direct savings realized by reduced treatment and feed costs.

*Implications*: The tools and knowledge developed through this research have been incorporated into industry practice (in the case of DDGS feeding recommendations), are being further developed into commercially available diagnostic tests (in the case of vibrio and trichomoniasis), will help industry

develop producer recommendations to manage the risk of exposure to vectors of a de-regulated disease (tick-borne anaplasmosis), and inform the development of science-based cattle transport regulations.

## VALUE – WHAT DOES IT MEAN FOR INDUSTRY

Animal Health and Welfare saw 5/11 successfully completed deliverables.

Minimizing the costs of animal health issues and production limiting diseases is critical to the economics of cow-calf and feedlot production. A 2% improvement in reproductive efficiency decreases the cost of cow-calf production by $16.50 per head, and a 1% decrease in pre-weaning death loss reduces cost of production by $7.45 per head. It is recognized that changes in management may require investment in order to achieve these results.

The National Beef Quality Audit has identified where industry has made gains in areas of animal welfare (reduced bruises, branding, and horns) as well as areas that need to be monitored (liver abscesses).

| RESEARCH INDICATORS | FINANCIAL IMPACT TO INDUSTRYŁ (MILLION $) |
|---|---|
| Reproductive efficiency increased from 86% in 2008 to 90% in 2012 | +$176.1 |
| Survival (birth to weaning) decreased from 96.8% (03-07 average) to 95.7% (08-11 average) | -$43.7 |
| Survival (weaning to slaughter) decreased from 88% in 2008 to 82% in 2012 | -$196.0 |
| Feedlot survival (overlap with above) increased from 87% in 2008 to 91% in 2012 | +$168.2 |
| Liver abscesses in fed cattle resulting in condemnation increased from 13.4% in 1998/99 to 23.2% in 2010/11 | |
| Liver abscesses in fed cattle resulting in livers being discounted to pet food have decreased from 10.4% in 1998/99 to 8.0% in 2010/11. | |
| Liver damage resulting in lost weight gain at $20.5 million in 2010/11 up from $2.99 million in 1998/99 as the cost of feed increased and cattle stayed on feed longer to get to finished weight | 20.5 |
| Liver condemnations in non-fed cattle increased from 18.1% in 1998/99 to 26.4% in 2010/11. | |
| Liver abscesses in non-fed cattle resulting in livers being discounted to pet food decreased from 33.7% in 1998/99 to 23.9% in 2010/11. | |
| Horns - the percentage of hornless cattle were approximately 20% higher in fed and non-fed cattle in the 2010/11 compared to the 1998/99 audit. | -$0.1 |
| Bruises -The percentage of non-fed cattle with bruises increased from 76.4% in 1998/99 to 85.7% in 2010/11; while the percentage of fed cattle with bruises decreased from 49.2% to 34.1% | +$2.4 |
| Heads and tongue condemnations rates decreased from 5% in 1998/99 to 3.8% in 2010/11 | -$3.64 |
| Carcass condemnations have decreased from 31.0 per 10,000 head slaughtered in 2008 to 27.5 in 2012 | +$1.1 |

ŁFor assumption and calculation details, refer to Appendix B.

The National Beef Research Strategy has outlined three Animal Health and Welfare research outcomes over the next ten years:

1. Improved surveillance of production limiting disease and welfare issues
2. Improved understanding and management of pain and stress in beef cattle
3. Improved prevention of animal disease and welfare issues

| Research Goal | Project | Deliverable | | Progress made on Deliverables |
|---|---|---|---|---|
| 1. Improve diagnostic tools and accelerate vaccine development *for Mycobacterium avium* spp. *paratuberculosis* (Johne's disease) | **ANH.01.09** Enhanced Sensitivity of Detection of MAP in Bovine Feces by Integration of Bacteriophage-Based Capture with Loop-Mediated Isothermal Amplification (LAMP) | Development and evaluation of potential diagnostic tests with improved sensitivity and specificity that would aid in control programs for Johne's disease in beef herds. | ? | A single MAP specific phage was identified, but given that most phage are strain specific, this diagnostic test is of extremely limited value to industry at this point. |
| | **ANH.02.09** Evaluation of a Low Dose Vaccination of Calves and Early Immune Response for MAP | Use of new diagnostic strategies for testing and culling | ✗ | This project was unable to achieve its stated objectives, largely due to challenges obtaining MAP strains from the CFIA and US. |
| | | Potential development of vaccination tools | ✗ | This project was unable to achieve its stated objectives, largely due to challenges obtaining MAP strains from the CFIA and US. |
| 2.Examine the Effects of Alternative Nutritional Strategies on Animal Health | **ANH.03.09** The Effect of Alternative Feeding Dried Distillers' Grains (DDGS) on Animal Health in Feedlot Cattle | Identification of animal health and performance concerns associated with feeding distillers' grains and other feed sources | ✓ | Feeding DDGS did not increase the risk of mortality, morbidity, ruminitis, lameness and poliencephalomalacia are negligible in feedlot cattle. |
| | | Development of best management practices that optimize performance while minimizing animal health concerns | ✓ | Diets containing up to 22.5% DDGS from corn or wheat had no effect on health, but cattle fed wheat DDGS had poorer ADG, F:G and slaughter weight than cattle fed corn DDGS or barley fed controls. |
| 3.Develop strategies to control emerging vector borne, zoonotic, and foreign animal diseases | **ANH.04.10** Biology of animal disease vectors – ticks and biting flies | Enhanced understanding of the population dynamics and ecology of arthropod vectors of animal disease in order to identify risks to cattle production and develop ecologically sound mitigation strategies. | ✓ | Gathered new information about factors influencing tick survival, movement, questing, and found that cattle do not develop an effective immune response to ticks (limiting the potential of anti-tick vaccines) to aid in anaplasmosis surveillance and control programs. |
| | **ANH.05.10** Genetic screening for Anaplasma in their tick vectors, and the development of species specific markers for different species of Anaplasma | Determine the prevalence of *Anaplasma marginale* and an *Anaplasma bovis*-like bacterium in Alberta and Saskatchewan | ✓ | An *A. bovis*-like bacterium was found in the anaplamosis tick vector (Dermacentor andersoni); this may increase the risk of false-positive diagnoses for anaplasmosis. |
| | | Determine whether current diagnostic Anaplasmosis tests cross-react with the *A. bovis*-like species | ? | Efforts to develop a test to distinguish the two bacteria were unsuccessful - errors in other's published research delayed this effort too much. |
| | | Development of species-specific PCR assay tests for the accurate detection of each species of *Anaplasma* | ? | See previous – health problems (unrelated to anaplas) also plagued the research team. |
| 4.Monitoring and Management of Key Animal Health and Welfare Issues | **ANH.09.10** Investigating reproductive failure in western Canadian cow-calf herds | Improved ability to prevent, diagnose and control reproductive failure in cow-calf herds. | ✓ | More rapid and cost-effective tests for trichomoniasis and vibrio were developed and are currently being validated. Mineral supplementation strategies for cow-calf herds in the pre- and post-calving periods were also developed. |
| | **ANH.12.10** Effects of ventilation management strategies and stocking density during transport on trailer microclimate and calf | Determine relationships between ventilation management practices, transport duration and loading density on trailer microclimate and calf welfare in order to develop science-based | ? | This project is continuing for another year using industry funding, so comprehensive final results are not available. No clear associations between loading density, trailer temperature or climatic conditions have been found so far. |

| | | | | |
|---|---|---|---|---|
| | welfare | recommendations regarding best management practices for the transportation of calves under Canadian conditions, with specific focus on ventilation strategies. | | |

 - Solid Results  - Failed  - Partial Results or Incomplete

## FEED GRAINS & FEED EFFICIENCY

**OVERARCHING OBJECTIVE**

Improve feed efficiency through the identification and validation of economical methods of identifying seedstock with improved feed efficiency and the development of alternative feeding strategies. Feed efficiency involves both the feed (nutrient composition, processing, etc.) as well as the animal (ability to extract and use these nutrients).

**Background**: Efficient cattle produce less methane, eat more slowly and less frequently, ruminate less, are less aggressive, have larger liver cells, greater cellularity in the crypts of the small intestine and higher fecal cortisol metabolite levels. Feed efficiency is a key determinant of economic competitiveness throughout the beef industry and has clear environmental implications through direct effects on manure and greenhouse gas production. A 5% improvement in feed efficiency would benefit all segments of the industry. Identifying strategies to appropriately incorporate novel feeds into existing feedlot rations without compromising performance or carcass value are important to ensure the economic viability of the feeding sector in the face of fluctuating feed grain costs and availability.

### FINDINGS

**RESEARCH GOAL #1:** Evaluation and identification of optimal strategies for feeding dried distillers' grains with solubles (DDGS)

**Background**: Ethanol by-products, primarily dried distillers' grains with soluble (DDGS) have been widely incorporated into feedlot rations across North America. A great deal of research has been conducted in the US to develop appropriate feeding recommendations for corn-based distillers' grains. In Western Canada, wheat is the main ethanol crop produced. Nutrient levels of wheat DDGS differ from those of corn, so research was needed to determine how to best incorporate wheat DDGS into Western Canadian feedlot diets.

Due to the widespread and rapid adoption of DDGS in feedlot diets, commercial operators were able to very quickly assess the economic and performance impacts of feeding wheat DDGS. However, assessment of the impact of feeding a variety of different DDGS on nutrient content and digestibility, animal health, manure composition, *E. coli* O157:H7 shedding, and shelf life of beef was also required. Technical data of this nature is very difficult for individual cattle feeders to collect. However, quantifying these impacts is critical so that Canada's beef industry could proactively address a variety of potential environmental, food safety, animal welfare and beef quality concerns in support of the Canada Beef brand.

Four protein ingredients were tested and found that they can be used effectively in diets fed to backgrounded cattle. This project has resulted in a compiled database for DDGS with information on crude protein (CP) content and amino acid (AA) profiles. This information will enable Canadian beef producers to feed cattle in a manner that maximizes utilization of ethanol co-products as protein sources without reducing cattle performance, depending upon availability and cost of the feed ingredient, while minimizing feed costs and maximizing the profits. As well as helping feedlots to appropriately price these alternative feeds relative to traditional feed grains, based on their effects on animal backgrounding and finishing performance, carcass value, beef quality and manure nutrient levels. Strategies effectively incorporating DDGS into backgrounding and finishing diets were developed and widely adopted by industry.

Feeding 40% wheat DDGS, 40% corn DDGS or their blend did not significantly affect meat quality in fresh or enhanced roasts. In fresh roasts, wheat DDGS offered enhanced colour stability over corn DDGS; the blend produced the poorest colour stability. The wheat-based DDGS fresh manure at 180 t $ha^{-1}$ on Brown soil and the wheat-based DDGS fresh manure at 240 t $ha^{-1}$ on Black soil resulted in the highest biomass yield, favourable nitrogen (N) recovery and low toxic effects. Composted manure contains less

dry matter, moisture, and more N, phosphorus (P), sulfur (S) and salt than raw manure. Soil salt, P and S rose as manure from DDGS-fed cattle was applied at higher rates, particularly for composted manure. The increased P in the composted manures has the potential for P loading in soil and would require reduced rates to avoid excessive buildup of $PO_4$-P in the soil. Phosphorus-based applications of manure would better match crop demand than N-based manure applications.

**RESEARCH GOAL #2:** Develop and validate economical methods of identifying beef cattle with improved feed efficiency

Although genotype differences between populations made it difficult to develop robust across-breed predictions, within population accuracies are of significant magnitude to suggest that genomic selection for feed efficiency within a population is quite feasible.

Relationships between feed efficiency and reproductive traits were positive in heifers and negative in bulls, but these results require further validation and must be viewed with caution. Research examining genetic and physiological markers related to feed efficiency found that genetic selection for feedlot feed efficiency should be done using an appropriately weighted economic section index to balance potentially unfavorable relationships with reproductive traits. Improving feedlot feed efficiency will have measurable environmental benefits; a 20% improvement in feed efficiency translates to a 30% decrease in manure production, as well as a 30% reduction in methane production.

Over-fed mature cows (diet exceeded requirements) ate more, grew more and weighed more than under-fed cows, but there were no significant differences in carcass weight, fat depth, ribeye area or marbling score. Maternal dietary treatment did not affect placental weight or fetal weight, length, circumference or any fetal organ weights. Birth and weaning weights did not differ among calves born to over- vs. under-fed cows, but differences in gene expression related to fat deposition and muscle development were seen.

This means that the pregnant cow's diet might affect the calf's gene expression or the timing of fetal muscle formation. It could also mean that the fetus can control which tissues get priority and which tissues are restricted when nutrients are limiting.

*Deliverables that were not met*: Marker assisted EPDs and indexes to assist in the identification and selection of breeding stock that are genetically superior for economically relevant traits were not completed through the Beef Cluster, but a number of individual cattle breed associations are in the process of developing these tools.

**RESEARCH GOAL #3:** Develop improved crop varieties

**Background**: Canadian feed barley yields have not increased as rapidly as US corn yields. Physiological differences between corn and barley, the self-pollinated nature of barley, and significant differences in the value of feed versus malting barley have limited commercial interest in private feed barley breeding in Canada. At the same time, the number of public feed barley breeders and breeding programs has declined.

Shifting public grain breeding programs from a focus on improved feed quality to developing varieties for ethanol production led the beef industry to make significant investments in feed barley breeding in 2009. This triggered larger feed grain investments by provincial funders, and was instrumental in convincing Alberta's provincial government to commit to hiring a new scientist to work with and ultimately replace one of Western Canada's leading feed barley breeders.

Due to substantial investments (e.g. $1.5 million invested by Alberta Beef Producers, which then stimulated further provincial government investments through the Alberta Crop Industry Development Fund and Alberta Livestock and Meat Agency), the BCRC elected not to invest additional funds in feed variety development through the Beef Cluster I.

## VALUE – WHAT DOES IT MEAN FOR INDUSTRY

Feed Grain and Feed Efficiency had 13/15 successfully completed deliverables.

Feed is the single largest variable input cost in both cow-calf and feedlot production. Feed efficiency of Canadian cattle has improved considerably over the past 50 years. Feed conversion ratios published in Canadian scientific literature improved by 40% between the 1950 and 2001. At current feed prices, that historical rate of improvement in efficiency has been worth $8 million per year.

| RESEARCH INDICATORS | FINANCIAL IMPACT TO INDUSTRYŁ (MILLION $) |
|---|---|
| The five-year average barley yield has increased 4% (2.5 bu/acre) from 57.0 bu/acre in 2003-07 to 59.5 bu/acre in 2008-12. This means 273,656 fewer acres were required to produce the same amount of barley. | +$94.0 |
| *Barley Varieties*<br>➢ 19 Triticale varieties have been registered from 2008 to 2012<br>➢ 48 Barley varieties have been registered from 2008 to 2012 | |
| The Feed:Gain Ratio in finishing feedlots reported by journal articles has decreased 1.1% from 6.78 in 2003-07 to 6.70 in 2008-12 (five year average). A 2% lower feedlot feed:gain reduces feed costs by $11/head. | +$13.9 |
| Average daily gain in feedlots reported by journal articles has increased 7% from 3.4 lbs/day in 2008 to 3.7 lbs/day in 2012. This means 13 fewer days emitting GHG per head & 36,148 fewer days in total. | |
| Steer carcass weights have increased 3.7% or 31 lbs from 842 lbs in 2008 to 873 lbs in 2012 | +$153.5 |
| Weaning weight increased from 548.9 lbs (2003-07 average) to 562.7 lbs (2008-11 average) | +$99.7 |

ŁFor assumption and calculation details, refer to Appendix B.

For the feedlot sector, a 5% improvement in feed efficiency could reduce feed costs by over $50 million annually dramatically reducing feed grain usage. While investments in increasing barley yields are being made, there is value in alternative feedstuffs (DDGS) that can be safety fed and reduce costs. For the cow-calf sector, a 5% improvement in feed efficiency would reduce winter feeding costs by close to $30 million annually, with improvements on pasture in addition to that. The value of the beef industry being able to utilize alternative feeds, allows producers to confidently make use of the lowest cost ration in the feedlot and when wintering cows.

**Other Research**: The public benefits in many ways from its investment in plant breeding R&D. In 2003, Nagy calculated the economic returns based on the investments made in feed barley research at the Field Crop Development Centre (FCDC) between 1973 and 2001. The study looked at three aspects of the FCDC feed barley breeding program:

- The development of higher-yielding feed barley varieties
- The development of disease resistant varieties that avoid disease threats
- The development of feed barley varieties that produce higher silage yields

Nagy has attributed about 52% of the benefit of the feed breeding program to increasing yield and 48% to disease resistance. The overall Internal Rate of Return (IRR) for this program was 27%.[3]

Investments in plant breeding also produce cascading economic benefits through the value chain. Plant breeding research produced 10-fold return on investment, with an investment of $8.6 million and overall monetary benefit over $109 million between 1983 and 2001 alone. The internal rate of return (IRR) was 29%, which is excellent for an agricultural research and development program. This type of

[3] Nagy, J. G. 2003. Economic returns to feed barley yield-increasing and disease resistance research at the Alberta Field Crop Development Centre. Can. J. Agric. Econ. 51: 281-298.

public plant breeding research also adds value to the rural economy and these public programs collect additional funds from the private sector.

With a 10-15 year lag from the time of the first breeding cross until the release of a commercial variety, plant breeding programs must start sooner, rather than later for maximum benefit. Focus cannot be solely placed on improving barley yields. Investing in a robust plant breeding program for feed grains that included alternatives would provide synergies and future potential for cross disciplinary work. While current varieties of corn available in western Canada do not consistently provide a high enough yield to offset their higher input costs, investigation into developing a variety that would provide the beef industry with more feed alternatives and the opportunity to choose the lowest cost crop.

With the Alberta Beef Producers' $1.5 million investment in feed grain breeding (and the substantial Alberta Crop Industry Development Fund Ltd. and Alberta Livestock and Meat Agency funds it leveraged) nearing an end, the BCRC will be investing in feed grain breeding research to maintain breeding momentum in the 2013-2018 period.

The National Beef Research Strategy has outlined four Feed Grains and Feed Efficiency research outcomes for the next ten years:

1. Improved feed efficiency through animal breeding
2. Improved feed supply and utilization
3. Improved management of manure nutrients
4. Research and training capacity

| Research Goal | Project | Deliverable | | Progress made on Deliverables |
|---|---|---|---|---|
| 1. Evaluation and identification of optimal strategies for feeding Dried Distillers' Grains with Solubles (DDGS) | **FDE.01.09** Develop Nutritional Strategies to Optimize Protein Value of Feeding Ethanol By-Products to Beef Cattle | Information on rumen degradability and intestinal digestibility of DDGS protein and development of recommendations to optimize protein utilization for feeding DDGS to beef cattle, while mitigating negative environmental impact due to less P excretion. | ✓ | FDE.01.09 through FDE.02.09 – these projects considerably increased the information available regarding the effects of grain type (wheat, corn or blends), source (ethanol plant) and processing (conventional or fractionation) on the nutrient value of DDGS and manure from cattle fed DDGS, and helped more precisely determine the market value of these feeds relative to corn or barley. |
| | **FDE.02.09** New Strategies to More Efficiently Utilize Cereal Grains (Oats, Barley, Corn) and Bioethanol By-Products for Beef Cattle | Development of strategies to optimize cereal grain utilization in combination with ethanol by-products for finishing cattle. | ✓ | Based on the previous deliverable, strategies to effectively incorporate DDGS into backgrounding and finishing diets were developed and widely adopted by industry, when DDGS are available and priced cost effectively. |
| | **FDE.03.09** Composition and Meat Quality of Cattle Fed Wheat or Corn-Based Distillers' Grains with Solubles from New Generation Ethanol Plants | Evaluation of the impact of wheat and corn-based distillers' grains on carcass composition and meat quality. | ✓ | Feeding 40% wheat DDGS, 40% corn DDGS or their blend did not significantly affect carcass weight, yield or quality grades, or sensory characteristics of steaks or roasts. |
| | **FDE.04.09** Rate of Nitrogen and Phosphorus Release in Soil Amended with Manure Derived from Animals Fed Ethanol By-products | Information on agronomic values of DDGS manure and compost generated | ✓ | Fresh or composted manure from cattle fed DDGS (wheat or corn) was comparable to a barley-fed control. The wheat-based DDGS fresh manure produced the highest canola biomass yield. Composting concentrates N and P in manure, and may lead to plant toxicity when high rates of manure are applied. |
| | | Identification of the potential impact of increased use of DDGS in the livestock industry on GHG emissions and nutrient availability and accumulation in soil. | ✓ | Substituting wheat or corn DDGS for barley grain improved the fertilizer value of cattle manure and compost without increasing GHG emissions from manure. Composting concentrates N and P in manure and may lead to soil accumulation when high rates of manure are applied. |
| 2. Develop and validate economical methods of identifying beef cattle with improved feed efficiency | **FDE.05.09** Whole Genome Scan for Feed Efficiency | Genotype another 2,000 animals, measuring residual feed intake (RFI) and combine with existing 1,500 animal genotypes in the data bank. Combine the predictive SNP from animals genotyped with those identified in current fine mapping to derive a panel of candidate SNP to predict feed efficiency and facilitate validation. | ? | Many population- or breed-specific feed efficiency markers were identified, but few have predictive value across breeds or populations. This has hindered the development of viable marker panels for sorting commercial feedlot cattle. However, several purebred associations have become very active in supporting research to develop marker panels for within-breed selection. |
| | **FDE.07.09** The Impact of Nutrition and Residual Feed Intake on Tissue and Molecular Characterization, | Improved understanding of the underlying factors influencing maintenance energy expenditure, fetal growth and programming in pregnant beef cows. | ✓ | A wide range of hormones and physiological indicators of feed efficiency were identified (which may help in future efforts to find better markers in the preceding deliverable) |
| | | Determine the impact of nutrition on regulating maintenance energy requirements and feed | ✓ | Overfeeding and underfeeding cows was shown to affect the expression of genes related to fetal growth, although no differences |

| | | | | |
|---|---|---|---|---|
| | Manipulation of Maintenance Energy Costs, and Fetal Growth and Programming in Wintering Pregnant Beef Cows | efficiency in pregnant beef cows and subsequent growth in fetuses. | | in calf birth weight, survival or health were observed. |
| | **FDE.06.09** Biological Predictors of Feed Efficiency in Feedlot Cattle | Better characterize what an efficient cow is (i.e. body composition, tissue mass, and gene/protein expression). | ✓ | Fecal progesterone, liver cells, thyroid hormones, milk composition and possibly immune function all differed between efficient and inefficient females; further research is needed to confirm these findings in larger populations. |
| | | Recommended protocols to use infrared thermography to predict/select cattle for feed efficiency. | ✓ | A graduate course in the use of infrared thermography in cattle was taught at the University of Guelph. |
| | | Identification of certain hormones/metabolites determinations to predict/select for feed efficiency. | ✓ | Fecal cortisol metabolites were found to be associated with feed efficiency. |
| | | Identification of economical feeding behavior traits that provide insights into feed efficiency. | ✓ | Inefficient bulls spend their free time fighting, while feed efficient bulls spend their free time ruminating and resting. There is increasing evidence that efficient bulls are less fertile. |
| 3. Develop Improved Crop Varieties | **FRG.01.10** The development of molecular markers for improved fibre quality in barley | Markers and genes in barley that affect digestibility of fibre will be identified and validated. | ✓ | Multiple genetic markers explaining between 5 and 36% of the variation in barley silage digestibility were discovered. Marker validation will be completed in summer 2013. |
| | | Heritability of fibre digestibility in barley will be determined. | ? | A reliable value for heritability could not be developed because the phenotype data was not collected in multiple locations, but the preceding result suggests that it is moderately to highly heritable. Related research from this team is underway to determine this. |
| | | Information on NDF levels and digestibility in 197 recombinant inbred lines of barley will be provided. | ✓ | 200 recombinant inbred lines (ril's) of barley using falcon, crossed with Tyto, Kasota, AC Virden, Seebe, Manny, i79207 and h93174006; digestibility parameters were used to identify genetic markers within and across the ril's. |

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

## FORAGE & GRASSLAND PRODUCTIVITY

**OVERARCHING OBJECTIVE**

Increase research program capacity to develop annual and perennial forage varieties with increased biomass yield per acre, maintained or improved nutritional value, improved water efficiency, and appropriate economic characteristics. Improve grassland management to increase productivity and sustainability.

**Background**: At 50 million acres, forage and grassland are the largest crops in Canada, and are responsible for approximately 80% of the weight gained by cattle. Higher grain prices increase feeding costs and put downward pressure on feeder calf prices. Narrow margins in the cow-calf sector increase the need for innovative ways to reduce production costs. High grain and oilseed prices have also resulted in the conversion of pasture into annual crop production. With less pasture land available as more is converted to grain, productivity must improve on remaining acres to support beef production.

Enhancing forage and grassland research capacity to develop drought-adapted forages that improve productivity, increase water use efficiency, identify new grazing and feeding strategies that optimize carrying capacity and feed production are critical to ensuring the competitiveness and sustainability of Canada's beef industry in the face of continued climate change and economic challenges. Improved forage productivity also has significant environmental benefits through improved carbon sequestration, soil health, biodiversity, wildlife habitat, and watershed protection.

### FINDINGS

**RESEARCH GOAL #1:** Development of legumes and grasses for summers that are warmer and drier than normal

**Background**: In spite of the importance of forage resources to Canada's beef industry, public investment in forage breeding programs has declined greatly over the past thirty years. This can be attributed to the fact that the forage sector lacks a system to raise funds to support forage breeding and production research. Recognizing this, the BCRC has doubled the proportion of funds it has allocated to forage research in the 2009-2013 period compared to 2001-2008. These investments have trained numerous forage breeders to serve Canada's forage and beef sector. A number of research proposals in Beef Cluster II are aimed at using this new expertise to develop new varieties that will provide both high yielding and highly nutritious forage cultivars for beef cattle.

Feed costs in pasture-based cow-calf production are best addressed by both increasing forage productivity and reducing winter confinement-feeding costs. A study to "Develop Drought-Tolerant Forage for the Dry Mixed-Grass Prairie" at AAFC Swift Current found that considerable variability exists in native grasses and legumes, suggesting that there are opportunities to appropriately align native forage species with regionally-specific growing conditions, soil types and climatic conditions.

Nine field nurseries of native plants were established, and side-oats grama and plains rough fescue were advanced to pre-breeder seed nursery establishment. Including a tame legume increased forage yields and animal performance, but out-competed the native grasses over time. Including a native legume did not improve forage production or animal performance in native grass pastures.

Newly developed sainfoin populations produced higher yields both in pure and mixed stands with alfalfa than an older sainfoin (Nova) variety over 3-4 years. The proportion of sainfoin in the mixed stand declined over years, but the new populations declined less rapidly than Nova both under irrigated and dryland conditions. No bloat was observed in a mixed alfalfa-sainfoin pasture over two grazing seasons. The sainfoin varieties did not differ in forage quality, and all produced similar growth performance, yields and grazing days under normal grazing pressure. The most promising new variety (Mountainview) is being offered for commercialization.

**RESEARCH GOAL #2:** Optimize yields and determine the optimal varieties and species mixtures for swath grazing

**Background**: Winter feeding can account for as much as two-thirds of annual production costs in the cow-calf sector. The development and adoption of extended winter grazing systems have reduced the need to harvest, transport, store and deliver feed to cows fed in confinement, and have reduced facility maintenance, pen cleaning and manure spreading costs. For instance, stockpiled grass costs are estimated to be 42% ($0.73/day) lower than traditional confinement feeding. Keeping all of Canada's beef cows and replacement heifers (4.78 million head) on pasture for one more day every winter would save the cow-calf sector an estimated $3.5 million annually. Beef cattle are the primary commodity produced by 69% of farm operations in Western Canada's brown soil zone and 79% of these farms have adopted extended grazing systems.

Research suggests that swath grazing triticale can reduce winter feeding costs by over $100 per cow compared to wintering cows for 100 days in a corral. Savings were lower for swath grazed barley ($89) due to lower yields, and for corn ($83) due to higher input costs. This has significant implications for Canada's beef industry, as reducing total winter feeding costs by as little as 1% would save Canada's cow-calf sector an estimated $6 million annually.

Spring triticale performed well under the cooler growing conditions of central Alberta, but oats and triticale did not perform as well as barley under the more adverse conditions at Brandon, Manitoba. Pea mixtures did not clearly improve the feeding value or cost of feed per day compared to pure stands of triticale and oats. In two swath-grazing trials, triticale was utilized as well as corn in both trials and to a greater extent than barley in one. Nutritive value of the swath was variable throughout the winter. Corn generally maintained the highest nutritive value over winter, triticale was intermediate and barley had the lowest nutritive value. Triticale had the lowest production cost, high yields, and a lower daily feeding cost compared to barley and corn. High-yielding crops which utilize a greater portion of the season than barley have the potential to reduce the cost of wintering cows further than previously envisioned.

**RESEARCH GOAL #3:** Examination of the impact of forage finishing strategies on growth performance, carcass characteristics, and meat quality

Forage-finishing resulted in slower, less efficient finishing performance compared to corn-based finishing. Forage-finished steers had lighter carcasses, lower yield and quality grades than corn-fed steers. A distinctive flavour of forage-finished beef from oxidation and off-flavours due to higher polyunsaturated fat levels may not be a concern for consumers who seek forage-finished beef. Fatty acid composition differences in diets were of questionable practical significance.

**RESEARCH GOAL #4:** The development of alternative grassland and forage management strategies

**Background**: Forage projects have been aimed at increasing the yield and nutritional quality of annual and perennial (both tame and native) forages in Canada. The root systems of healthy pastures have also been shown to sequester as much carbon as old-growth forests; this information will be helpful to promote positive public messages about the contribution the beef industry makes to Canada's environment.

Lower fertilizer costs improved returns for alfalfa-grass pastures. Swath grazing in late summer / early fall (instead of late fall / early winter) increased the duration and stability of pasture grazing, but had poorer cattle gains during the earlier swath grazing period. Economic simulation indicated substantial benefit to alfalfa inclusion and small detriments to rested grazing, though these may be overcome if cow-calf performance on early-seeded and early-swathed annuals could be improved.

A genetic map for barley was generated, and markers explaining 5 to 36% of the variation in silage quality were identified across barley's seven chromosomes. Markers for lignin, starch and digestibility appeared to cluster in chromosomal "hot spots". Appropriate forage and legumes mixtures can provide an optimal ratio of forage quality and yield. Complex mixtures with alfalfa, meadow fescue, and timothy provided

the best combination of forage quality and yield, regardless of the other grasses included in the particular mixture. Birdsfoot trefoil and meadow fescue should be considered for use in eastern Canada.

## VALUE – WHAT DOES IT MEAN FOR INDUSTRY

Forage and Grassland Productivity had 15/15 successfully completed deliverables.

Canada's forage industry is the single largest crop with 80% of production going to livestock feed. As a critical input for the cow-calf and backgrounding sector Canada's forage productivity must continually improve to support Canada's international competitiveness. There are challenges to valuing this commodity as only a small proportion is actually traded, with the majority being produced and used on farm. The cost of production is rarely measured to determine if the enterprise is profitable for the operation, frequently resulting in underinvestment both on the farm and by industry as a whole.

Understanding the value of biodiversity and other ecosystem services will help producers benefit from sustainable management practices.

| RESEARCH INDICATORS | FINANCIAL IMPACT TO INDUSTRY Ł (MILLION $) |
|---|---|
| The five-year average[4] tame hay yield increased 8% from 1.69 tons/acre in 2003-07 to 1.84 tons/acre in 2008-12 | +$0.14 |
| *Registered varieties*<br>➢ 58 alfalfa varieties have been registered from 2008 to 2012<br>➢ 6 bromegrass varieties have been registered from 2008 to 2012<br>➢ 4 ryegrass varieties have been registered from 2008 to 2012<br>➢ 11 clover varieties have been registered from 2008 to 2012<br>➢ 1 birdsfoot trefoil variety has been registered from 2008 to 2012<br>➢ 8 orchardgrass varieties have been registered from 2008 to 2012 | |
| *Grassland productivity*<br>➢ In 2011 36.33 million acres were in natural pasture, down 4.7% or 1.8 million acres from 38.16 million acres in 2006.<br>➢ In 2011, 13.67 million acres were in tame or seeded pasture, down 2.4% or 340,000 acres from 14.01 million acres in 2006.<br>➢ In 2011, 31.2% of Canadian agricultural land was in permanent pasture compared to 31.3% in 2006 | |
| *Best management practices*<br>➢ In 2011, 51,589 farms reported they use rotational grazing (75.4% of beef farms) compared to 70,798 farms or 82% in 2006. Part of the decline is from producers leaving the industry.<br>➢ In 2011, 30,260 farms reported they used in-field winter grazing or feeding: 44.2% of the 68,434 beef farms in Canada.<br>➢ In 2011, 41,541 farms reported they used nutrient management planning: 41.7% of the 99,573 agricultural operations that applied manure (includes all livestock manure, not just cattle)<br>The number of acres that receive fertilizer have been steady from 2006 (37.5% of total farm area) to 2011 (38.4% of total farm area) | |

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

As fuel and land costs increase, the per unit cost of producing hay has also increased. Gains in forage yields nationally have been very modest with some provinces reporting declines. The industry is not keeping up with increasing input costs and consequently the industries competitive advantage is eroding. Research that focuses on reducing the per unit cost of production in the forage sector will evaluate all plant breeding and management practices with economic analysis.

**Other Research**: In the US recommended fertilizer rates have not changes substantially since the 1970s (based on soil zone, precipitation), however efficiency and use of fertilizer by plants has improved (decreasing volatilization and runoff) resulting in larger yield response with new varieties. This implies

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

that continued research into yield response with genetic advancements (application method, type of fertilizer, variety) will change the economic cost/benefit.

Preventing further reductions in research capacity is a high priority for the BCRC. One of the forage researchers trained has become a Forage Management Specialist with Saskatchewan Ministry of Agriculture. Unfortunately, industry efforts to get several of these scientists hired into permanent positions to reinforce federal carcass composition and forage research capacity at AAFC Lacombe and AAFC Swift Current have not yet been successful.

The National Beef Research Strategy has outlined four Forage and Grassland research outcomes for the next ten years:

1. 33% improvement in yields and nutritional quality of tame, native and annual species through improved pasture, forage and grazing management and plant breeding
2. Environmental sustainability
3. Research and training capacity
4. Extension, outreach and policy

| Research Goal | Project | Deliverable | | Progress made on Deliverables |
|---|---|---|---|---|
| 1.Development of legumes and grasses for warmer and drier summers | **FRG.01.09** Development of Drought-Tolerant Forage for the Dry Mixed-Grass Prairie | Develop drought adapted forages to mitigate the impact of climate change and increase water use efficiency to improve productivity of short-grass prairie. | ✓ | 9 field nurseries of native plants (primarily side-oats grama and plains rough fescue grass) were advanced to pre-breeder seed nursery establishment |
| | | Determine impact of specific forages on livestock nutrition – impact of condensed tannins and antimicrobial activity on E. coli within the digestive tract. | ✓ | In fall (but not summer), cattle grazing pastures containing purple prairie clover had reduced levels of fecal *E. coli* shedding compared to cattle grazing bromegrass. |
| | | Maintained and enhanced human resources in breeding forage for the short-grass prairie. | ✓ | A post-doc was trained and hired as a forage management specialist with the Saskatchewan Ministry of Agriculture |
| | **FRG.02.09** Advancing the Development of Bloat-Safe Alfalfa Grazing Through the Development and Establishment of Improved Sainfoin Germplasm | Identification of potential new sainfoin cultivars and alfalfa/ sainfoin mixtures under grazing to eliminate bloat risk and demonstrate longevity for highly productive legume pastures. | ✓ | Three new sainfoin populations were developed that produced higher biomass both in pure and mixed stands with alfalfa than Nova, and declined less rapidly than Nova both under irrigated and dryland conditions. |
| | | Assessment of the ability of sainfoin condensed tannins to reduce methane emissions from grazing ruminants. | ✓ | No differences in methane emissions were observed. |
| | | Facilitate the development and uptake of new cultivars of sainfoin by industry through technology transfer. | ✓ | The most promising sainfoin line (Mountainview) has been offered for commercialization, and this research has been highlighted in numerous field days and industry publications, particularly in Alberta and Saskatchewan. |
| 2. Optimize yields, performance of swath grazing as a feeding program and determine the optimal varieties and species mixtures for swath grazing | **FRG.03.09** Reducing the cost of swath grazing cows by increasing the swathed-crop yield<br><br>**FRG.02.10** Reducing the cost of swath grazing cows by increasing the swathed-crop yield | Provide new agronomic recommendations for swath grazing to improve economic efficiency by increasing carrying capacity, yield and yield stability of swath grazed crop. | ✓ | This research has been highlighted in numerous field days in Alberta, particularly in collaboration with the Grey-Wooded Forage Association. |
| | | Determine the feasibility of winter swath grazing of two high yielding long season crops – spring triticale and corn. | ✓ | Swath grazing triticale reduced winter feeding costs by over $100 per cow compared to wintering cows for 100 days in a corral. Savings were lower for swath grazed barley ($89) due to lower yields, and for corn ($83) due to higher input costs. |
| | | New agronomic recommendations to lower the daily cost of swath grazing will be developed. | ✓ | At both Brandon and Lacombe there was a general trend for decreasing yields with later planting dates (May 10, May 24, June 1, June 7). Winter triticale and field pea did not improve *in vitro* true digestibility (IVTD) in mixtures over oat and spring triticale grown alone. However, when field pea was grown in mixture with barley the IVTD of the mixture was raised to a level significantly higher than oat and spring triticale grown alone. |
| 3. Examination of the impact of forage finishing strategies on growth performance, carcass characteristics, and meat | **FRG.04.09** Effect of Method of Forage Finishing and Cattle Breed on Growth Performance, Carcass Characteristics, Eating Quality, and Nutrient Composition of | Determine if beneficial changes in the fatty acid and vitamin composition of beef occurs regardless of the method of forage finishing. | ✓ | Differences in fatty acid and vitamin composition of beef were negligible among cattle finished on pasture, hay silage, grass or grain. |
| | | Determine how the method of forage finishing (pasture, hay, silage) and differing fatty acid composition of forages affects growth performance, carcass traits, eating quality, shelf-life, and nutrient composition of beef relative to grain-finished beef | ✓ | Forage-finishing resulted in slower, less efficient finishing performance compared to corn-based finishing. Forage-finished steers had lighter carcasses, lower yield and quality grades than corn-fed steers. A distinctive flavour of forage-finished beef from oxidation and off-flavours due to higher polyunsaturated fat levels was noted for forage-finished beef. |
| | | Determining if cattle breed influences the effect of forage conservation on performance, quality, and nutrient | ✓ | Both Angus and Hereford cattle responded the same way to all finishing methods. These were the only breeds tested in this study. |

| | | | | |
|---|---|---|---|---|
| quality | Forage Finished Beef Relative to a Grain Finished Product | composition. | | |
| | | Determine year to year variation on performance and product quality with forage finishing. | ✓ | Year to year variation is a reality with forage finishing programs due to temperature and rainfall effects on forage and pasture productivity. |
| 4. The development of alternative grassland and forage management strategies | **FRG.07.10** Performance on forage mixtures under a beef grazing management system in the northern latitudes | Development of regional recommendations to help agronomists and beef producers identify forage mixtures suitable for the environment and management systems in which they will be grown. | ✓ | Preliminary results have identified that birdsfoot trefoil and meadow fescue have potential advantages for use in eastern Canada. This research will continue under Beef Cluster II. |
| | **FRG.09.10** Effect of resting perennial pastures during the critical acclimation period on beef cattle performance, alfalfa persistence, pasture productivity, and water use efficiency | Identification of potential benefits in productivity, stand and root health, alfalfa persistence, system energy balance, water use efficiency and economics from grazing either meadow brome or meadow brome/alfalfa pastures with and without a period of rest in mid- to late-summer where grazing is deferred and pasture stockpiled for grazing after October 1. | ✓ | Early season swath grazing increased the duration and stability of pasture grazing, but had poorer cattle gains during the resting period. Economic simulation indicated substantial benefit to alfalfa inclusion and small detriments to rested grazing. |

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

## BEEF QUALITY

**OVERARCHING OBJECTIVE**

To increase the demand for Canadian beef domestically and globally through improvements in production to reduce inconsistencies and increase quality, product development, implementation of alternative strategies and technologies to enhance the value of underutilized cuts, and continued investments in carcass quality and grading technologies.

**Background**: Canada's beef quality forms the basis of consumer choice contributing to the competitiveness of Canadian beef with other proteins and against competitors' beef in markets around the world. Traditionally Canada has successfully produced a youthful, lean product from a primarily grain-based feedlot production system that responds to a grading system that rewards for certain characteristics. The beef industry recognizes the importance of strengthening Canada's competitive advantages through evolving carcass and meat quality as consumer preferences and competitor attributes continually change.

Significant effort has been placed by industry on building the Canadian Beef Advantage brand in domestic and international markets. The Canadian Beef Advantage strategy is founded upon several differentiating attributes relating to animal production, profitability, health and beef safety, quality, and nutrition. The strategy is to clearly differentiate Canadian beef and cattle genetics, establishing a distinct value to customers and a competitive advantage for the Canadian industry.

Successful brand differentiation will result in increased demand for Canadian products, but its success is contingent on delivering consistently high quality, tender beef and demonstrating to customers and consumers that Canadian beef can be truly differentiated from its competitors. The National Beef Quality Audit (NBQA) and carcass and meat quality research that provide objective measures will be utilized on two fronts. First, results will identify areas for improvement in primary production to accelerate enhancements in quality. The NBQA will also establish objective indicators of quality that substantiate the points of differentiation for Canadian beef, enhancing our industry's ability to position Canadian beef against competitive products domestically and internationally.

### FINDINGS

**RESEARCH GOAL #1:** Completion of a national beef quality satisfaction survey and carcass audit

**Background**: Since the mid-1990's, the Canadian beef industry has supported three National Beef Quality Audits covering both carcass quality and retail consumer satisfaction. The carcass quality audits are designed to monitor a wide variety of quality defects that can be improved through better management, as well as to measure whether these quality defects become less common in response to producer-directed communications about carcass defect prevention strategies. Retail consumer satisfaction audits are designed to assess consumer demographics pertaining to beef purchase decisions, awareness and adoption of industry recommendations regarding cooking practices, and satisfaction with eating quality.

Carcass quality audits have been conducted in 1995-96, 1998-99 and 2010-11. Retail consumer satisfaction audits have been conducted in 1998-99 and 2009-10. Results of the first carcass quality audit were used to inform producer messaging through the Quality Starts Here program in an effort to reduce the incidence of avoidable defects such as bruising, horns, brands and injection site lesions. These efforts have been successful. In 2010-11, the average per head cost of avoidable carcass defects was $59.67. If defects had not fallen from the 1998-99 level, the average per head cost would have been $76.79. The percentage of steaks given a 10/10 by Canadian consumers has increased from 20% in 2001 to 23% in 2009.

The intent is to have these audits recur on a regular five-year cycle. Audits provide invaluable information to inform and support marketing strategies, as well as identifying future research priorities based upon identifying areas where opportunities for improvement exist.

Consumers reported improved satisfaction with juiciness (up 8%), flavour (up 8%) and tenderness (up 12%) of Canadian beef in 2009 compared to 2001. Improved satisfaction with the eating quality of Canadian beef will contribute to improved consumer confidence.

This is enhanced by the positive animal welfare messages implicit in the finding that horns, brands, and bruises are less prevalent than in previous audits. The proportion of fed/non-fed cattle with brands and horns decreased by 82%/57% and 59%/66%, respectively in 2010/11 compared to 1998/99. The proportion of cattle with bruises declined by 31% for fed cattle, but increased by 12% for non-fed cattle, and the incidence of condemned livers increased in both fed and non-fed cattle compared to 1998/99.

**RESEARCH GOAL #2:** Enhance grading and carcass evaluation capacity and technology development in Canada

**Background**: Canadian retailers will not sell dark cutting beef due to its dark purple color (and possibly reduced shelf life), even though eating quality is not greatly impacted. Dark cutting beef is assigned to the B4 grade, and can be docked up to $40/cwt (carcass weight) or $340/head. The US grading system allows darker colored meat to stay in the quality grades, resulting in fewer carcasses being designated as dark cutting and discounted. The BCRC's communication efforts have outlined known cattle management factors that influence the risk of dark cutters. A University of Alberta research project is investigating carcass management practices that may help packers to lower the frequency of dark cutters (BQU.02.09). Another research project (BQU.01.09) is assessing consumer reactions to dark cutting beef, as well as alternative packaging strategies that may help overcome some of the stigma associated with dark cutting beef.

Over the last five years the proportion of carcasses grading AAA or higher increased from 51.6% in 2008 to 56.7% in 2012, while the proportion of yield grade 1 carcasses decreased from 60.8% in 2008 to 48.8% in 2012. Dark cutting beef (B4 grade) prevalence in youthful cattle decreased from 1.4% in 2008 to 1.2% in 2012.

The dark cutting phenomena is more complex than previously suspected. Dark cutting in beef carcasses was not affected by slightly lower chilling temperatures, indicating that the incidence of atypical or borderline dark cutting is not likely related to the number of carcasses in the cooler. Three distinct subcategories of dark cutters were observed. Classical dark cutters have a high pH, dark color in most muscles, and do not brighten up with prolonged exposure to air. Atypical dark cutting carcasses have fewer dark muscles in the forequarters, suggesting that value may be recovered by removing unaffected, normal-colored muscles from the front quarter. Borderline dark cutters have an intermediate pH, with less pronounced darkness in the hindquarter, and produce noticeably tougher beef.

**RESEARCH GOAL #3:** Development of alternative feeding strategies to enhance beef fatty acid composition

*Deliverables that were not met*: Optimal feeding strategies to enhance omega-3 levels in mature and youthful cattle were not developed. A fatty acid workshop held in the fall of 2009 clarified that the omega-3 fatty acids predominant in beef have no known human health benefits. Attaining a CFIA nutrient content label claim for beef would require that omega-3 fatty acids be increased by approximately 1,000%. This would compromise shelf life, taste, odour and consumer acceptability. There was no apparent value in pursuing this line of research from a commercial opportunity perspective, although continued research to characterize fatty acid composition from a human health and nutrition perspective is still warranted.

**RESEARCH GOAL #4:** Development of processing technologies that will optimize the value of tougher cuts

Four plant enzymes were found to increase the heat solubility of perimysium, and are therefore potentially useful for the tenderization of meat. Papain reduced the toughness of the beef

substantially, but a consumer panel found the beef to be unacceptably soft. The flavours imparted by kachri and ginger were acceptable and if a method of injecting a more concentrated solution of these enzymes was devised, both tenderness and flavour may be improved.

**RESEARCH GOAL #5:** The development and validation of genomic tests for identifying beef tenderness

Past research investments that contributed to determining the sequence of the bovine genome revealed thousands of unique DNA markers. Marker frequencies were compared in research populations of cattle (that had tenderness measurements as well as a defined genetic background). Promising markers from each population were then compared across populations as well as independent validation populations. The DNA panel was able to explain 40% of the genetic variation in beef tenderness in the population it was developed in. While promising markers were found within each population, very few markers had predictive value across populations. This suggests that breed-specific marker panels are likely the most appropriate approach to follow until the actual functional mutations responsible for differences in tenderness and eating quality are identified.

## VALUE – WHAT DOES IT MEAN FOR INDUSTRY

Beef Quality had 7/12 successfully completed deliverables.

The goal of improving beef quality is to support beef demand by increasing consumption or increasing the price consumers are willing to pay for beef. Without advancements in beef tenderness, juiciness and consumer satisfaction as shown in the National Beef Quality Audit one could expect that beef demand would have declined further, but in fact, beef demand has stabilized over the last 15 years after declining throughout the 1980s and into the first part of the 1990s.

<table>
<tr><th>RESEARCH INDICATORS</th><th>FINANCIAL IMPACT TO INDUSTRYŁ (MILLION $)</th></tr>
<tr><td>
Tenderness<br>
➢ Overall consumer satisfaction rose from 73% in 2001 to 80% in 2009<br>
➢ Satisfaction drivers: percentage of satisfied customers*
<table>
<tr><th></th><th colspan="2">Tenderness</th><th colspan="2">Juiciness</th><th colspan="2">Flavour</th><th colspan="2">Overall</th></tr>
<tr><th>Steak Type</th><th>2009</th><th>2001</th><th>2009</th><th>2001</th><th>2009</th><th>2001</th><th>2009</th><th>2001</th></tr>
<tr><td>Strip loin</td><td>84%</td><td>82%</td><td>87%</td><td>82%</td><td>86%</td><td>85%</td><td>87%</td><td>84%</td></tr>
<tr><td>Top sirloin</td><td>83%</td><td>76%</td><td>88%</td><td>81%</td><td>90%</td><td>82%</td><td>86%</td><td>83%</td></tr>
<tr><td>Boneless cross rib</td><td>71%</td><td>58%</td><td>72%</td><td>62%</td><td>79%</td><td>69%</td><td>75%</td><td>65%</td></tr>
<tr><td>Inside round</td><td>63%</td><td>55%</td><td>65%</td><td>61%</td><td>70%</td><td>69%</td><td>69%</td><td>59%</td></tr>
<tr><td>ALL STEAKS</td><td>76%</td><td>68%</td><td>78%</td><td>72%</td><td>82%</td><td>76%</td><td></td><td></td></tr>
</table>
*A satisfied customer was defined as one who gave a rating of 7/10 or higher<br>
➢ Laboratory measurements backed up consumer comments. Shear force tests conducted at the AAFC Lacombe Research Centre found the percentage of steaks requiring no tenderness enhancement increased for striploin (2001 89%; 2011 99%), top sirloin (2001 70%; 2011 87%), inside round (2001 52%; 2011 61%) and cross-rib (2001 65%; 2011 76%) steaks.
</td><td></td></tr>
<tr><td>Quality Grading<br>AAA and Prime as a percentage of all A grades increased from 51.6% in 2008 to 56.7% in 2012</td><td>+$4.62</td></tr>
<tr><td>Yield Grades<br>➢ Y1 decreased 12% from 60.8% in 2008 to 48.8% in 2012<br>➢ Y2 increased 5.2% from 28.4% in 2008 to 33.5% in 2012<br>➢ Y3 increased 6.9% from 10.9% in 2008 to 17.7% in 2012</td><td>-$18.8</td></tr>
<tr><td>Dark Cutters - In the past five years, B4 incidence declined 0.2% from 1.4% of youthful slaughter in 2008 to 1.2% in 2012<br>Reducing B4 level from 1.2% in 2012 to 0.8% seen in 1999 will save the industry $1.77 million</td><td>+$0.87</td></tr>
</table>

ŁFor assumption and calculation details, refer to Appendix B.

Reduced consumption and lost market share resulted in further losses in the overarching research indicators for beef quality. While gains were seen in the percentage of carcasses grading AAA, there

were fewer yield grade 1 cattle and more yield grade 3 cattle. By heavily focusing market signals on AAA production, the industry is actually seeing a net loss as costs from putting on additional fat are accrued by the feedlot which is then trimmed by the packer. This is an area where preventing further losses is critical to reducing waste and the amount of feed industry uses in production.

**Other Research**: *Beef Demand: Recent Determinants and Future Drivers* by Ted Schroeder, Glynn Tonsor and James Mintert (April 20, 2013[5]) indicated that there are seven broad beef product attributes identified as prominent demand factors for beef: (1) price (2) food safety (3) product quality (4) health (5) nutrition (6) social aspects and (7) sustainability. Product quality and food safety were consistently in the top three items named in importance by consumers and industry experts (price being the first). Product quality includes a wide range of attributes from taste, juiciness, consistency, color and appearance to freshness, shelf life, preparation ease, convenience and tenderness. Consumers desire consistent high quality products with excellent flavour, color, texture, juiciness, freshness, preparation ease and package/portion size.

The Consumer Beef Index (2012) shows "taste of beef" and "quick and easy" as the two most common reasons for eating more beef. Beef experts rated preparation ease as one of the potentially more impactful future demand drivers. Nintey-two percent of experts stated that preparation ease was likely to impact ground beef demand and 82% stated it was likely to impact steak demand over the next ten years. An expert survey revealed that more than 70% agreed that over the next ten years beef product freshness could positively impact beef demand. In the 2013 Power of Meat Study, only 25% of American consumers felt that they were very knowledgeable about how to assess meat freshness. Because meat freshness has been identified as important to consumers, this is an opportunity for education.

The National Beef Research Strategy has outlined three Beef Quality research outcomes for the next ten years:

1. Improved consumer satisfaction with Canadian beef
2. Validation of the Canadian Beef Advantage relative to international competitors
3. Extension, outreach and policy

[5] Funded by the Cattlemen's Beef Board http://www.beefboard.org/evaluation/130612demanddeterminantstudy.asp

| Research Goals | Projects | Deliverable | | Progress made on Deliverables |
|---|---|---|---|---|
| 1. Completion of national beef quality satisfaction survey and carcass audit | **BQU.01.09** National Beef Quality Satisfaction Survey and Carcass Audit | Conduct a national consumer satisfaction survey of retail beef products to determine the current quality of beef consumed in Canada and the improvements made since previous surveys in 2001 and 1995. | ✓ | Consumer satisfaction with the flavour, juiciness and tenderness of Canadian beef all increased by 8 to 12% since the 2001 beef quality audit. |
| | | Conduct a comprehensive national audit of carcass defects in processing plants to determine the economic costs to the industry and the improvements made since previous audits in 1995 and 1998/99. | ✓ | Notable reductions in the incidence of brands, horns and bruises were noted since the previous audit; a considerable increase in the incidence of liver discounts was also observed. |
| | | Conduct a survey of feedlot to processing plant management practices to determine potential causes of significant carcass defects and ways to enhance meat quality. | ✓ | Bruising, horns, dark cutters and general lack of consistency were identified as key animal management related issues of shared concerns among both the feedlot and processing sectors |
| | | Utilize information to support industry's efforts to market Canadian beef advantages, develop applied research plans to correct deficiencies, and develop communication and education programs to promote necessary advancements within the Canadian beef industry to improve quality, increase consistency, and reduce deficiencies. | ✓ | A series of workshops, video presentations, brochures and articles have been developed and conducted, primarily through www.beefresearch.ca. |
| | | Technologies currently in use in feedlots and processing plants will be refined so that high carcass grades can be guaranteed with greater certainty. | ? | Achievement of this deliverable is expected to follow from effective communication in the preceding box. |
| 2. Enhance grading and carcass evaluation capacity and technology development in Canada | **BQU.02.09** Carcass Classification and Grading Capacity and Technology Development | Prototype technologies to affordably and objectively sort carcasses by grade and other quality parameters will be developed and/or evaluated. | ? | Prototype technologies to objectively assess marbling have been developed; prototype technologies to objectively assess tenderness have shown less progress. |
| | | Training and mentoring of new meat scientists with experience in beef carcass evaluation, grading, and quality attributes. | ✓ | A new meat scientist has been trained by AAFC Lacombe; efforts to bring him into the AAFC system as a permanent scientist have not been effective yet. |
| 3. Development of alternative feeding strategies to enhance beef fatty acid composition | **BQU.O3.09** Omega-3 and Fatty Acid Beef Workshop | Identify the key opportunities for research in the area of increasing omega-3 fatty acid content of fat and meat in fed cattle and cull cows. | ✓ | A workshop was conducted where it became very apparent that this is not a practical objective and therefore is no longer a research goal. |
| 4. Development of processing technologies that will optimize the value of tougher cuts | **BQU.04.10** Improvement of high connective tissue beef cuts with collagenolytic enzymes | Identification of enzymes that specifically tenderize collagen within beef and that are viable for use in a commercial beef processing system. | ✓ | Four plant enzymes were found to increase the heat solubility of perimysium, and are therefore potentially useful for the tenderization of meat. |
| 5. The development and validation of genomic tests for identifying beef | **BQU.03.10** Genomic testing for tenderness in Canadian beef | A DNA test for beef tenderness and associated production traits in Canadian beef cattle | ? | Many population- or breed-specific feed efficiency markers were identified, but few work across breeds or populations. This has hindered |

| | | | | |
|---|---|---|---|---|
| tenderness | | | | the development of commercially viable panels for sorting feedlot cattle or carcasses, but within-breed panels are being pursued by purebred associations. |

 - Solid Results  - Failed  - Partial Results or Incomplete

## FOOD SAFETY

**OVERARCHING OBJECTIVE**

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

**Background**: Maintaining domestic and international consumer confidence is of the utmost importance. Food safety incidents pose health risks to consumers and are very costly to society and industry due to the associated health care costs, product recalls, lawsuits, and reduced consumer demand over the short, medium and long term from lost confidence.

"Domestically acquired foodborne illness in Canada is estimated at four million episodes per year. This represents a substantial burden of illness, with approximately one in eight Canadians getting sick with a food- related illness in Canada each year." - Public Health Agency of Canada (April 29, 2013)

### FINDINGS

**RESEARCH GOAL #1:** Evaluation of existing and new intervention strategies and technologies to reduce *E. coli* 0157:H7

**Background**: Assurances in food safety at the packing plant are important for the entire industry; poor performance does not pay over the long term. The United States Department of Agriculture (USDA) Economic Research Services (ERS) estimates that slaughter plants with poor quality control records had 3-8% higher rates of exit from the industry than plants with better records. Small and medium sized plants rarely survive a large recall or food safety outbreak as ensuing damages and negative impact on branded products mount. This ultimately results in increased packer concentration. In addition, a food safety incident can reduce consumer confidence in beef, decreasing consumption and prices for up to 3-6 months. Therefore, primary producers have an incentive to ensure robust food safety technology and protocols are available to packers.

Modern beef packing plants using multiple interventions can produce dressed carcasses carrying as few as 4 viable *E. coli* cells per carcass. However, beef can be contaminated with pathogens during carcass breaking. At one plant the numbers were about 1 viable *E. coli* on the average steak and 1 per 1000 $cm^2$ on trim; 1 viable cell per 100$cm^2$ was observed at the other plant. The main sources of contamination are from personal equipment, which can be wholly avoided by ensuring that hands, cotton gloves, steel mesh gloves and knives are thoroughly and regularly cleaned, and by wearing disposable rubber gloves between cotton gloves and steel mesh gloves. This research also contributed to AAFC hiring a food safety scientist to work with and be mentored by Dr. Colin Gill, ensuring AAFC's continued involvement in applied food safety research.

While lactic acid sprays and washes are very beneficial for reducing microbial contamination on dressed carcasses, they had limited benefit on beef trim. Fat and cut muscle surfaces have tiny cracks that some bacteria can hide in. If there are very few bacteria on the surface to begin with, it will be easier for most of them to hide in the fat and muscle cracks. The *E. coli* that hide in the cracks of the fat or muscle were protected from the lactic acid treatment, and acid can't kill *E. coli* that it doesn't touch.

E-beam treatment can achieve more comprehensive pathogen control on trim. Using beef that had been experimentally contaminated with up to a million times more bacteria than would normally be found in beef, including 32 different VTEC (including *E. coli* O157:H7 and the "top 6" non-O157 VTECs) plus six different *Salmonella* serovars, treatment with a 1kGy e-beam eliminated more than 99.99% of the VTEC and 99% of the *Salmonella.* A trained panel observed no effects of irradiation on the colour, aroma, texture, juiciness or flavour of beef patties, even when they were made entirely with beef that

had been e-beam treated. These results will help inform discussions into the regulatory approval of irradiation as a food safety intervention for beef.

Antimicrobial resistance is a high profile issue in the media. Industry communication efforts have been well-received and continued surveillance, research and extension efforts will be critical to maintain consumer confidence, inform outcome- and science-based regulation, and counter activist messages. Resistance to antimicrobials of very high importance in human health (as well as multi-drug resistance) is very low and is not increasing. Similar results are seen in the US and Denmark.

**RESEARCH GOAL #2:** Evaluate the impact of alternative feeding strategies on shedding of *E. coli* 0157:H7

Compared to barley-based finishing diets, feeding diets containing 22.5% wheat or corn DDGS did not affect *E. coli* O157:H7 shedding, or the numbers of *E. coli* O157:H7 on cattle leaving the feedlot.

**RESEARCH GOAL #3:** Establishment of a post-doctoral fellow in food safety research to maintain food safety scientific capacity

Agriculture and Agri-Food Canada (AAFC) agreed to transition a post-doctoral fellow into a scientist position to strengthen key research capacity. This success is notable for several reasons. Firstly, food safety research capacity is critically low at the federal (AAFC) level, so this re-investment is encouraging. Secondly, the new scientist was hired before the previous researcher retired, meaning that there is an opportunity to mentor this new researcher. Thirdly, this new researcher has already shown a strong and active interest in working with commercial beef processors to address issues of practical relevance and concern to industry.

**RESEARCH GOAL #4:** Evaluation of existing and new intervention strategies and technologies to reduce food-borne pathogens

Careful dressing and effective carcass cleaning practices used in large commercial packing plants can essentially eliminate *E. coli* from whole carcasses. Smaller plants that cannot afford to install costly equipment can still produce carcasses that carry very few *E. coli* by drying carcasses during chilling. Carcass decontaminating treatments and carcass drying are likely just as effective against *E. coli* O157:H7 and *Salmonella* as they are against generic *E. coli*. With current practices at Canadian plants, the risks from pathogens on carcasses are largely eliminated.

## VALUE – WHAT DOES IT MEAN FOR INDUSTRY

Food Safety had 9/12 successfully completed deliverables.

Advancements in food safety are quickly adopted by the packing industry. Reduced incidence of *E. coli* in beef does not reduce the negative impact to industry when a recall occurs. Measuring the benefits of this reduction is difficult as the benefit is from avoiding a recall.

**RESEARCH INDICATORS**

*Incidence of E. coli 0157:H7* ŧ

- The number of reported *E. coli 0157:H7* cases in the country over the ten-year period from 2002 to 2011 by the Public Health Agency of Canada (PHAC) show 3.8 people in 100,000 were infected with *E. coli* O157:H7 in 2002 and that figure has dropped to 1.4 in 100,000 in 2011 – a reduction of almost two thirds over the decade. In fact, with the exception of the waterborne outbreak of *E. coli* O157:H7 in Walkerton, Ontario in 2000, which took the lives of seven people and affected hundreds more, the decline of reported cases began in 1995.
- The PHAC reports that 1.39 Canadians in 100,000 were infected with *E. coli* O157:H7 in 2012 – or some 458 individuals. While this number may appear low, given that Canada's surveillance and tracking system relies solely on patients reporting their symptoms to a health practitioner to be captured in the data, the actual number of infections is speculated to be considerably higher. For every case reported by a patient to a doctor, an estimate of between ten and 47 cases go unreported. Even applying a conservative estimate of ten unreported cases for every captured one, roughly 4,600 Canadians suffer the effects of *E. coli* O157:H7 infection each year, at a significant cost to the health care system.

| |
|---|
| ➢ PHAC also reports that between 5-10% of those who become ill as a result of *E. coli* O157:H7, as well as approximately 15% of young children and the elderly, will develop the potentially fatal hemolytic uremic syndrome – or HUS.<br>➢ The death rate statistics in Canada from *E. coli* O157:H7 over the five-year period between 2000 and 2004 are compiled by PHAC from the Canadian Institute for Health Information (CIHI), and Statistics Canada's Vital Statistics. There is a minor variance between the two databases: CIHI has a total number of deaths at 18, while Statistics Canada's database shows a total of 14 fatalities over the five years in question (Statistics Canada's database limits the number of deaths to only those for which these organisms were the *principal* cause of death).<br>*E. coli* O157:H7 infections have been declining over the past decade. PHAC is responsible for tracking these infections, and medical laboratories that test patient blood samples report any STEC cases confirmed through testing weekly to the Agency's National Enteric Surveillance Program. |
| *Outbreaks*<br>➢ In 2012, there were two multi-jurisdictional *E. coli* outbreaks known to have been caused by beef. The previous multi-jurisdictional outbreak with beef identified as the source was in 2007. In the interim, there were two multi-jurisdictional outbreak in 2009 with beef suspected to be the source.<br>In September 2012, an *E. coli* outbreak at the XL Lakeside plant at Brooks, Alberta resulted in Canada's largest beef recall in history with 18 people becoming sick and zero deaths. In January 2013, XL sold the Lakeside plant to JBS. It is very difficult for a small or mid-sized plant to survive a large recall. |
| *Scope of E. coli tests*<br>➢ The number of *E. coli* strains monitored in beef has increased from one strain in 2008 to include an additional 6 non-O157 STEC strains in 2012 as Canada followed the USDA rule implemented in March 2011. |

ŧ For assumption and calculation details go to Appendix B

**Other Research**: A number of food safety events and recalls have raised consumer awareness of risks associated with food borne pathogens. While consumer confidence in the food safety system as a whole has not waned in the long run, short and medium term impacts are not uncommon. Schroeder et al. (April 2013) notes that food safety is clearly an important demand shifter. If the industry can improve beef safety via investment in new technology or by enhancing safety interventions in beef production, processing, handling or preparation or if the industry can improve consumer perception of beef safety, then making a strategic investment in food safety could have a significant impact on beef demand.

Cranfield (Sept 2013[6]) showed there was a structural shift in how consumers responded to a food safety recall in Canada after the *Listeria* recall in 2008. After mid-2008, this relationship became negative and suggested that a one percent increase in beef recalls would lead to a 0.037 percent decrease in beef demand. This is in line with U.S. studies that show a one percent increase in U.S. beef recalls lead to a 0.023 percent decrease in U.S. beef demand (Tonsor et. al. 2010[7]). Simulations from 1998:Q3 to 2010:Q3 showed that on average one additional beef recall in Canada would lead to a 2,260 tonne reduction in beef consumption per quarter (with a range of 710-5,740 tonnes), valued around $C26.5 million at the retail level (with a range of $8-67 million); this is equivalent to a one percent drop in consumer beef expenditures.

Recalls have a cumulative effect for consumers as was seen with a structural shift in how consumers responded to food safety incidence after the *Listeria* recall in 2008. Greater consumer awareness on these issues leave a lasting impression. The benefits of avoiding a single recall event is valued around $C26.5 million, making public and private investments into food safety research a worthwhile endeavor.

Preventing further reductions in research capacity is a high priority for BCRC. A food safety researcher has been hired to work at AAFC Lacombe.

[6] John Cranfield. Sept 2013. "Does Canadian Beef Demand Respond to Food Safety Recalls and Food Quality Improvements?" http://www.beefresearch.ca/files/pdf/fact-sheets/canadian_beef_demand_response_to_food_safety_quality_cranfield_sept2013.pdf

[7] Glynn Tonsor, James Minert, and Ted Schroeder. 2010. "US Meat Demand: Household dynamics and media information impacts" Journal Agricultural and Resource Economics 35:1-17

The National Beef Research Strategy has outlined four Food Safety research outcomes for the next ten years:

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

| Research Goals | Projects | Deliverable | | Progress made on Deliverables |
|---|---|---|---|---|
| 1. Evaluation of existing and new intervention strategies and technologies to reduce *E. coli* 0157:H7 | **FOS.01.09** Examining the Decontamination of Beef Trim by Spraying it with Lactic Acid Solution | Identification of an optimum lactic acid treatment and criteria for decontaminating beef trimmings to achieve the maximum consistent reduction in *E. coli* 0157:H7 will be determined. | ✓ | This research was redirected; initial results clearly justified refocusing the research to develop methods to effectively clean and dry conveyor belts, knives, gloves and hands instead. |
| | | Reduction in numbers of *Salmonella* and *Listeria monocytogenes* achieved will be determined. | ? | This research focused on *E. coli* instead (being a much greater concern in beef). The spray treatments were effective at destroying *Salmonella* and *Listeria* on membrane covered surfaces, but not on fat or cut muscle surfaces (another reason to redirect the research) |
| | | Effect of lactic acid treatment of trim on eating quality and shelf life of ground beef will be determined. | ? | As the research was redirected, this deliverable was not accomplished. |
| 2. Evaluate the impact of alternative feeding strategies on shedding of E. coli 0157:H7 | **FOS.02.09** Examining the Impact of Wheat Distillers' Grains on the Shedding of *E. coli* 0157:H7 | Quantity of *E. coli* 0157:H7 shed from cattle fed different inclusion levels of wheat-based distillers' grains, substituted for barley, will be determined. | ✓ | No effects of diet on *E. coli* O157:H7 shedding were observed. |
| | | Causes of increases in *E. coli* 0157:H7 loading in cattle due to environment will be discriminated from causes due to diet and distillers' grains in particular. | ✓ | Cattle fed finishing diets containing CDDGS or WDDGS had higher fecal pH than did the control steers ($P < 0.05$), but fecal pH was not related to shedding or persistence of *E. coli* O157:H7 |
| | | Determine the maximum level of wheat DDGS which can be safely added to diets of feedlot cattle without increasing loads of *E. coli* 0157:H7. | ? | Only one DDGS inclusion rate (22.5%) was used, although this research was conducted at a commercial feedlot and as such is likely representative of industry practice rather than theory. Theoretical information may be available elsewhere. |
| 3. Establishment of a post-doctoral fellow in food safety research to maintain food safety scientific capacity | **FOS.03.09** Establishing a Post-Doctoral Fellow in Food Safety Research | A post-doctoral fellow will be hired and employed to facilitate the transition of food safety scientific capacity at AAFC Lacombe. | ✓ | Dr. Yang was hired at AAFC Lacombe, and is working with Dr. Colin Gill. |
| | | By working with other scientists at the Lacombe Research Centre, the post-doctoral fellow will play a major role in the completion of several sub-projects as identified in pre-proposal FOS.03.09 that focus on delivery of applied food safety research and processes for industry benefit. | ✓ | The post doc was involved in the lactic acid work described above, identifying sources of re-contamination in commercial packing plants and ways to avoid this re-contamination, as well as assessing the shelf life of Canadian vacuum packaged beef. |
| 4. Evaluation of existing and new intervention strategies and technologies to reduce food-borne pathogens | **FOS.04.10** Use of low dose e-beam irradiation to reduce *E. coli* O157:H7, non O157 VTEC and *Salmonella* viability on meat surfaces | Determine the extent to which 1 kGy e-beam irradiation of meat reduces the viability of multi-pathogens on the surface of fresh beef. | ✓ | Low dose e-beam irradiation can destroy 99% of *Salmonella* and 99.99% of *E. coli*. |
| | | Understand the effects of 1 kGy e-beam irradiation on sensory properties of beef patties containing different levels of fat and on the colour of treated surfaces of beef. | ✓ | Low dose e-beam irradiation does not negatively affect the aroma, tenderness, juiciness or flavour of hamburger patties. |
| | **FOS.07.10** Decontamination of | Determine the effectiveness of acidified sodium chlorite, peroxyacetic acid, neutral electrolysed water | ✓ | This work was an enhancement of the lactic acid work described above, but was redirected towards an |

| | | | | |
|---|---|---|---|---|
| | beef trim and primal cuts by spraying with antimicrobial solutions | and nanobubble ozone in killing bacteria on primal cuts, exposed muscle, and beef trim. | | investigation of the sources of re-contamination and methods of avoiding that, which delivered solid results |
| | | Identify the optimum parameters for applying solutions in to decontaminate trim, any negative effects on organoleptic properties of the ground beef, and their cost effectiveness compared to alternatives. | ✓ | As noted above, although these deliverables were not achieved, the redirection of the project (given the limitations of the spray approach) towards recontamination issues produced much greater value for industry. |

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

## SPECIFIED RISK MATERIAL UTILIZATION & DISPOSAL

**OVERARCHING OBJECTIVE**

Reduce costs associated with specified risk materials (SRM) and carcass disposal through the development of alternative utilization and disposal strategies that are effective, economical, and environmentally acceptable.

**Background**: The Enhanced Feed Ban implemented July 2007 was important to obtain controlled BSE risk status in Canada. This product which previously had a value of $0.68 to $3.15 per head now costs between $5.29 to $12.41 per head to remove and dispose of (SRM is now being landfilled). Similarly on-farm and feedlot disposal of animals which would have previously been rendered are now a net cost and a growing concern given negative public perceptions, and environmental and food safety concerns of on-farm disposal. Developing alternative on-farm disposal methods, such as composting, has an intangible value in terms of maintaining consumer confidence in the beef industry's production and on-farm food safety practices while reducing risks of environmental contamination. If successful, on-farm composting of deadstock would provide a valuable by-product once again in the form of fertilizer.

### FINDINGS

**RESEARCH GOAL #1:** Develop alternative SRM disposal strategies that are effective and environmentally acceptable.

*Laboratory-scale composting*: Prions were spiked into and detected in the manure before composting began. After 14 days, the compost that contained no feathers had fewer prions than at the start, and no prions were found in the compost that contained feathers. After 28 days, no prions were found in either type of compost. A sensitive protein misfolding cyclic amplification (PMCA) test indicated that 99.9% of the prions had been destroyed. After one year, Syrian hamsters cranially implanted with prions composted for 230 days have not shown any signs of disease. Therefore, composting is an effective method of destroying BSE prions. These results can inform efforts to relieve some of the regulatory burden pertaining to on-farm deadstock disposal under the Enhanced Feed Ban, particularly the prohibition on between-farm movement of composted manure containing SRM.

*Field-scale composting*: Bacterial biofilms and fungal populations worked together to break down hoof proteins and it seems likely that a similar approach is used to destroy prions during composting. Further study and characterization of these microbes may identify methods of speeding up the rate of prion breakdown in compost.

*Bioassays:* The longer non-membrane bound prions were in the field-scale composter, the longer it took Syrian hamsters to get sick after being cranially implanted with those prions. Disease onset was delayed in hamsters injected with prions composted for 14, 56 and 144 days, and hamsters implanted with prions composted for 230 days still had not developed the disease nearly one year after being implanted. This clearly demonstrates that composting reduces the infectivity of prions, and prolonged composting may render them non-infective.

*Implications:* BSE is rare in Canada, so most SRM does not contain any BSE prions. Because feeding prions failed to cause disease in animal bioassays and composting prions greatly delayed the onset and reduced the occurrence of disease in cranially implanted hamsters, the probability of compost acting as a vector for prions is infinitesimally small. Even if a fraction of prions remained infective after composting, they would be greatly diluted within the compost. Subsequent spreading onto agricultural land would make it extremely unlikely that any livestock would ever contact sufficient prions to develop BSE. With these considerations, composting is a viable method for the controlled disposal of SRM in Canada. This research provides the potential to inform science-based regulatory change to reduce a

regulatory burden facing Canada's beef industry. At present, this practice will be of the greatest applicability to on-farm mortality disposal. For this technology to benefit the packing sector (where the majority of SRM disposal costs are incurred), regulatory change will be needed. At the present time, the CFIA does not recognize composting as a method of prion destruction. However, the knowledge generated by this research can help to inform efforts to develop science-based amendments to this costly regulation.

## VALUE – WHAT DOES IT MEAN FOR INDUSTRY

If legalized, the ability for producers to use fertilizer from compost that includes SRMs will offset some of the costs currently accrued from SRM disposal. This is particularly valuable for feedlots currently paying for deadstock removal, but could sell manure to farmers in their area.

| RESEARCH INDICATORS | CURRENT FINANCIAL COST TO INDUSTRYŁ (MILLION $) |
|---|---|
| *Deadstock Removal* – Historically, renderers picked up deadstock free of charge. Following the long-list SRM rule in July 2007 renderers started charging for deadstock removal, $45 per animal for 76,670 animals. | $3.45 |
| *Deadstock Removal* - Death loss at the cow-calf level – 1% on 4.23 million cows 42,283 head to dispose or 19,030 head at $121.50/head | $2.3 |
| *SRM Disposal*<br>➢ Canadian packers have additional costs due to long list SRMs compared to US counterparts which have a short list. Additional costs are estimated at $31.70/cwt for OTM cattle and $4.52/head for UTM cattle.[8]<br>➢ There is also a significant cost to packers when an OTM animal is found during a UTM shift since the SRM material contaminates all carcasses on the floor. Therefore, producers are charged for incidental OTM cattle that are actually UTM cattle. The Canadian Meat Council (CMC) estimates misidentified OTM animals have a daily cost of $300-400/day or $0.02-0.03/head. | $0.13 |

ŁThese costs could be reduced if regulations were changed based on this research. For assumption and calculation details, refer to Appendix B.

SRM utilization and disposal were not included as a separate priority in the 2013-18 National Beef Research Strategy, but are implicit in monitoring animal health and welfare issues as well as manure management.

**RESEARCH GOAL #1:** Develop alternative disposal strategies that are an effective and environmentally acceptable means of destroying SRM.

| PROJECT | DELIVERABLE | | OUTPUT |
|---|---|---|---|
| **SRM.01.09** Defining the Fate of Prions During Composting of Specific Risk Material | Determine the fate of BSE prions during composting | ✓ | 99.9% of prions can be destroyed after 28 days of composting in beef manure. |
| | Optimize composting conditions to maximize the destruction of prions during composting | ✓ | Research using BSE Prions can only be done in highly bio-secure facilities, but this research developed effective laboratory scale composting conditions for the degradation of organic matter and possibly recalcitrant infectious prions. Due to the limited biomass, temperatures in the laboratory-scale composter only stayed elevated for days as compared to months in field scale composters. Field scale composting should be as effective if not more so than the lab scale composting system used here. |

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

[8] CMC Fed Ban Cost Survey July 2009

## TECHNOLOGY TRANSFER & KNOWLEDGE DISSEMINATION

### OVERARCHING OBJECTIVE

Support and encourage rapid adoption of innovation to sustain competitive advantage.

**Background**: Knowledge dissemination and technology transfer are critical to realize the economic, environmental and social benefits of investments in beef research. In order for industry to adopt and profit from research they must be aware of how the research could fit into their operation and how to implement it. Improved communication, collaboration and understanding between researchers and industry result in dissemination of meaningful research results to stakeholders along the production chain, influence management decisions concerning beef production and improve beef products for all customer segments and markets. Extension also supports science-based regulation, public education, and continued investments in research.

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, and lost opportunities to positively impact the profitability and sustainability of the industry through improved production efficiencies and beef demand. Having recognized this, the BCRC with support from Beef Cluster I placed greater emphasis on playing a leadership role in Canada to renew knowledge and technology transfer among stakeholders in the beef cattle industry.

As part of Beef Cluster I, a 10-year Knowledge Dissemination and Technology Transfer Plan (TEC Plan) was developed. The plan includes a full-range of technology transfer activities with a clear focus on accelerating the uptake of research results and outcomes by industry. Development of the TEC Plan included: a situation assessment that analyzed the context in which BCRC operates, gathered information about technology transfer needs from stakeholders and reviewed existing organizations known for best practices in technology transfer globally. The strategic direction of technology transfer efforts was determined and the following mandate was established.

### MANDATE

*Enable industry uptake of research-supported innovations by supporting and delivering a range of best practice technology transfer mechanisms.*

Frameworks for action were then established which outline broad approaches to increase and enhance technology transfer. The following strategic action priorities were identified:

- Making technology transfer core to BCRC's strategy and innovation processes
- Understand industry needs through representative industry information to drive research and technology transfer needs
- Develop an engaged community of industry stakeholders and researchers through a carefully-focused, comprehensive approach to communications
- Deliver world-class technology transfer by using the collaborative power of the community to share resources nationally across the industry
- Constantly improve transfer effectiveness by measuring results, analyzing effectiveness and making positive changes
- Create a nationally-unified research agenda through industry-coordinated innovation and knowledge transfer
- Achieve adoption of best practices sector-wide by collaborating with other technology transfer-focused organizations
- Make industry competitiveness and sustainability the core drivers in the industry's innovation and transfer processes and practices, optimizing all available research results

Finally, performance measurement strategies were established to identify successes and areas where modifications are needed. In conjunction with continual feedback from industry stakeholders, the TEC Plan informs BCRC's approach to technology transfer and knowledge dissemination.

**RESEARCH GOAL #1:** A comprehensive website that provides a central hub for all beef industry research

Following the development of the TEC Plan, a new Beef Extension Coordinator role was created and filled in January 2012. A new extension website, beefresearch.ca, was then developed and launched in August 2012. The website was also optimized for viewing on mobile devices, making it accessible and convenient for producers in the field. This website is envisioned and designed to develop into a central one-stop source for comprehensive, reliable production and research information. The website provides access to general information on research topics, fact sheets that explain in-progress and completed research projects in lay terms, and regular blog articles. Blog articles, posted online and delivered through email subscription, announce new research findings, proactively offer a scientific perspective related to misconceptions or unsound concerns about beef production, and help producers make informed decisions on implementing innovation into their production practices.

Though initially focused on the Beef Cluster, the beefresearch.ca site is intended and designed to ultimately incorporate relevant and scientifically sound research and production information from a variety of other interested funders and sources. The intension is to encourage and cultivate technology transfer skills among the research community, make pertinent research available to industry in a timely, meaningful and user-friendly manner, and foster relationships between applied researchers and early research adopters. This will complement ongoing BCRC efforts to ensure that industry and policy makers are aware of the value and results of beef, cattle and forage research, and ultimately help fill the technology transfer functions that were at one time carried out by federal and provincial agriculture departments. The tools developed will also provide another avenue through which researchers and producers can communicate with the public about how they produce food in a responsible and sustainable manner.

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. Views per video are increasing and social media networks of stakeholders continually grow. The number of email subscriptions is also increasing.

**RESEARCH GOAL #2:** Regular communication of current research to industry

In addition to the website a full range of social media communication tools have been employed (including Facebook, a Blog, Twitter, and a YouTube channel), which engage producers and agriculture media directly and offer mediums for feedback and discussion. Communication through the CCA's Action News e-newsletter continues, and communication channels have been broadened through a partnership with RealAgriculture.com to develop a Beef Research School video series. This video series, and another series created in-house on the results of the National Beef Quality Audit, present information in an alternative format and increase the profile of Canada's leading beef researchers, industry experts and innovative producers. A monthly research column by BCRC's Science Director is a regular feature in Canadian Cattlemen – the Beef Magazine, the leading national beef magazine. Continued presentations by BCRC staff at numerous industry events have also delivered research information to various audiences and encouraged industry stakeholders to remain engaged by visiting the website, subscribing to the BCRC Blog, and connecting via social media.

Feedback from industry stakeholders indicates a greater awareness of investments in beef research by the Beef Cluster I, and a greater appreciation for the value of investments compared to prior to the implementation of the enhanced knowledge and technology initiative.

***Quality Starts Here***

The Quality Starts Here program was initiated in the mid 1990's as a producer education program aimed at correcting some of the carcass defects identified in the first National Beef Quality Audit. The effectiveness of this producer education program is evidenced by significant reductions in the prevalence and costs of several defects. Total defects cost to the industry were $82.62 per head in 1998-99. This decreased to $61.80 per head in 2010-11. From 1998-99 to 2010-11, decreases were observed in the percentage of branded cattle (49% to 12%), horned cattle (30% to 12%), bruised cattle (54% to 44%). These were partially offset by increases in the prevalence of dark cutters (0.8% of youthful cattle in 1998-99 to 2.5% in 2010-11) and liver condemnations (14% to 24%). As mentioned above, ongoing BCRC research is expected to help understand some of the factors that may explain the increased incidence of liver abscesses and dark cutting, and help develop and encourage implementation of strategies to reverse these negative trends.

***Verified Beef Production***

The Quality Starts Here program has evolved into the Verified Beef Production (VBP) program, which is focused on improving food safety through record keeping demonstrating that producers follow recommended practices to produce beef that is free of biological, chemical and physical hazards. The Canadian Food Inspection Agency has recognized this Hazard Analysis Critical Control Point (HACCP) based program as the Canadian beef industry's official on-farm food safety program. The proportion of Canada's beef raised by producers who have attended a VBP training workshop has increased from a base of zero to 67% (2012). The proportion of Canada's beef raised by producers who have had their operations audited and registered through VBP has increased from zero to 18% (2012). VBP field staff are an avenue for the BCRC to connect new research results with progressive producers, and have expressed interest in doing so. BCRC provides the funding for the maintenance of the national Verified Beef Production program including both a national coordinator and program funding.

## VALUE – WHAT DOES IT MEAN FOR INDUSTRY

In Beef Cluster I, researchers were asked to indicate their technology transfer plans related to industry factsheets, industry presentations, journal publications, research papers, or conference presentations. However, they are not required to report on these activities. Results from Beef Cluster I will be communicated to producers throughout Beef Cluster II in a number of ways including the BCRC blog, videos, and a series of webinars featuring some of the lead researchers, in addition to researchers' own technology transfer efforts and traditional industry communication channels.

A greater emphasis has been placed on encouraging and enabling communications and technology transfer activities led by researchers through the Beef Cluster II proposal process. Researchers were asked to outline their intentions to transfer key results back to the desired beef industry stakeholders to encourage adoption, uptake and/or commercialization where appropriate.

Allocating project funds to industry publications, industry meetings or workshops, conferences, and other technology transfer activities as appropriate were encouraged in addition to scientific publications. Advancement of funds for technology transfer activities will be contingent upon the completion of a technology transfer plan and review of research outcomes by the BCRC.

Technology transfer and knowledge dissemination will remain an ongoing focus for the BCRC, with continued regular communication to industry, development of new resources and partnerships,

measurement of successes and modifications to the tools and strategy throughout Beef Cluster II. A greater emphasis will be placed on promoting and enabling the engagement of researchers with industry, such as the involvement of young researchers in an industry-led mentorship program. Extension, outreach and policy are key components under a number of the priority areas (Beef Quality, Food Safety, Forage and Grassland Productivity) in the National Beef Research Strategy going forward.

BCRC's work to increase communication and collaboration between researchers and across industry partners is aimed at:

1. Increasing the percentage of successful research projects that meet industry needs
2. Reducing the lag from development to adoption
3. Increasing the proportion of producers adopting new technology

Increased investment in technology transfer has ensured that research results from Beef Cluster I will be communicated to industry. Encouraging adoption of new technology and providing recommendations for management changes that can incrementally improve productivity on individual operations.

## APPENDIX A : RESEARCH SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| **Long Term Goal (>10 years)** | Long Term Goal<br>**A profitable, sustainable Canadian industry that results in Canadian beef and cattle being recognized as the most outstanding by Canadian and world customers**<br>Long Term Indicators:<br>1. NCO Study - ROI for marketing & research efforts (foreign/domestic promotion & domestic research) | | | | |
| | **Animal Health & Welfare** | **Feed Grains & Feed Efficiency** | **Forage & Grassland Productivity** | **Beef Quality** | **Food Safety** |
| **Medium Term Goals (5-10 years)** | **Medium Term Goal:** | **Medium Term Goal:** | **Medium Term Goal:** | **Medium Term Goal:** | **Medium Term Goal:** |
| | Not available with this plan | Not available with this plan | Not available with this plan | Not available with this plan | Not available with this plan |
| | **Medium Term Indicators:** | **Medium Term Indicators:** | **Medium Term Indicators:** | **Medium Term Indicators:** | **Medium Term Indicators:** |
| | Survival rates (feedlot, pre-weaning) | Feed:gain ratio | Forage varieties commercially available | Per capita consumption | Incidence levels |
| | Reproductive efficiency | Average daily gain | Forage yields | Demand index | Number of strains monitored |
| | Condemnations | Steer carcass weights & weaning weight<br>Barley varieties & yields | Adoption of best management strategies | Grading data - B4, AAA, Y1 | |
| **Short Term Goals (3-5 years)** | **Short Term Goal:** | **Short Term Goal:** | **Short Term Goal:** | **Short Term Goal:** | **Short Term Goal:** |
| | Improve diagnostic tools and accelerate vaccine development for *Mycobacterium avium* spp. *paratuberculosis* (Johne's disease) | Evaluation and identification of optimal strategies for feeding dried distillers' grains with solubles (DDGS) | Development of legumes and grasses for warmer and drier summers | Completion of national beef quality satisfaction survey and carcass audit | Evaluation of existing and new intervention strategies and technologies to reduce *E. coli* 0157:H7 |
| | Examine the effects of alternative nutritional strategies on animal health | Develop and validate economical methods of identifying beef cattle with improved feed efficiency | Optimize yields, performance of swath grazing as a feeding program and determine the optimal varieties and species mixtures for swath grazing | Enhance grading and carcass evaluation capacity and technology development in Canada | Evaluate the impact of alternative feeding strategies on shedding of *E. coli* 0157:H7 |
| | Develop strategies to control emerging vector borne, zoonotic, and foreign animal diseases | Develop improved crop varieties | Examination of the impact of forage finishing strategies on growth performance, carcass characteristics, and meat quality | Development of alternative feeding strategies to enhance beef fatty acid composition | Establishment of a post-doctoral fellow in food safety research to maintain food safety scientific capacity |
| | Monitoring and management of key animal health and welfare issues | | The development of alternative grassland and forage management strategies | Development of processing technologies that will optimize the value of tougher cuts<br>Development and validation of genomic tests for identifying beef tenderness | Evaluation of existing and new intervention strategies and technologies to reduce food-borne pathogens |

| | Short Term Performance Measures: | Short Term Performance Measures: | Short Term Performance Measures: | Short Term Performance Measures: | Short Term Performance Measures: |
|---|---|---|---|---|---|
| | Improved diagnostics for Johne's disease | Optimal inclusion rates for DDGS in feedlot rations | New drought/heat resistant varieties | Increased tenderness of tougher cuts | New strategies, technologies and protocols to reduce incidence |
| | Updated best management practices | Reliable gene evaluations that ID feed efficiency | Higher yielding varieties | Increased consistency | |
| | Strategy development | Higher yielding feed grains | New management strategies | Information on fatty acid composition | |
| | Updated monitoring | | Better animal performance (lbs gained/acre) | | |

**Common Strategic Approaches:**

1. Technology Transfer - Website, Blog, Canadian Cattlemen Articles
2. BIXS

## APPENDIX B : CALCULATIONS AND ASSUMPTIONS USED IN VALUE SECTIONS

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

### ANIMAL HEALTH & WELFARE

***Reproductive efficiency***

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

- Reproductive efficiency has increased from 86% in 2008 to 90% in 2012
    - It should be noted that eastern Canada, reproductive efficiency only increased from 73% in 2008 to 74% in 2012 while in the west, reproductive efficiency increased from 90% in 2008 to 95% in 2012.
    - This represents an additional $176.1 million in revenue to the industry
        - 4 more calves were born to every 100 cows
        - Assumes an average $897/head for a 550 lbs steer calf (using 2012 average price = $163/cwt)

*Calculation:* If 4 more calves were born to every 100 cows then 4% x 3,955,500 head of beef cows on July 1, 2012 = 158,200 additional head of calves valued at $897/head = $141.8 million additional revenue

***Survival rate from birth to weaning***

*Definition:* Survival rate is the proportion of calves weaned compared to the number of calves born
    - Conversely , death loss of calves = # calves died/ live births

*Source:* Alberta Agriculture, AgriProfit$ *(contact: Dale Kaliel)*

- Survival rate from birth to weaning in Alberta has decreased from 96.8% (03-07 average) to 95.7% (08-11 average)
    - Survival rate from birth to weaning has increased from 3.5% in 2008 to 4.6% in 2010
- This represents a lost value of $43.7 million to the industry.
    - Assumes an average $897/head for a 550 lbs steer calf ($163/cwt)
    - Assumes 2011 calf crop level (4.4 million head)
- Average survival rate reported by producers with low total production cost (one-third of the provincial pool for each year) has been relatively steady at 96.4% (08-11) compared to 96.8% (03-07)
- Increasing overall survival rate to the level reported by low cost producers will save the industry $27.8 million

*Calculation:* 0.9% decrease in survival rate = 48,774 fewer calves weaned in 2012
Valued at $897/head = $43.7 million lost in revenue for the cow-calf industry
0.7% increase in survival rate = 31,038 additional calves weaned in 2012
Valued at $897/head = $27.8 million saved for the cow-calf industry

***Survival rate from weaning to slaughter***

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

- Survival rate has decreased from 88% in 2008 to 82% in 2012
- This represents $196.0 million of lost in revenue for the industry
    - Calve crop on July 1st 2011 = 4.434 million head
    - 4% decrease in survival rate = 117,340 fewer cattle survived in 2012

- $1,105/head value per animal (2012 average of $130/cwt on 850 lbs)

*Calculation:* 4% decrease in survival rate x 4.434 million head of calves = 117,340 additional cattle survived for export or domestic slaughter in 2012. Valued at $1,105/head = $196.0 million lost revenue to the beef industry

***Feedlot Survival Rate***

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

*Source:* Alberta & Saskatchewan Cattle on Feed Report from Canfax

- Feedlot survival rate has increased from 87% in 2008 to 91% in 2012
- This represents $168.2 million of additional revenue for the feedlot industry
  - 2012 Fed cattle marketings = 2.756 million
  - 4% in feedlot survival rate = 110,240 additional fed cattle marketed in 2012
  - $1,525/head value per fed animal (2012 First half average of $113/cwt on 1350 lbs)

*Calculation:* 4% increase in survival rate = 110,240 additional fed cattle marketed in 2012
Valued at $1,525/head = $168.2 million additional revenue for the feedlot industry

***Liver abscesses***

*Source:* National Beef Quality Audit, 1999-2011 National Beef Quality Audit carcass summary table

- Liver abscesses in fed cattle resulting in condemnation increased from 13.4% in 1998/99 to 23.2% in 2010/11
- Liver abscesses in fed cattle resulting in livers being discounted to pet food have decreased from 10.4% in 1998/99 to 8.0% in 2010/11.
- Combined, this represents a cost of $7.77 million to industry in 2010/11 up from $4.16 million in 1998/99.
- The largest loss from liver damage was not from condemns or discounts but from lost weight gain at $20.5 million in 2010/11 up from $2.99 million in 1998/99 as the cost of feed increased and cattle stayed on feed longer to get to finished weight.
- Liver condemnations in non-fed cattle increased from 18.1% in 1998/99 to 26.4% in 2010/11.
- Liver abscesses in non-fed cattle resulting in livers being discounted to pet food decreased from 33.7% in 1998/99 to 23.9% in 2010/11.
- Combined discounts on fed and non-fed cattle represent a cost of $29.85 million to industry ($9.36/head) in 2010/11 up from $8.8 million ($2.66/head) in 1998/99.
- This represents a lost value of $21.1 million to industry.

***Horns***

*Source:* National Beef Quality Audit

- The percentage of hornless cattle were approximately 20% higher in fed and non-fed cattle in the 2010/11 compared to the 1998/99 audit
- Processors lost $192,535 in 2011 ($0.06/head) versus $106,003 ($0.032/head) in 1998/99 due to extra labour costs of removing horns at the packing plant.
  - Although the industry loss in 2011 exceeded that in 1998/99, the increase was a result of higher labour costs
  - This represents a lost value of $0.1 million to industry.

***Bruises***

*Source:* National Beef Quality Audit

- The percentage of non-fed cattle with bruises increased from 76.4% in 1998/99 to 85.7% in 2010/11; while the percentage of fed cattle had bruises decreased from 49.2% to 34.1%.
- The economic loss to the industry in 2011 due to bruises on the carcasses was $6.7 million vs. $4.3 million in 1998/99.
- This represents a saved value of $2.4 million to industry

***Head, tongue and carcass condemnations***

*Definition:* Carcasses or parts of the carcass deemed unfit for human consumption

*Source:* National Beef Quality Audit

- The heads and tongue condemnation rates decreased from 5% in 1998/99 to 3.8% in 2010/11.
- The economic loss due to head and tongue condemnation totaled $1.55 million in 2010/11 compared to $5.19 million in 1998/99.
    - This represents a saved value of $3.64 million to industry.
- All carcass condemnation rate was reported at 0.25% in 2010/11, down from 3% in 1998/99.
- The 2011 economic loss due to carcass condemnation was $11.0 million in 2010/11 compared to $8.18 million in 1998/99.

| | **1998/99** | **2010/11** | **$/Head*** 2010/11 ǂǂ | **% Change ǂǂ** from 1998/99 |
|---|---|---|---|---|
| Liver abscesses (condemned)<br>Liver abscesses (pet food) | 13.4% ǂ<br>10.4% ǂ | 23.2% ǂ<br>8.0% ǂ | 9.36 | +252 |
| Horns | 30.2% ǂ<br>10.6% ǂǂ | 12.5% ǂ<br>10.6% ǂǂ | 0.06 | +89 |
| Bruising | 49.2% ǂ<br>76.4% ǂǂ | 34% ǂ<br>85.7% ǂǂ | 2.10 | +62 |
| Heads condemned | 5% ǂǂ | 3.8% ǂǂ | 0.16 | -43 |
| Tongue discount | 5% ǂǂ | 3.8% ǂǂ | 0.32 | -75 |
| Carcasses condemned | 0.3% ǂǂ | 0.25% ǂǂ | 3.44 | +39 |
| Injection site lesions** | 0.4% ǂ<br>0.5% ǂǂ | 0.56% ǂ<br>7.34% ǂǂ | 0.21 | -96 |

ǂ Fed cattle only ǂǂ Non fed cattle only ǂǂ All cattle

*Total industry loss divided by total cattle slaughtered

**The 1999 audit included a purveyor audit where injection site lesions were determined in cuts. This separate study was not conducted in 2010/11. The purveyor study in 1998/99 indicated a cost of injection site lesion amounting to $5.45/hd. The cost of internal injection site lesions is not accounted for in the 2010/11 audit and therefore caution is advised when comparing the costs between the two studies.

***Condemnations***

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

*Source:* Canadian Beef Grading Agency

- The condemnation rate has decreased from 31.0 per 10,000 head slaughtered in 2008 to 27.5 in 2012
- This represents a saved value of $1.10 million to industry.
    - 2012 total slaughter(Federal and Provincial plants) = 2.78 million head
    - 0.04% decrease in condemnation rate = 1,113 less condemned cattle
    - Assumes an average $956/head for a 1,350 lb cattle (using 2012 average cow price of $63.93/cwt)
    - Assumes an average $122/head deposal fee for a condemned animal weighed 1,350 lbs (cost of deadstock removal in Alberta was 9¢/lb August 2012)
    - A value of $985/head on D3 cows vs. a disposal cost of $122/head for condemned cattle.
    - Total loss of condemned is $985/head
    - 1,327.8 less condemned cattle cost $985/head = $1.10 million saved

*Calculation:* 0.04% decrease in condemnation rate x 2.78 million head total slaughter (fed and non-fed) = 1,113 fewer head cattle being disposed. Value per head of cattle at $863 + disposal fee per head at $122 = loss per head of cattle at $985. Reduced number of condemned cattle of 1,113 x loss per condemned cattle = $1.10 million.

## FEED GRAINS & FEED EFFICIENCY

***Barley yields***

*Definition:* Bushels per acre

*Source: Agriculture and Agri-Food Canada*

- The five-year average[9] barley yield has increased 4% (2.5 bu/acre) from 57.0 bu/acre in 2003-07 to 59.5 bu/acre in 2008-12
- This represents a saved value of $94 million to industry through increased production
    - Assumes holding harvested area at 6.8 million acres (2012 level)
    - Assumes average barley price =$5.51/bu[10]

*Calculation:* 4% increase in yield = 2.5 additional bushels per acre; 6.8 million acres x 2.5 bushel/acre = 17.1 addition bushels of barley produced at $5.51/bu for a total value of $94 million

- This means 273,656 fewer acres were required to produce the same amount of barley. This land can be put into other production – representing a significant gain opportunity for producers.
    - Assumes holding barley production steady at 368 million bushel (2012 level)
    - 4% increase in yield =273,656 fewer acres of land required
- The raise of grain prices in recent years has resulted in farmers switching to more profitable alternatives that bring a higher return. The number of farms reporting barley acreage in the 2011 Census of Agriculture was down 31% from 2006 just under 30,000 farms. The number of acres in barley was down 24% (or 1.23 million acres) at 6.9 million acres.

***Barley Varieties***

*Definition:* Number of varieties registered

*Source:* Canadian Food Inspection Agency

- 19 triticale varieties have been registered from 2008 to 2012
- 48 barley varieties have been registered from 2008 to 2012

| Type | Varieties | |
|---|---|---|
| | **2008** | **2012** |
| Spring triticale | - | 15 |
| Winter triticale | - | 4 |
| **Total triticale varieties** | | **19** |
| Barley, six-row, spring | 119 | 125 |
| Barley, six-row, spring, hull-less | 7 | 8 |
| Barley six-row, for spring forage | 8 | 8 |
| Barley, two-row, spring | 84 | 88 |
| Barley, two-row, spring, hull-less | 18 | 17 |
| Barley two-row, for spring forage | 2 | 2 |
| Barley, winter | 4 | 4 |
| **Total barley varieties** | **242** | **290** |

***Feed:gain ratio***

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

*Source:* Values reported in the Canadian Journal of Animal Science articles compiled by Canfax Research Services

- The feed:gain ratio in finishing feedlots reported by journal articles has decreased 1.1% from 6.78 in 2003-07 to 6.70 in 2008-12 (five year average)
- This represents a saved value of $13.9 million to industry
    - 2012 fed cattle marketing = 2.756 million head
    - Assumed 550 lb/head gained in the feedlot (800 lbs in-weight & 1350 lbs out-weight)
    - Assumes $253/tonne of feed for average ration - Lethbridge barley price 2012

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

[10] Based on 2012 Lethbridge barley price – source: Canfax

*Calculation:* 550lb/head weight gain x 2.756 million heads of cattle marketed = total weight gain of 687,555 tonnes. A 0.08 decrease in feed:gain ratio = 55,004 fewer tonnes of feed required at average price of $253/tonne = savings in feed of $13.9 million

***Average daily gain***

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

*Source:* Values reported in the Canadian Journal of Animal Science articles compiled by Canfax Research Services

- Average daily gain in feedlots reported by journal articles has increased 7% from 3.4 lbs/day in 2008 to 3.7 lbs/day in 2012
- This represents 13 fewer days emitting greenhouse gas per head and 36,148 fewer days in total
    - Assumes 550 lbs gained in the feedlot on average (800 lb in-weight and 1350 lb out-weight
    - 2012 fed cattle marketings = 2.756 million

*Calculation:* 550 lbs gained at 3.7 lbs per day is 162 days on feed compared to 550 lbs gained at 3.4 lbs per day is 149 days on feed. Therefore a higher ADG reduces days on feed by 13 days from 162 days to 149 days. 13 days x 2.756 million fed cattle = 36,148 fewer days on feed.

## PRODUCTION EFFICIENCY

***Steer carcass weight***

*Definition:* Warm carcass weight

*Source:* Canadian Beef Grading Agency

- Steer carcass weights have increased 3.7% or 31 lbs from 842 lbs in 2008 to 873 lbs in 2012
- This represents a revenue gain of $153.5 million to industry
    - Assumes 2012 fed cattle marketings (2.756 million head) and composite cutout value ($180/cwt)

*Calculation:* 31 additional lbs per animal x 2.756 million fed cattle marketed = 85.43 million additional pounds valued at $1.80/lb (composite cutout weighted for AAA/AA production) = $153.5 million in additional revenue to the feedlot industry from increased carcass weights

***Weaning weight***

*Definition:* Average weight at weaning

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

- Weaning weight has increased from 548.9 lbs (03-07 average) to 562.7 lbs (08-11 average)
- This represents $99.7 million additional revenue for the industry
    - Assumes 4.43 million head calf crop is weaned (July 1, 2011 level)
    - Assume calf price at $163/cwt (2012 level)
- Weaning weight reported by producers with low total production cost (one-third of the provincial pool for each year) has been 10 lbs heavier than the provincial average at 572.6 lb (08-11 average)
- Increasing overall weaning weight to the level reported by lowest total production cost producers (one third of provincial pool each year) which were 10 lbs heavier at 572.6 lbs for the 08-11 average would represent an addition $96.9 million in cow-calf revenue

*Calculation:* 13.8 additional lbs per calf weaned x 4.43 million calves = 61.1 million additional pounds
Valued at $163/cwt = 99.7 million in additional revenue to the cow-calf industry
9.9 additional lbs per calf weaned x 4.43 million calves = 43.9 million additional pounds
Valued at $163/cwt = 96.9 million in additional revenue to the cow-calf industry

***Productivity per cow***

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

*Source:* Statistics Canada, Canadian Beef Grading Agency

- Productivity per cow has decreased from 574 lb/cow in 2008 to 567 lb/cow in 2012
- This represent a lost value of $121.5 million

- Assumes composite cutout of $180/cwt (2012 level)
- Assumes 5.2 million head of cow (2010 Jun 1st level)

Calculation: 13 fewer lbs of beef produced per cow x 5.2 million cows in 2010 = reduced beef production of 67 million lbs at $180/cwt = reduced revenue of $121.5 million

***Weaning weight as a % of mature cow weight***

*Source:* Alberta Agriculture, AgriProfit$

- Weaning weight as a % of mature cow weight increase from 42.4% (03-07 average) to 43.2% (08-11 average)

***Steer carcass weight as a % of cow carcass weight***

*Source:* Alberta Agriculture, AgriProfit$

- Steer carcass weight as a % of cow carcass weight has increased from 124% in 2008 to 130% in 2012.

## FORAGE & GRASSLAND PRODUCTIVITY

***Forage Yields***

*Definition:* Tons per acre harvested for hay

*Source:* Statistics Canada Table 001-0017

- The five-year average[11] tame hay yield increased 8% from 1.69 tons/acre in 2003-07 to 1.84 tons/acre in 2008-12
- This represents a saved value of $0.14 million
  - Assumes holding harvested area at 15.3 million acres (2012 level)
  - Assumes average barley price =$62.16/ton (Alberta price,2012)
- This means 1.3 million fewer acres were needed to produce the same amount of hay at the 2012 level. This land can be put into other production – representing a significant gain of opportunity for producers.
  - Assumes holding forage production steady at 2012 level at 27.8 million tons.
- Land in tame or seeded pasture declined 2.4% or 340,000 acres between 2006 and 2011 to 13.67 million acres.[12] This decline reflects the reduced cattle inventories and consequently reduced demand for forage.

***Registered varieties***

*Definition:* New varieties registered

*Source:* Canadian Food Inspection Agency

- 58 alfalfa varieties have been registered from 2008 to 2012
- 6 bromegrass varieties have been registered from 2008 to 2012
- 4 ryegrass varieties have been registered from 2008 to 2012
- 11 clover varieties have been registered from 2008 to 2012
- 1 birdsfoot trefoil varieties have been registered from 2008 to 2012
- 8 orchardgrass varieties have been registered from 2008 to 2012

| Type | Varieties | | Type | Varieties | |
|---|---|---|---|---|---|
| | **2008** | **2012** | | **2008** | **2012** |
| Alfalfa | 175 | 228 | Alsike clover | 4 | 4 |
| Alfalfa hybrids | 1 | 6 | Red clover, single cut | 2 | 3 |
| **Total alfalfa** | **176** | **234** | Red clover, double cut | 27 | 35 |
| Meadow brome | 4 | 7 | Sweet clover | 2 | 2 |
| Smooth brome | 10 | 13 | White clover, low-growing | - | 1 |
| **Total bromegrass** | **14** | **20** | White clover, tall-growing | 12 | 13 |
| Annual ryegrass | 17 | 19 | **Total clover** | **47** | **58** |

[11] As annual forage yields can be significantly impacted by weather patterns ( drought, flooding), the five year average is used here

[12] 2011 Agriculture Census, Statistics Canada

| | | | | | |
|---|---|---|---|---|---|
| Perennial ryegrass | 16 | 18 | | | |
| Altai wildrye | 3 | 3 | **Bird'sfoot trefoil** | **10** | **11** |
| Dahurain wildrye | 2 | 2 | | | |
| Russian wildrye | 4 | 4 | **Orchardgrass** | **39** | **47** |
| **Total ryegrass** | **42** | **46** | | | |

***Grassland productivity***

*Source:* 2011 Census of Agriculture, Statistics Canada

- In 2011 36.33 million acres were in natural pasture down 4.7% or 1.8 million acres from 38.16 million acres in 2006.
- In 2011 13.67 million acres were in tame or seeded pasture down 340,000 acres or 2.4% from 14.01 million acres in 2006.
- In 2011 31.2% of Canadian agricultural land was in permanent pasture compared to 31.3% in 2006.

***Best management practices***

*Source:* 2011 Agriculture Census, Statistics Canada

- In 2011 51,589 farms reported they use rotational grazing (75.4% of beef farms) compared to 70,798 (82.3% of beef farms) in 2006.
- In 2011, 30,260 farms reported they used in-field winter grazing or feeding, 44.2% of the 68,434 beef farms in Canada.[13]
    - Data from Alberta indicates that hay-based confinement feeding costs approximately $1.75/head per day, while grazing stockpiled pasture costs approximately $1.02/head per day. Each day of extended grazing is worth around $0.73/head per day.
    - Extending the grazing season by a single day, for 5.19 million beef cows and replacement heifers, would represent nation-wide savings of nearly $3.8 million per year.
    - This does not include the cost savings associated with increasing productivity that allows for increased carrying and feeding capacity on fixed acreage, which will also reduce feeding costs substantially.
- In 2011 41,541 farms reported they used nutrient management planning, 41.7% of the 99,573 agricultural operations that applied manure (includes all livestock not just cattle).
- Acres receive fertilizer have been steady from 2006 (37.5% of total farm area) to 2011 (38.4% of total farm area)

## BEEF QUALITY

***Tenderness***

*Source:* 2009 Retail Beef Satisfaction Benchmark Survey & National Beef Quality Audit (shear force tests conducted at the AAFC Lacombe Research Centre)

- Overall consumer satisfaction rose from 73% in 2001 to 80% in 2009
- Satisfaction drivers: Percentage of satisfied customers*

| | ***Tenderness*** | | ***Juiciness*** | | ***Flavour*** | | ***Overall*** | |
|---|---|---|---|---|---|---|---|---|
| ***Steak Type*** | ***2009*** | ***2001*** | ***2009*** | ***2001*** | ***2009*** | ***2001*** | ***2009*** | ***2001*** |
| Strip loin | 84% | 82% | 87% | 82% | 86% | 85% | 87% | 84% |
| Top sirloin | 83% | 76% | 88% | 81% | 90% | 82% | 86% | 83% |
| Boneless cross rib | 71% | 58% | 72% | 62% | 79% | 69% | 75% | 65% |
| Inside round | 63% | 55% | 65% | 61% | 70% | 69% | 69% | 59% |
| ALL STEAKS | 76% | 68% | 78% | 72% | 82% | 76% | | |

**A satisfied customer was defined as one who gave a rating of 7/10 or higher*

[13] New for 2011; therefore comparison with 2006 is not possible

- Laboratory measurements backed up consumer comments. Shear force tests conducted at the AAFC Lacombe Research Centre found the percentage of steaks requiring only a standard amount of force increased for striploin (2001 89%; 2011 99%), top sirloin (2001 70%; 2011 87%), inside round (2001 52%; 2011 61%) and cross-rib (2001 65%; 2011 76%) steaks.

***Quality grading***

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

*Source:* Canadian Beef Grading Agency

- AAA and Prime as a percentage of all A grades increased from 51.6% in 2008 to 56.7% in 2012
- This represents an additional value of $4.62 million to industry through improvements in grading quality
    - Using 2,168,119 head of A grade cattle in 2012 (federal and provincial slaughter)
    - The difference due to quality is 110,574 head with a steer carcass weight of 878 lbs in 2012 this means 97,084,032 addition pounds of AAA+ product produced
    - The AAA/AA spread was $4.76/cwt in 2012

***Yield grades***

*Definition:* Y1 is >=59% lean, Y2 is 54-58% lean, and Y3 is <=53% lean

*Source:* Canadian Beef Grading Agency

- Y1 decreased 12% from 60.8% in 2008 to 48.8% in 2012
- Y2 increased 5.2% from 28.4% in 2008 to 33.5% in 2012
- Y3 increased 6.9% from 10.9% in 2008 to 17.7% in 2012
- Combined this represents a loss of $18.8 million to industry
    - Using 2,168,119 head of A grade cattle in 2012
    - Assumes yield discounts of $46/carcass on Y2, $92/carcass on Y3[14]
    - Total discount on the addition Y2 carcasses =$5.1 million
    - Total discount on the addition Y3 carcasses =$13.7 million

*Calculation:*

A 5.2% increase in Y2 x 2,168,119 head of A grade cattle = 111,666 additional Y2 carcasses
A 6.9% increase in Y3 x 2,168,119 head of A grade cattle = 148,728 additional Y3 carcasses
Use the 2012 average cutout prices at $180/cwt and assume average carcass weight = 850 lb
Estimated reduced revenue from lean meat per Y2 carcass = 850 lb x $180/cwt x (59% - 56%) = $46/carcass
Estimated reduced revenue from lean meat per Y3 carcass = 850 lb x $180/cwt x (59% - 53%) = $92/carcass
Total discount on the addition Y2 carcasses = 111,666 heads x $46/carcass =$5.1 million
Total discount on the addition Y3 carcasses = 148,728 heads x $92/carcass =$13.7 million

***Dark cutters***

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

*Source:* Canadian Beef Grading Agency

- The number of dark cutter (B4) increased from 0.8% of youthful slaughter in 1998/99 to 1.2% in 2011/12 (Based on CBGA data in the National Beef Quality Audit 2011).
- In the past five years, B4 incidence declined 0.2% from 1.4% of youthful slaughter in 2008 to 1.2% in 2012
    - Using 2,208,813 head of Maturity 1 cattle slaughtered in 2012 (federal and provincial slaughter)
    - The difference resulted from the 0.2% decline is 4,418 head (Note: there were 8,995 head fewer B4's in 2012 due to reduced slaughter numbers as well as the reduced percentage, the reduction from inventories is held constant here).
    - The 0.2% decline in B4 represents a saved value of $875,299 to industry
        - Assuming $200/head discount on dark cutting cattle on the 4,418 fewer head of B4 cattle.[15]

[14] Based on reduced revenue from red meat per carcass using average cutout price in 2012 at $180/cwt

- Based on the actual 5,193 head it was a $1.80 million in savings
- Reducing B4 level from 1.2% in 2012 to 0.8% seen in 1999 will save the industry $1.77 million
  - Assumes $200/head discount on dark cutting cattle on the 8,835 fewer head of B4 cattle

## FOOD SAFETY

***Incidence of E. coli 0157:H7***

*Source:* The National Enteric Surveillance Program (NESP), Public Health Agency of Canada (PHAC), Canadian Institute for Health Information (CIHI), and Statistics Canada's Vital Statistics.

- The number of reported *E. coli 0157:H7* cases in the country over the ten-year period from 2002 to 2011 by the Public Health Agency of Canada (PHAC) - show 3.8 people in 100,000 were infected with *E. coli* O157:H7 in 2002 and that figure has dropped to 1.4 in 100,000 in 2011 – a reduction of almost two thirds over the decade. In fact, with the exception of the waterborne outbreak of *E. coli* O157:H7 in Walkerton, Ontario in 2000, which took the lives of seven and affected hundreds more, the decline of reported cases goes back to 1995.
- The PHAC reports that 1.39 Canadians in 100,000 were infected with *E. coli* O157:H7 in 2012 – or some 458 individuals. While this number may appear low, given that Canada's surveillance and tracking system relies solely on patients reporting their symptoms to a health practitioner to be captured in the data, the actual number of infections is speculated to be considerably higher. For every case reported by a patient to a doctor, an estimate of between ten and 47 cases go unreported. Even applying a conservative estimate of ten unreported cases for every captured one, roughly 4,600 Canadians suffer the effects of *E. coli* O157:H7 infection each year, at a significant cost to the health care system.
- PHAC also reports that between 5-10% of those who become ill as a result of *E. coli* O157:H7, as well as approximately 15% of young children and the elderly, will develop the potentially fatal hemolytic uremic syndrome – or HUS.
- The death rate statistics in Canada from *E. coli* O157:H7 over the five-year period between 2000 and 2004 are compiled by PHAC from the Canadian Institute for Health Information (CIHI), and Statistics Canada's Vital Statistics. There is a minor variance between the two databases: CIHI has a total number of deaths at 18, while Statistics Canada's database shows a total of 14 fatalities over the five years in question (Statistics Canada's database limits the number of deaths to only those for which these organisms were the *principal* cause of death).
- The good news is that *E. coli* O157:H7 infections have been declining over the past decade. PHAC is responsible for tracking these infections. Medical laboratories that test patient blood samples report any STEC cases confirmed through testing to the Agency's National Enteric Surveillance Program weekly.

***Outbreaks***

*Definition:* The Public Health Agency of Canada (PHAC) is responsible for coordinating multi-jurisdictional food-borne outbreak investigations in Canada. A food borne disease outbreak is defined as two or more individuals with a similar illness resulting from consuming common food or water source. This information by no means represents all outbreaks as food borne disease is under-reported for a variety of reasons including no treatment sought, doctor did not report, misdiagnosis, and no further exploration of source if diagnosed. While the overall value is under-reported, the overall trend is valuable in knowing if the industry is making progress in this area or not. This data only includes incidence of national investigations which cross provincial borders. The National Enteric Surveillance Program (NESP) collects data on laboratory confirmed isolations of pathogens from provincial laboratories.

*Source:* Public Health Agency of Canada (PHAC)

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

- In 2012, there were two multi-jurisdictional *E. coli* outbreaks known to have been caused by beef. The previous multi-jurisdictional outbreak with beef identified as the source was in 2007. In the interim, there were two multi-jurisdictional outbreaks in 2009 with beef suspected to be the source. [16]
- In September 2012, an *E. coli* outbreak at the XL Lakeside plant at Brooks, Alberta resulted in Canada's largest beef recall in history and 18 people becoming sick. In January 2013, XL sold the Lakeside plant to JBS.

***Scope of E. coli tests***

*Source:* Public Health Agency of Canada (PHAC)

- The number *E. coli* strains monitored in beef has increased from one strain in 2008 to include an additional 6 non-O157 STEC strains in 2012 as Canada followed the USDA rule implemented in March 2011.

## SPECIFIED RISK MATERIAL UTILIZATION & DISPOSAL

***Deadstock removal***

- Historically renderers would pick up deadstock free of charge. Following the long-list SRM rule in July 2007 renderers started charging for deadstock removal.
    - Cost of deadstock removal in Alberta was 9¢/lb (August 2012)
    - The highest risk animal in the feedlot is the calf; assume average weight of dead animal is 500 lbs equates to $45/head.
    - Feedlot average deathloss of 2.6% on 2,948,706 million fed cattle is 76,670 head of deadstock
- At $45 per animal for 76,670 animals equals total cost of $3.45 million to the feedlot industry for deadstock removal
- Deathloss at the cow-calf level – 1% on 4.23 million cows 42,283 head to dispose of
    - 3% deathloss on calves, however carcass are rarely found with predators cleaning the carcass before disposal is necessary
    - Around 45% of deadstock RFID numbers are captured. This indicates that 55% of deadstock is not picked up by renderers. 42,284 x 45% = 19,030 head
    - 9 cents/lb on a 1,350 lbs cow = $121.50/head
    - This represents a cost of $2.3 million on 19,030 head at $121.50/head to the cow-calf industry

***Cost of Disposing SRM***

- Canadian packers have additional costs due to long list SRMs estimated at $31.70/cwt for OTM cattle and $4.52/head for UTM cattle.[17]
- There is also a significant cost to packers when an OTM animal is found during a UTM shift since the SRM material contaminates all carcasses on the floor. Therefore, producers are charged for cattle sold as UTM but are classified as OTM by dentition at the plant. CMC estimates misidentified OTM animals have a daily cost of $300-400/day or $0.02-0.03/head.
- This represents a cost of $0.13 million to industry annually
    - 2.78 million heads slaughtered in 2012 (Federal and Provincial plants) with a cost of $0.02-0.03/head

[16] Note that this data only include the incidence of multi-jurisdictional enteric outbreaks, which are enteric outbreaks that have ill cases identified in more than one Canada province or territory or involve ill cases from Canada and another country. Multi-jurisdictional enteric outbreaks may represent only a proportion of all Canadian enteric outbreaks.

[17] CMC Feed Ban Cost Survey July 2009