



July 2021

Five-Year Canadian Beef Research & Technology Transfer Strategy



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I. Executive Summary

Canada is a world leader in meeting beef demand in an environmentally, socially and economically sustainable manner. The beef industry leaders recognize that consumers, end-users, governments and other stakeholders are looking for continued leadership in reaching broader environmental and industry sustainability goals.

In response, the **Canadian Beef Advisors**, which represent Canada's seven national beef organizations responsible for policy, marketing, research and sustainability, developed a National Beef Strategy to align end-user and industry sustainability goals. With science and technology transfer being critical to achieving these goals, the **Five-Year Canadian Beef Research and Technology Transfer Strategy** was renewed and is outlined in this document.

The **Beef Cattle Research Council** (BCRC) worked with the Canadian Beef Advisors, partner funding agencies, producers, researchers and other industry stakeholders to renew the Five-Year Canadian Beef Research and Technology Transfer Strategy. The Five-Year Strategy identifies target research and technology transfer outcomes and priorities under the following program areas:

- feed efficiency and utilization
- forage and grassland productivity
- environmental sustainability
- animal health, welfare and antimicrobial resistance
- beef quality
- food safety

All priorities within the Five-Year Strategy align with one or more of the National Beef Strategy 10-year industry goals, which cover areas relating to greenhouse gas (GHG) emissions and carbon sequestration, animal health and welfare, land use and biodiversity, water, beef quality and food safety, human health and safety, as well as technology. While the Five-Year Strategy is divided into the six program areas listed above, in most cases, improvements in all of these areas contribute to achieving the industry's 10-year environmental sustainability goals.

For example, achieving the 10-year industry goal of a 33% reduction in the GHG emission intensity of primary production will require research that improves production efficiencies at all stages of the cattle production chain, including improved reproductive efficiency (i.e. improved animal health and welfare), improved hay yields (i.e. improved forage and grassland productivity), and improved feed grain yields, feed conversion efficiency and carcass weight (i.e. feed efficiency and utilization).

Similarly, achieving the 10-year industry goal of sequestering an additional 3.4 million tonnes of carbon annually will require science-based improvements in forage yields and resilience (i.e. forage productivity), grazing management (i.e. grassland productivity) and soil health and quality (i.e. environmental sustainability).

As a final example, the industry goal of 92% of cows weaning a calf every year will require the development and adoption of beneficial practices that ensure nutritional requirements are understood



The Five-Year Strategy provides a framework to achieve national coordination of beef research priorities, funding and technology transfer efforts. It directly supports the industry's 10-year goals and improved productivity in a sustainable manner, with targeted outcomes for both research and technology transfer.

I. Executive Summary, cont.

and met at all stages of production, ensuring animal health and welfare needs are met through appropriate vaccination, other prevention-based herd health management and appropriate breeding, calving and weaning management. Achieving 92% reproductive efficiency will contribute to industry goals related to reduced GHG intensity, animal health and welfare and antimicrobial stewardship.

Technology transfer is critical to drive industry and producer awareness and adoption of existing and new research, technology and practices, and it is a priority under each of the above-listed program areas. The Five-Year Strategy provides a framework to achieve national coordination of beef research priorities, funding and technology transfer efforts. It directly supports the industry's 10-year goals and improved productivity in a sustainable manner, with targeted outcomes for both research and technology transfer. This is the third iteration of the Canadian Beef Research and Technology Transfer Strategy, following earlier versions released in 2012 and 2017. As research and the transfer of research into application are long-term endeavors, taking a long view illustrates the value of research. As examples, Canadian cattle, forage and beef research has contributed to:

- A 40% improvement in feed efficiency over a 60-year period
- Significant reductions in winter feeding costs
- A 15% reduction in greenhouse gas intensity per kilogram of Canadian beef over a 30-year period
- Significant reductions in antimicrobial use in feedlot production
- Maintained consumer satisfaction with the eating quality of Canadian beef
- Improved microbiological safety of Canadian beef

The BCRC will continue to engage beef industry stakeholders as the Five-Year Canadian Beef Research and Technology Transfer Strategy is implemented to ensure priority research and technology transfer needs are met. The BCRC is also committed to measure progress against achieving the 10-year goals in partnership with the Canadian Beef Advisors, to advance the competitiveness and sustainability of the Canadian beef industry in a coordinated manner.



II. BCRC & Five-Year Strategy Overview

1. Background

The Beef Cattle Research Council (BCRC) is Canada's industry-led funding agency for beef, cattle and forage research and extension. The BCRC is directed by a board of beef producers from across Canada and is funded primarily through the Canadian Beef National Check-Off.

In 2020, the BCRC received on average \$0.67 (unaudited) of every \$2.50 of the Canadian Beef Cattle Check-Off collected by the provincial beef cattle associations. This funding is leveraged under various programs to maximize producer returns on their check-off investment. Typically for every \$1 in producer check-off invested, BCRC looks to leverage \$2-3 in other direct funding in addition to indirect leverage through in-kind and other funding.

The BCRC prioritizes and funds, both research and extension activities with the greatest potential to improve the competitiveness and sustainability of Canada's beef cattle industry. As of June 2021, the BCRC collaborates with more than 25 different research entities and is funding over 80 projects.

This document presents the renewed 2021 Five-Year Canadian Beef Research and Technology Transfer Strategy. The Canadian beef industry has identified research and technology transfer¹ as key priorities for the Canadian beef industry and supports its renewal. It is increasingly important to ensure science is available to position the beef industry correctly when it comes to communicating with the public, consumers and government.

The beef industry leaders also recognize that organizations like the Global Roundtable for Sustainable Beef, end-users, non-governmental organizations and governments are looking to the beef industry to help them reach goals with respect to the environment and industry sustainability. These organizations are actively engaging with the beef industry in their goal setting. With research and technology transfer being a major component of these goals, the BCRC has assumed a leadership role in ensuring the alignment of the Five-Year Strategy with achieving these goals.

Through the Five-Year Canadian Beef Research & Technology Transfer Strategy, the BCRC is focused on facilitating and encouraging collaboration amongst researchers, producers, industry stakeholders and funding agencies to address the key research and technology priorities identified in a coordinated manner to maximize benefits obtained from investments in beef research and extension.

The Five-Year Strategy provides a framework to achieve national coordination of beef research priorities, funding and extension efforts. It is intended to influence and guide the investments of the BCRC and other Canadian beef research funding agencies and encourage greater collaboration and coordination of limited funding and resources. This coordination across funding agencies leads to efficiencies with limited funding and supports a portfolio approach to research investments, ensuring key research, capacity and extension priorities are addressed in a coordinated manner. This coordination and five-year strategy oversight are a key part of the BCRC's mandate.

Footnote:¹ For the purpose of this document, the terms "technology transfer" and "extension" are used interchangeably, with them generally defined as the transformation and exchange of information and tools between researchers or developers and end users, which in most cases, are Canadian beef cattle farmers and ranchers.



II. BCRC & Five-Year Strategy Overview, cont.

2. Rationale for an Overarching Strategy

It is a challenge to forecast industry needs in beef and forage research and technology transfer that strategically invests in all elements — including improvements in productivity, food safety and quality, maintaining critical research capacity and science to address public trust and consumer questions. It is particularly challenging considering more than 30 funding agencies are involved in funding beef and forage research at national and provincial levels and across both government and industry.

Consequently, the BCRC and the Canadian Beef Value Chain Roundtable (BVCRT) recognized the importance of taking a coordinated and strategic approach to the first five-year National Beef Research Strategy in 2012. The 2012 National Beef Research Strategy was intended to influence and guide the investments across BCRC and other funding agencies and to encourage greater collaboration and coordination of limited funding and resources, thereby reducing duplication and ensuring high priority research and capacity needs were addressed in a coordinated manner. The value of such a collaborative and strategic approach was recognized and encouraged the renewal of the Strategy in 2017.

The development, renewal and ongoing stewardship of the Canadian Beef Research and Technology Transfer Strategy has contributed to significant progress, including more regular sharing of information between industry and government funding agencies and coordination when defining annual funding priorities. Having a single national strategy has provided a greater focus on specific, targeted research outcomes with clear direction to researchers and extension agents. It has also assisted in informing and encouraging more proactive industry and government discussions about needed infrastructure and capacity, and how to work together moving forward.

The previous five-year strategies are available on the BCRC website at www.beefresearch.ca.



An overview of the 2018-2023 and updated Canadian Beef Research and Technology Transfer Strategies are available at [beefresearch.ca](http://www.beefresearch.ca).

II. BCRC & Five-Year Strategy Overview, cont.

3. Strategy Development Stakeholders

The previous two five-year strategies, which the BCRC developed in partnership with the BVCRT, demonstrated the value of having a nationally coordinated five-year research and technology transfer strategy. Through these previous strategies, input was sought from a broad range of producers, researchers, extension specialists, government, funders and other industry stakeholders through various means including direct consultation, an online survey and workshops. This engagement helped to identify needs in research capacity, infrastructure, programming, funding and coordination, and to ensure priority industry outcomes are being addressed.

The renewed 2021 Five-Year Strategy has been developed by the BCRC, in consultation with the Canadian Beef Advisors, partner funding agencies, producers, researchers and other industry stakeholders, through a process involving direct consultation, focus groups, virtual workshops and an online survey. In 2020-21, Agriculture and Agri-Food Canada (AAFC) began transitioning away from commodity-specific roundtables to a new roundtable format, but the Canadian Beef Advisors was well-positioned to engage in the Five-Year Strategy development process in place of the BVCRT.

The Canadian Beef Advisors is a diverse group of elected leaders and staff representatives of the seven national beef organizations responsible for policy, marketing, research and sustainability. The seven organizations include the BCRC, Canadian Beef Breeds Council, Canada Beef, Canadian Cattlemen's Association (and its provincial member associations), Canadian Meat Council, Canadian Roundtable for Sustainable Beef and the National Cattle Feeders' Association. On behalf of the Canadian beef industry, the Canadian Beef Advisors is tasked with prioritizing and reaching the goals outlined in the **National Beef Strategy**. This broader strategy encompasses the Five-Year Canadian Beef Research and Technology Transfer Strategy in tandem with objectives related to policy, marketing and public trust.

CANADIAN BEEF ADVISORS



III. Context for the Canadian Beef Research & Technology Transfer Strategy

1. Industry Competitiveness

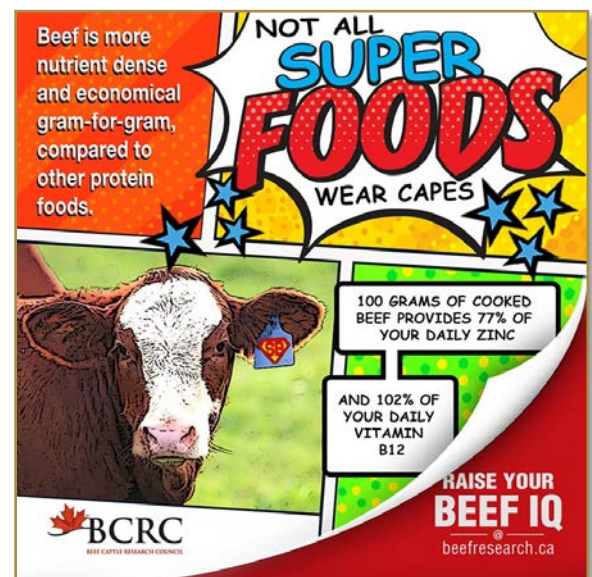
As the second largest sector in Canadian agriculture, the beef industry contributed \$9.1 billion annually in farm cash receipts on average during 2016-2020 and over \$21.8 billion to Canada's Gross Domestic Product (GDP). Every beef sector job yields another 3.9 jobs elsewhere in the economy, supporting 347,352 full-time equivalent jobs. Beef producers are the stewards of Canada's grasslands that preserve approximately 1.5 billion tonnes of soil carbon, provide habitat for over 1,000 plant, animal and insect species and conserve 44.2 million acres of the endangered Northern Great Plains ecosystem.

The Canadian beef industry is in a positive position for expansion due to the combination of Canada's progressive producers, an ideal landscape for beef production and strong global meat demand that is projected to continue to rise. Growth in production and beef exports would position the industry as a strong economic driver and contribute positively to the Canadian government's environmental goals.

The industry must maintain its competitive position. Canadian beef is recognized globally as being a safe, high quality, nutritious and delicious protein source demanded by consumers. But, it must compete with other meat and plant-based protein sources vying for a place on consumers' plates. Canada's beef industry must also maintain its competitive position against other major beef-exporting countries. Canada represents 2% of global cattle inventories, producing 1.5 million tonnes of beef and exporting 45% of our production (including live slaughter cattle exports) valued at \$4.4 billion in 2019. As the third largest exporter of high-quality, grain-fed beef in the world and an important contributor of low greenhouse gas (GHG) emission beef to international consumers, industry competitiveness ensures producer viability and a continued role in the international market.

The beef industry has a responsibility to address world hunger. With sustainable production practices, higher productivity and reduced emissions go hand in hand. Beef is a nutrient-dense, high-quality protein source containing 14 essential nutrients including zinc, bioavailable iron, selenium, potassium and a range of vitamins. Iron and zinc found in red meat is more bioavailable than from plant sources. The inadequate intake of iron and zinc remains a concern even in developed countries.

Gram for gram, Canadian beef provides substantial and cost-effective nutrient benefits over other protein options. A **recent study** found that for a person to get as much protein from plant sources as they would from a single 100-gram serving of beef, they would have to eat 160 grams of nuts or 500 grams of legume vegetables. Eating that much plant protein would mean consuming twice as many calories from legume vegetables (443 calories) or four times as many calories from nuts (940 calories) as from beef (235 calories). Beef can also help meet daily B12 requirements and provide more zinc and digestible iron than plant-based protein sources on a per-gram basis. In addition, 160 grams of nuts would cost nearly twice as much (\$4.65) and 500 grams of legume vegetables would cost almost the same (\$2.02) as 100 grams of beef (\$2.17).



III. Canadian Beef Research & Technology Transfer Strategy, cont.

1. Industry Competitiveness, cont.

Beef's place in a healthy environment. Beef production in Canada provides a unique set of positive environmental and human health benefits that few other food products can match. Much of the land that cattle graze cannot be used for other purposes. Sensitive grassland ecosystems, like the threatened Northern Great Plains and the endangered plants, animals and birds they support can be protected when managed by cattle producers. Well-managed grazing can also restore unproductive soils that have been degraded through improper management. Most of the plants cattle eat are not digestible by humans, primarily consisting of low-quality forage, grains and by-products from other agricultural sectors that fail to meet standards for human consumption and would otherwise go to waste. A vibrant Canadian environment and agriculture landscape includes beef production.

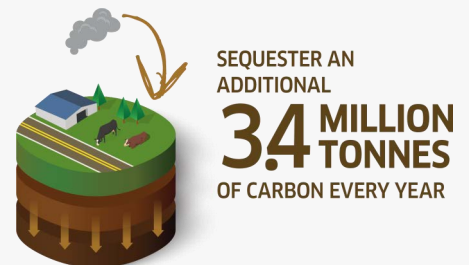
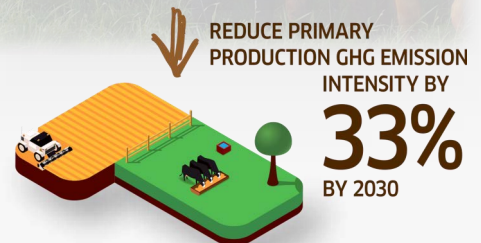
When grassland is converted to crop production, sequestered carbon is released into the atmosphere. Further, efforts to remove red meat from the diet may create a food supply in Canada incapable of supporting nutritional requirements, as ensuring intakes of all essential nutrients can become a challenge when plant-based diets are scaled up from the individual to an entire population (White & Hall 2017, Canadian research pending). Canada can secure its food supply and mitigate climate change through sustainable beef production, with continued research and adoption of innovations by producers.

Canadian beef is already successful in the global climate conversation, but it's not stopping there. The Canadian beef industry's greenhouse gas footprint is less than half the world average and one of the lowest in the world at 12 kilograms CO₂ equivalent per kilogram of live weight. As a direct result of improved production practices, the industry's emissions dropped in intensity by 15% from 1981 to 2011. Producing one kilogram of Canadian beef today creates 15% less greenhouse gases and uses 17% less water and 24% less land than in 1981 (Legesse et al. 2015, Legesse et al. 2018).

The Canadian beef industry has set ambitious goals to improve its environmental performance even further by 2030, such as:

- reduce primary production GHG emission intensity by 33%,
- sequester an additional 3.4 million tonnes of carbon per year,
- maintain and enhance 68% of wildlife capacity within agricultural lands supported by beef production,
- maintain 35 million acres of native grasslands and
- reduce food loss and waste by 50% from secondary processing to consumer. (**Beef Goals continue on p. 11.**)

2030 CANADIAN BEEF GOALS



- 2030 Beef Goals continue on p. 11 -

III. Canadian Beef Research & Technology Transfer Strategy, cont.

1. Industry Competitiveness, cont.

Canada has only ten years to reduce emissions by over 200 megatonnes to meet Paris Agreement commitments. The beef industry is aware of its positive and negative impacts on the environment as well as how it may be impacted by climate change. In readying itself for the challenges ahead, the beef industry has become part of a resilient, clean growth solution. Research and technology transfer are integral to sustainably increasing beef production to meet growing global demand, while also achieving the goals set out by industry and contributing to the Canadian government's climate commitments. Mitigation strategies involve reducing the intensity of beef emissions through research and technology transfer around forage production and quality, grazing managing, feed production and alternate feeding strategies, animal genetics and animal health.

The beef industry contributes positively to carbon sequestration and biodiversity. Carbon sequestration is required to offset emissions. Grazing land managed by beef production stores significant amounts of carbon at an estimated 1.5 billion tonnes (**CRSB, 2016**). This sequestered carbon is lost when grasslands are converted to industrial use, mono-cropping for plant proteins or urban development. That is why the industry's land use goal is to conserve grasslands through grazing management practices that optimize carbon sequestration and promote biodiversity. Managing grazing lands to sequester carbon have potential even at low annual rates given the 18 million acres potentially impacted across Canada (**CRSB, 2016**).

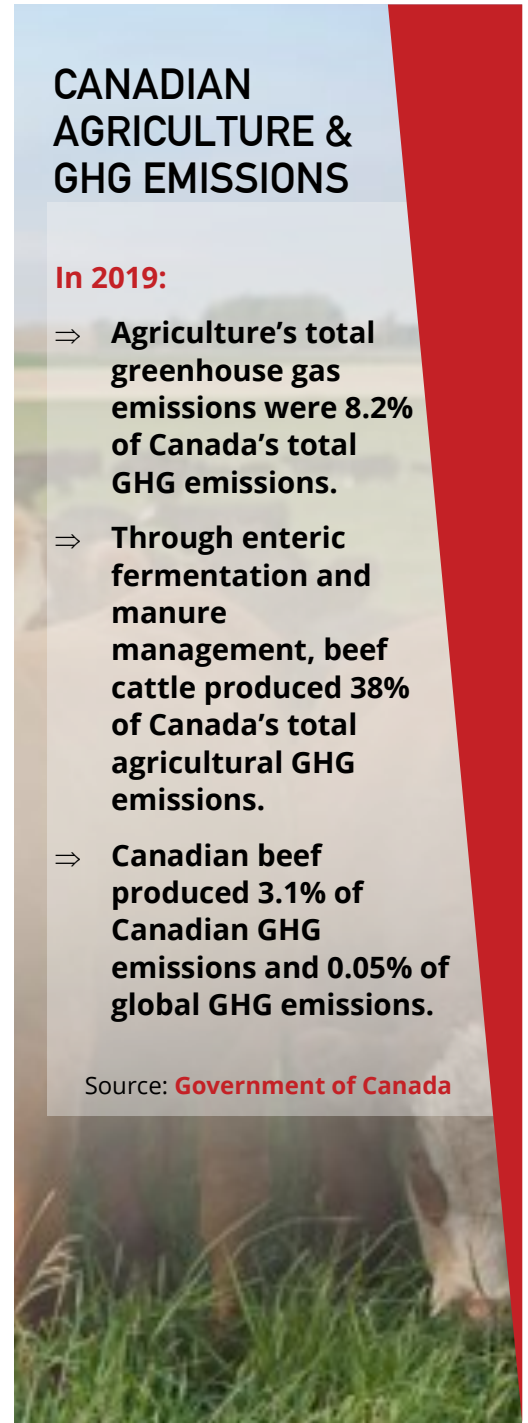
The Canadian beef industry's story is and always has been one of readiness, resilience and responsibility toward Canadians and the global community. It is called upon to increase food production while reducing greenhouse gas emissions. The Canadian beef industry firmly believes this is possible through the research, innovation and extension outlined in this Strategy.

CANADIAN AGRICULTURE & GHG EMISSIONS

In 2019:

- ⇒ **Agriculture's total greenhouse gas emissions were 8.2% of Canada's total GHG emissions.**
- ⇒ **Through enteric fermentation and manure management, beef cattle produced 38% of Canada's total agricultural GHG emissions.**
- ⇒ **Canadian beef produced 3.1% of Canadian GHG emissions and 0.05% of global GHG emissions.**

Source: **Government of Canada**



III. Canadian Beef Research & Technology Trans-

2. Beef Industry Goals to 2030

i. Overview

The Five-Year Canadian Beef Research & Technology Transfer Strategy was developed with significant direction from industry stakeholders, but also with an eye to the 10-year goals established by the Canadian Beef Advisors in the National Beef Strategy.

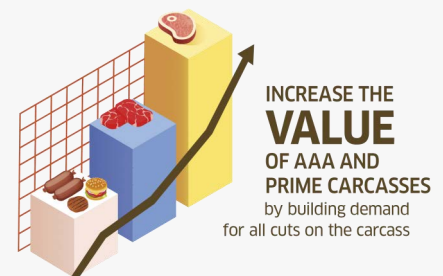
The National Beef Strategy promotes a united approach to position the Canadian beef industry for greater profitability, growth and continued production of a high-quality beef product of choice around the world. Demonstrating its far-sighted leadership, the Canadian Beef Advisors developed a suite of 10-year “reach” goals. These 10-year goals align global, end-user and industry sustainability goals and provide a single set of targets that the national beef organizations will be aiming to achieve together. These ambitious goals outline how the Canadian beef industry is striving for incremental and continual improvements—economically, environmentally and socially.

The topics addressed under the 10-year goals include greenhouse gas emissions and carbon sequestration, animal health and welfare, land use and biodiversity, water, human health and safety, beef quality and food safety and technology. This suite of goals covers productivity and supports the delivery of a high-quality product. These goals recognize the breadth of benefits from beef production beyond supplying global protein demand.

Highlights of the 2030 goals include:

- Reduce primary production GHG emission intensity by 33%.
- Sequester an additional 3.4 million tonnes of carbon yearly.
- Protect and maintain the 35 million acres of native grassland in the care of beef producers.
- Protect animal well-being by ensuring the five freedoms of health, mental state, nutrition, environment and behaviour.
- Cut food loss and waste by 50% from secondary processing to consumers.
- Maintain and enhance 68% of wildlife habitat capacity within agricultural lands being supported by beef production.
- Develop and promote best practices to preserve the continued effectiveness of existing and future antimicrobials to support human and animal health and welfare.
- Increase the value of AAA and prime carcasses by building demand for all cuts.
- Support innovation, research and commercialization of technology throughout the supply chain.
- Protect wetlands, filter nutrients and build resilience to drought and flooding.
- Invest in innovative solutions for a better tomorrow.

2030 CANADIAN BEEF GOALS, cont.



III. Canadian Beef Research & Technology Transfer Strategy, cont.

2. Beef Industry Goals to 2030, cont.

ii. 2030 Goal Development

An iterative process was used to develop the proposed 10-year goals including a literature review, interviews with researchers, veterinarians, producers and other industry experts that provided feedback on what was feasible for industry to accomplish. Historical performance was considered, recognizing that previous achievements came from multiple small, incremental improvements across the entire production system. It was recognized that there are diminishing marginal returns and biological limits in some areas, while other areas may experience acceleration due to technology, adoption and new opportunities. Where feasible, scenarios were provided that included a continuation of historical trends and potential breakthroughs.

Preliminary options were presented to a producer task force for feedback and discussion. The Canadian Cattlemen Association's Environment Committee and the Canadian Roundtable for Sustainable Beef membership provided further input. This was followed up by an industry comment period prior to final approval by the Canadian Beef Advisors.



III. Canadian Beef Research & Technology Transfer Strategy, cont.

2. Beef Industry Goals to 2030, cont.

iii. The Role of Research and Technology Transfer

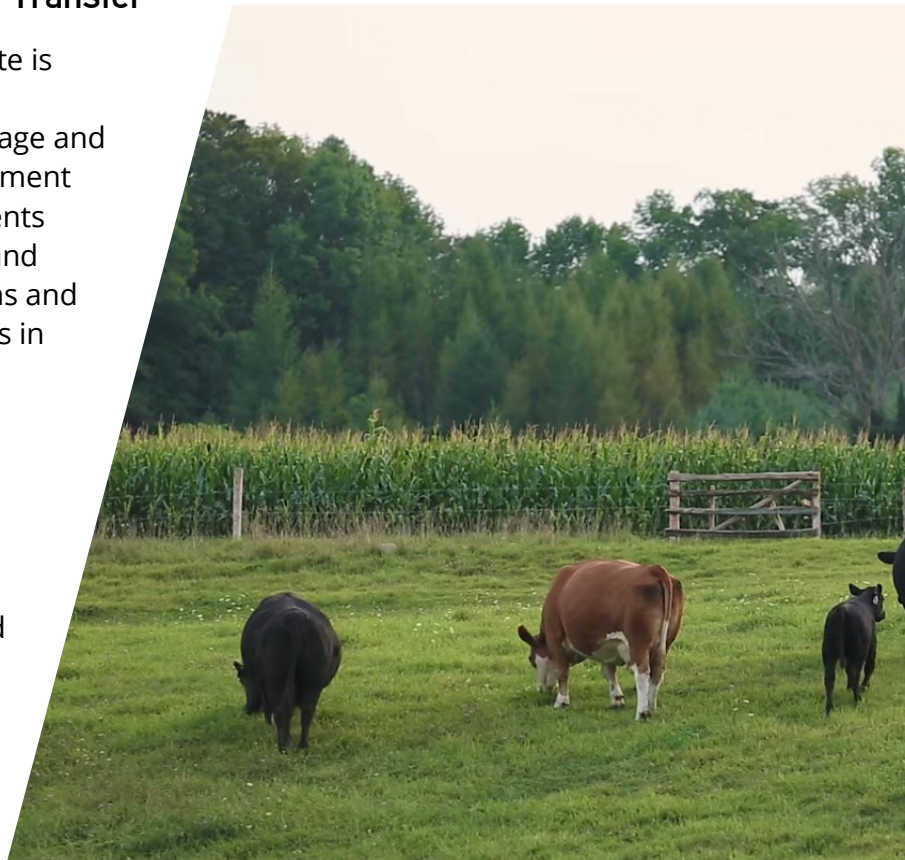
Much of Canada's beef industry success to date is due to improvements in average daily gain, reproductive efficiency and animal health, forage and feed yields, nutritional and grassland management and conservation initiatives. These achievements have been supported by research to understand realities, to identify and test potential solutions and to make continued incremental advancements in the productivity of forages and feeds, animal health, genetic improvements and overall production.

Research dollars are needed to make feed efficiency, improved breeding and grazing findings from lab, plot or small-pen research meaningful at the herd scale. Surveillance and networks to monitor disease prevalence, antimicrobial use and animal welfare practices are required. Waste in the supply chain is an emerging issue for the beef industry. Food waste in packing, retail and consumption represents 19% of edible, bone-free meat. A 50% reduction in

waste prevents 3 kg of CO₂ production and 60 L of water per kilogram packed, avoiding the release of 1.6 Mt CO₂ equivalent in the atmosphere. Measuring and monitoring progress is underway and will need to continue for the next decade toward the 2030 goals. The 2030 goals are ambitious and will require the industry to stretch.

Technology transfer is also critical in driving industry and producer awareness and adoption of existing and new research, technology and practices. There is more work to do to encourage broadscale adoption of recent major breakthroughs. Supporting producers' efforts to improve record keeping is critical to measure performance against established benchmarks and to identify key opportunities to make additional improvements by adopting or adapting specific practices or innovations on an individual operation. Further refinement of beneficial management practices related to animal health and enhanced producer awareness of these practices will be imperative to increase productivity and efficiency, reduce antimicrobial use and ensure animal welfare.

Identifying barriers to the adoption of current genetic tools and supporting producers' appropriate decision-making processes related to genetic selection will drive ongoing gains in efficiency. Beneficial management practices related to forage and feed production, grazing management and feeding strategies need to be advanced in tandem with the development of decision-making tools that allow producers to understand the feasibility of implementing improved management practices within their specific operations.



III. Canadian Beef Research & Technology Transfer Strategy, cont.

2. Beef Industry Goals to 2030, cont.

iii. The Role of Research and Technology Transfer, cont.

Both research and technology transfer play a key role in achieving these goals as identified in this Five-Year Canadian Beef Research and Technology Transfer Strategy. **See Section V** for the Canadian Beef Research and Technology Transfer Strategy alignment with the 2030 Industry Goals.

There is a recognized need to continue to build trust with Canadian and global consumers and the broader public around the various topics including beef quality and nutrition, food safety, best practices and public trust issues including environmental sustainability, the safety and use of production technologies within the industry, animal health and welfare and other areas of priority to consumers and the public.

While research and extension can play an important role in generating science to inform these areas and ensure best practices are implemented within industry, it is not within the mandate of this Five-Year Strategy to focus on direct consumer and public education related to these areas. BCRC and other research and extension funders, as well as the researchers, will continue to work closely with industry organizations such as Canada Beef, the Canadian Cattlemen's Association's Public and Stakeholder Engagement program, the Canadian Roundtable for Sustainable Beef and other members of the Canadian Beef Advisors as appropriate whose mandates are more directly aligned to working with consumers, the public, policy makers and regulators.

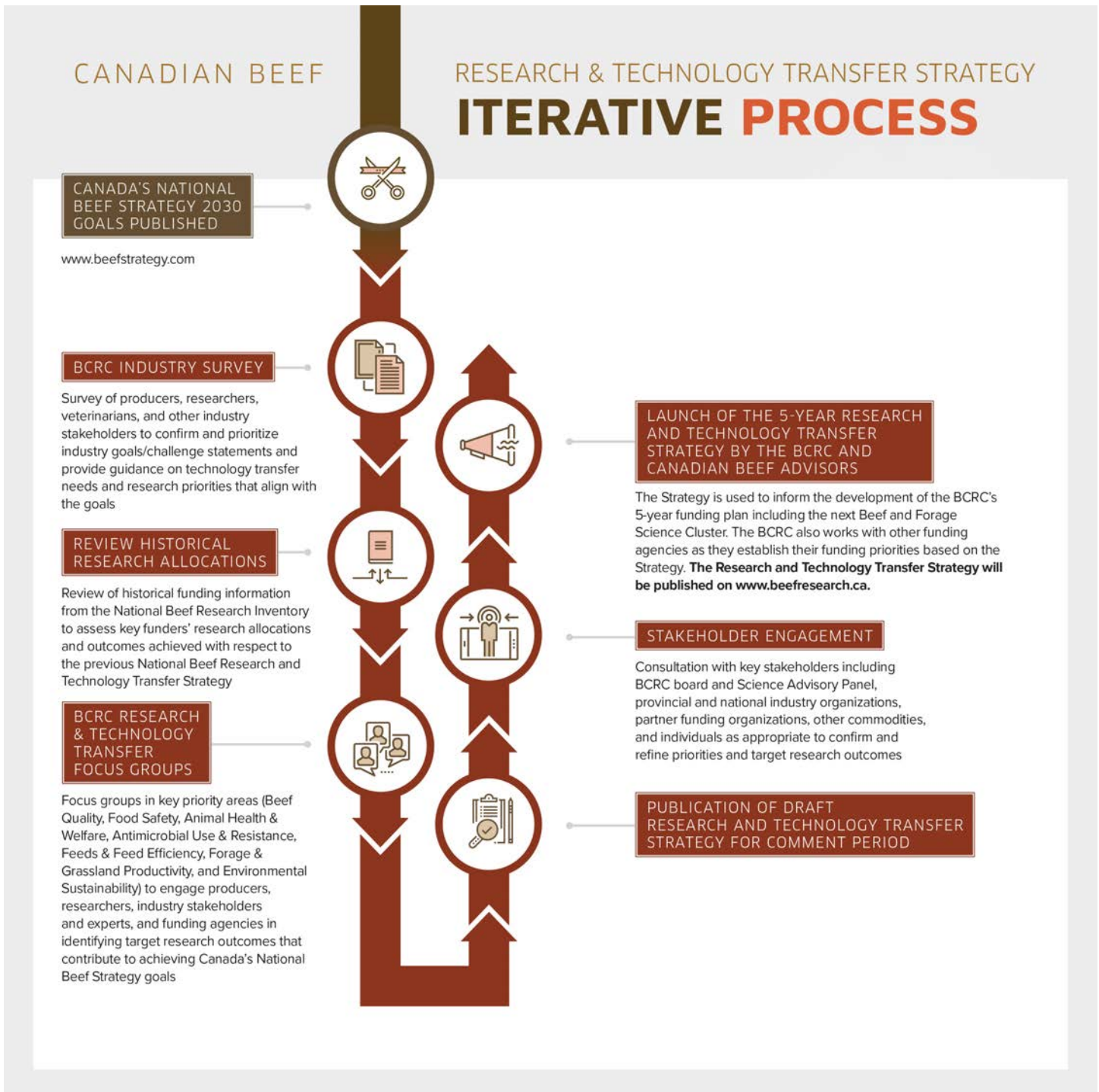
The Five-Year Canadian Beef Research & Technology Transfer Strategy is intended to feed into the broader National Beef Strategy and 10-year goals of which the Canadian Beef Advisors and other partners must work collaboratively to achieve.



III. Canadian Beef Research & Technology Transfer Strategy, cont.

3. Research & Technology Transfer Strategy Development Process

Following the successful launch of the industry's 10-year goals by the Canadian Beef Advisors, the BCRC launched a process to develop the next Five-Year Canadian Beef Research & Technology Transfer Strategy in 2020. The process involved seeking input from producers, researchers, funders, government and other supply chain stakeholders.



III. Canadian Beef Research & Technology Transfer Strategy, cont.

3. Research & Technology Transfer Strategy Development Process, cont.

To ensure the strategy development process was truly collaborative and highly focused to target future research and extension priorities, input was sought through various means including direct stakeholder consultation, an online survey that provided input from over 900 industry stakeholders, virtual focus group discussions, a funder engagement session, and a broader industry comment period. Due to COVID-19 impacts throughout 2020 and 2021, virtual focus groups were held for each of the following program areas:

- feed efficiency and utilization
- forage and grassland productivity
- environmental sustainability
- animal health, welfare and antimicrobial resistance
- beef quality
- food safety
- extension

The various focus groups identified program-area-specific research and extension priorities that contribute to achieving the industry goals and advancing the Canadian beef industry. These focus groups engaged industry stakeholders including producers, veterinarians, packers, non-government organizations, industry partners, researchers, funders and extension groups and included 180 participants in total. A list of focus group participants is included in **Appendix 2**. Each focus group had an initial brainstorming session that had participants bring key strategies as to how to achieve priority outcomes and the industry's 10-year goals. A second session for each group involved refining priorities and addressing any key gaps. The second sessions also used polling to rank research and extension priorities to inform future programming.

The extension focus group engaged individuals and organizations involved in knowledge and technology transfer in the beef industry. They reviewed the extension priorities identified across all of the key program areas and identified key opportunities and approaches to focus extension efforts to achieve those priorities. The extension session focused on increasing awareness of and collaboration between extension groups and identifying significant innovations that, if adoption rates increased, would have the greatest potential to advance the competitiveness and sustainability of the Canadian beef industry. See **Appendix 3** for extension program area details.

In addition to the focus group recommendations, input was sought from industry through an open online survey. The online survey, conducted January to March 2021, allowed participants to rate the importance of a broad range of research issues. The 962 survey respondents included cow-calf producers (52%), seedstock breeders (7%), feedlot operators (3%), veterinarians (4%), researchers (7%), abattoir staff (1%), government staff (7%), industry staff (4%), non-governmental organizations (3%) and other (12%) — including producers from other countries and other supply chain stakeholders. Representation was provided from across the country with Ontario, Quebec and Atlantic Canada representing 25% of seedstock, 18% of cow-calf and 44% of feedlot responses.



III. Canadian Beef Research & Technology Transfer Strategy, cont.

3. Research & Technology Transfer Strategy Development Process, cont.

The cow-calf responses were disproportionately represented by younger producers than the average demographic with 33% being under 40 years old, 38% between 40 and 60 years old and 29% over 60 years old. This highlights the demographic currently engaging with material at beefresearch.ca.

Due to limitations on the number of individuals that could participate in focus groups, the online survey results allow for validation and confirmation of what was heard within the different focus groups topics. Particular attention was paid to issues that were identified as “very” or “extremely” important by a large proportion of respondents, as well as those rated as “low” or “not” important by many respondents. In addition, the survey provides valuable information about how to connect with producers with technology transfer material going forward. A summary of the survey results is included in **Appendix 1**.

Beyond the focus groups and online survey, two broader virtual engagement sessions were held. The first was focused on consulting with industry and government funding agencies and key stakeholders within the sector. Provincial and federal government and industry funders were engaged in discussions about opportunities to improve funding coordination and delivery of research and extension that aligns with the five-year draft priorities. The second webinar session was an open session that provided an overview of the industry’s 10-year goals and the five-year research and extension priorities aligned with those goals. It encouraged feedback through an online open industry comment period that BCRC facilitated to encourage feedback on the draft strategy and priorities.

Upon the completion of these broader engagement sessions and industry comment period, the draft strategy was reviewed and approved by the BCRC and the Canadian Beef Advisors.



IV. Outcomes and Priorities by Program Area

1. Core Research & Technology Transfer Principles

The beef industry has defined several overarching core principles for the renewed Canadian Beef Research and Technology Transfer Strategy under which more specific outcomes are established:

1. Increase producer profitability by increasing productivity or decreasing costs of production and risks.
2. Develop, enhance and encourage adoption of beneficial practices and innovations that maximize the environmental benefits industry provides and continue to reduce our environmental footprint, while supporting industry competitiveness.
3. Support continuous improvements in Canadian beef demand through advancements in the quality and safety of Canadian beef.
4. Generate science to inform decision makers, policy and best management practices and to support consumer confidence and public trust.
5. Develop, enhance and encourage adoption of leading-edge technologies that support industry competitiveness, automation and sustainability.
6. Ensure the maintenance and rejuvenation of critical research capacity and infrastructure that facilitate proactive inquiry and innovation to support industry advancement.



IV. Outcomes and Priorities by Program Area, cont.

2. Feed Efficiency & Utilization

Feed efficiency research and extension activities are integral to developing and validating cost-effective methods to identify more efficient cattle, feeds and feeding strategies. Improving the feed-to-gain ratio (feed:gain) by 1% would save Canada's feedlot sector an estimated \$13.5 million annually. A 1% improvement in feed:gain could have an economic effect four times greater than a 1% improvement in average daily gain. Feed efficiency plays an even larger role in the value equation at times of high grain prices or forage shortages. A difference in feed conversion of one pound represents \$52 per head over a 550-pound weight gain and \$5.30-per-bushel corn (2020 Ontario prices).

Cattle: Feed efficiency and a lower feed:gain ratio in cattle at all stages of the life cycle (preweaning, post-weaning, backgrounding, grassing and feedlot) is key to reducing cost of production and ensuring industry competitiveness. Feed efficiency is heritable and will respond to selection, although measuring individual feed intake is time consuming and costly. Feed:gain is genetically correlated with average daily gain, so selecting for average daily gain indirectly improves feed:gain, though less rapidly than selecting specifically for feed:gain.

The rate of genetic improvement for feed efficiency could be significantly increased through DNA testing, although genetic markers for feed efficiency have had somewhat limited accuracy outside of the discovery population to date. Furthermore, the strength and nature of the genetic relationship between feed efficiency in growing cattle and feed efficiency and fertility traits mature cows is unclear. What is clear is that improvements in feedlot feed:gain must not be to the detriment of reproductive or feed efficiency in mature cows. Research is needed to identify the best way to define and express feed efficiency in breeding females that are maintaining or regaining body weight and condition but not growing steadily, and for which feed:gain is of limited value.



IV. Outcomes and Priorities by Program Area, cont.

2. Feed Efficiency & Utilization, cont.

In addition to continuing to focus research and technology transfer efforts on genetic improvement, genomic tests that could quickly, accurately and cost-effectively sort individual feeder cattle according to their genetic potential for feed efficiency or to achieve different finish weights, quality or yield grades would facilitate the assembly of more uniform, economically optimal marketing groups, less re-sorting of cattle on feed and more strategic implanting and feeding practices.

Feed: Canadian corn yielded on average 16% less than U.S. corn from 2000 to 2020, ranging from 36% less than the United States to 24% more. These fluctuations significantly impact the competitiveness of cattle feeders, particularly in eastern Canada. Significant increases in acreage seeded to grain (28,000 acres per year) and silage corn (32,500 acres per year) in western Canada are likely related to Monsanto and DuPont Pioneer's recent corn breeding investments. In eastern Canada, 1 acre was seeded to silage corn for every 6.4 acres seeded to grain corn; this ratio is 1:1 in western Canada.

Canadian barley yields were on average 8% lower than U.S. yields between 2000 and 2020, ranging from 14% lower to 0.5% higher. Between 2011 and 2016, the number of Canadian farms growing barley dropped by 15%, while between 2010 and 2020 seeded barley acreage remained stable, yields increased by 1.27 bushels per acre annually and total production increased by 214,324 metric tonnes annually. Breeding and agronomic research efforts that improve barley and other feed grain yields will be essential to reverse this trend.

Price per tonne is the main feed grain purchasing consideration for cattle feeders. Considerably less attention is paid to nutrient profile, feed quality or processing characteristics. When kernel size varies widely, setting grain rollers to adequately process the smallest kernels will over-process large kernels, produce excessive fines and increase the risk of acidosis and liver abscesses. Alternatively, setting rollers to optimizing processing of large kernels allows small kernels to pass through unprocessed. This reduces grain digestibility, reduces feed efficiency and increases the amount of intact grain that passes through into the manure. No cost-effective solution has been developed to address this dilemma.

Increased corn production in western Canada may warrant research and technology transfer efforts to identify optimal corn silage harvesting, chopping, packing and storage practices to reduce nutrient losses and maintain quality.

A wider range of by-products will become available as the acreage of alternative crops expands and processing facilities are developed. By-products that are abundant, affordable and economical to transport can be economically attractive feeds for cattle, provided proactive research and extension efforts can identify and mitigate potential risks related to nutrient levels, potential toxins, etc.

Feeding strategies to improve production and feed efficiencies appear to be quickly adopted by industry at both the feedlot and cow-calf levels. Steer carcass weights increased 7.7 lbs. per year between 2010 and 2020, slightly higher than Canada's long-term average of 7 lbs. per year. Feed efficiency in Canadian feedlot cattle has improved by more than 40% (12.5:1 to 6.5:1 or less) since the 1950s. Growth enhancing technologies are readily available and widely publicized throughout the industry. However, there is a need for effective alternatives to these technologies to balance industry needs for efficient production with desires and concerns expressed by some global trading partners, consumers, foodservice and retail operations. Basic research is needed to investigate and develop these alternatives to the point where they can be commercialized.



IV. Outcomes and Priorities by Program Area, cont.

2. Feed Efficiency & Utilization, cont.

Beef Industry 10-Year Goals Related to Feed Efficiency & Utilization

- ⇒ **Reduce primary production GHG emission intensity by 33% by 2030**
- ⇒ **Improve water use efficiency in the beef value chain**
- ⇒ **Attain 92% reproductive efficiency in Canadian beef production**
- ⇒ **Reduce food loss and waste (from secondary processing to consumer) by 50% by 2030**

10-Year Feed Efficiency & Utilization Goals for Canada's Beef Industry: Improvements in feed grains and feed efficiency will be instrumental to achieving industry goals related to GHG emission intensity, because most of the fossil fuel emissions associated with beef production are directly related to feed production, and digestive efficiency is inversely related to the enteric and manure emission intensities.

The Role of Research & Technology Transfer in Advancing Feed Efficiency & Utilization

Goals: Achieving these ambitious goals will entail significant research and extension efforts and investment across a range of specialties, including animal and plant genetics, animal nutrition, the production and processing of traditional and alternative feedstuffs and evaluation of feed additives that may reduce enteric methane emissions.

2021 National Beef Research & Technology Transfer Priority Survey: Cow-calf and seedstock respondents prioritized differences in wintering costs between efficient and inefficient cows, while feedlot operators identified the impacts of feed quality and feedlot management practices on feed efficiency as high priorities.

2021 Feed Grains and Feed Efficiency Focus Group: Target feed grains and feed efficiency research and technology transfer outcomes and priorities were further developed and refined through focus groups consisting of 29 producers, industry stakeholders, researchers and funder representatives.

Feed Efficiency & Utilization Outcomes and Priorities

Outcome 1: Improve feed grain and silage yields through plant breeding, agronomic practices and harvest strategies

Research Priorities:

1. Develop new, high yielding feed grain and silage varieties with superior agronomic performance and nutritional quality
2. Investigate agronomic, harvest, and ensiling practices to optimize feed and silage yield, nutritional quality, and animal health and performance

Extension Priorities:

1. Improve producer awareness and adoption of regionally appropriate varieties for feed grain and silage
2. Improve producer awareness and adoption of optimal agronomic, harvest and storage practices for feed grains and silage production

IV. Outcomes and Priorities by Program Area, cont.

2. Feed Efficiency & Utilization Goals, cont.

Outcome 2: Investigate feed processing, by-products, additives, supplements or other feeding strategies that optimize productivity and profitability

Research Priorities:

1. Develop rapid and cost-effective ways to assess nutritional value, digestibility, and optimal processing of feedstuffs and by-products
2. Develop cost-effective methods to measure, and feeding strategies to ensure, uniform supplement intake on pasture
3. Re-investigate and update nutritional recommendations to maintain optimal animal health and performance
4. Investigate feed processing methods and practices, additives and management systems to improve digestibility, animal maintenance costs and cost of gain
5. Quantify the role and identify opportunities to further use cattle to upcycle and reduce food loss and waste

Extension Priorities:

1. Promote the adoption of best management practices for utilizing by-products, additives, supplements, and other feed processing and feeding strategies
2. Evaluate the economic feasibility of feed processing, by-products, additives, supplements or other feeding strategies

Outcome 3: Improved feed efficiency through identification of genetic differences and animal breeding

Research Priorities:

1. Develop and validate practical, accurate and cost-effective ways to quantify forage intake in grazing cattle and feed efficiency in the cow herd and the feedlot
2. Validate genetic markers for feed efficiency in commercial crossbred cattle
3. Identify genes with functional roles in microbiological and physiological processes affecting feed intake and efficiency in feedlot and cow-calf production
4. Determine the impact of genetics, management, and environmental interactions on growth and reproductive efficiency

Extension Priorities:

1. Identify barriers to the adoption of genetic tools
2. Improve feed efficiency through genetic selection in breeds for which breeding values for feed efficiency exist

IV. Outcomes and Priorities by Program Area, cont.

3. Forage & Grassland Productivity

Forage and grassland productivity research and technology transfer efforts are focused on developing improved annual and perennial forage varieties and management strategies that increase yields, maintain or improve nutritional value and contribute to economically competitive cow-calf production and backgrounding operations.

Approximately 80% of Canada's beef production occurs while animals consume forage, primarily because cow-calf operations rely almost exclusively on grazing and stored forage. Extending the winter grazing season continues to present a major opportunity to reduce winter feeding costs. Research has focused on the viability of individual winter grazing alternatives, but has not evaluated various combinations of swath-, bale- and stockpiled grazing that would help encourage wider adoption among producers. Keeping all of Canada's beef cows and replacement heifers on pasture for one more day every winter would save the cow-calf sector between \$3 million and \$4.9 million annually.

The four western provinces have 96% of Canada's natural land for pasture, 92% of the nation's tame pasture and 83% of the beef cows. Expanding annual crop production has come at the expense of forage; between 2011 and 2016, Canada's acreage of natural land for pasture and tame forage decreased by 8% and 17%, respectfully. Canadian hay production was estimated at 18 million tonnes in 2020; this has decreased from 25 million tonnes in 2015. The five-year (2016-2020) average hay yield of 1.82 tons/acre is consistent with the 2000-2015 average (1.84 tons/acre), but below the peak of 2.2 tons/acre in the 1980s. As annual crop acreages increase, producers grow forages on increasingly marginal land, which makes maintaining yield and productivity more difficult. A 2.5% increase to restore average hay yields to 1990's levels would be worth \$89 million per year.

Significant efforts have been made to rebuild forage research capacity across the country, with new researchers hired at the Universities of Manitoba, Saskatchewan and Guelph and new AAFC positions filled in Beaverlodge, Lethbridge, Swift Current, Quebec, Kentville and St. John's. However, the returns on these investments will not be immediate, given the long timeframe required for new varieties, mixtures and management practices to be developed, commercialized and adopted.

Maintaining international competitiveness requires improved forage yields and beef production (fewer acres per cow or more beef per acre) on marginal land. Higher yielding varieties have been developed but have not fully compensated for the move to less productive marginal land. Public investment into forage varieties is necessary as the ability of companies to recoup their initial investment in a reasonable timeframe is low.



IV. Outcomes and Priorities by Program Area, cont.

3. Forage & Grassland Productivity, cont.

Beef Industry 10-Year Goals Related to Forage & Grassland Productivity

- ⇒ Safeguard the existing 1.5 billion tonnes of carbon stored on lands managed with beef cattle
- ⇒ Sequester an additional 3.4 million tonnes of carbon each year
- ⇒ Maintain the 35 million acres of native grassland in the care of beef producers
- ⇒ Maintain a network of natural landscapes and healthy functioning ecosystems through well-managed grazing systems that maintain sustainable plant communities and healthy rangelands

10-Year Forage and Grassland Productivity Goals for Canada's Beef Industry: Grasslands play a major role in the ability to maintain and sequester carbon. Ensuring producers can produce forages in an economically viable way ensures that marginal lands stay in grasslands and continue to sequester carbon and provide value to the producer and the environment.

The Role of Research & Technology Transfer in Advancing These Goals: Achieving these ambitious goals will entail significant research and extension efforts including: investment across a range of specialties, forage and grassland productivity, plant breeding, animal nutrition, grazing and animal behaviour, and soil health and quality.

2021 National Beef Research and Technology Transfer Priority Survey: Forage yield and quality were priorities across both the cow-calf and feedlot sectors. The cow-calf sector also prioritized stand longevity and rejuvenation, grazing management and winter feeding strategies.

2021 Forage and Grassland Productivity Focus Group: Target forage and grassland productivity target outcomes and research and extension priorities were further developed and refined through focus groups consisting of 25 producers, industry stakeholders, researchers and funder representatives.

Forage & Grassland Productivity Outcomes and Priorities

Outcome 1: Improve the management and productivity of native/naturalized pastures to enhance profitability and discourage land conversion

Research Priorities:

1. Identify practices that optimize utilization and resilience of pastures which may include indicators of appropriate recovery times
2. Identify or develop cost-effective management strategies to control the spread of invasive plant species on rangeland

Extension Priorities:

1. Promote grazing management practices that optimize the productivity of native plant species
2. Promote best management practices to help producers control invasive plants

IV. Outcomes and Priorities by Program Area, cont.

3. Forage & Grassland Productivity, cont.

Outcome 2: Better understand the impact of grazing management on plant, animal and soil interactions and how the overall system contributes to plant and animal health and productivity

Research Priorities:

1. Quantify the impact of agronomic and grazing management practices on economic and environmental outcomes such as plant health, forage yields and quality, animal health and performance, soil carbon sequestration and organic matter, soil health and quality, water infiltration and nutrient cycling in different ecoregions of Canada
2. Identify and validate technology to simply and cost-effectively manage grazing systems and quantify improvements in forage productivity
3. Identify simple, practical, cost-effective indicators of soil quality that have impacts on forage quality and productivity
4. Evaluate long term effects of incorporating grazing on crop production land

Extension Priorities:

1. Encourage the development and adoption of forage and grazing management plans and practices that encourage long term plant, soil and animal health and productivity
2. Encourage the adoption of cost of production analysis to assist in decision making
3. Promote the use of resources and tools to evaluate grazing management practices
4. Encourage the adoption of management practices that extend the grazing season
5. Identify and promote best management practices for incorporating grazing on cropland



IV. Outcomes and Priorities by Program Area, cont.

3. Forage & Grassland Productivity, cont.

Outcome 3: Cost-effectively improve the agronomic performance, yields, nutritional quality and palatability of annual and perennial tame species for grazing or stored forages

Research Priorities:

1. Develop strategies and best management practices to promote stand productivity and longevity, preserve forage quality and prevent waste in stored forages
2. Develop and evaluate new varieties with improved germination, emergence, yield, digestibility, salinity, drought and flood tolerance, reduced fall dormancy and improved winter hardiness and plant persistence
3. Independent comparisons of promising international and domestic forage varieties and mixtures on a meaningful scale to determine varietal and mixture adaptation under a range of environmental conditions and soil types

Extension Priorities:

1. Promote regionally appropriate management practices that encourage long-term stand maintenance and profitability
2. Identify simple, cost-effective strategies to rejuvenate tame pastures when required
3. Communicate the potential forage yield and animal carrying capacity improvements that can be cost-effectively achieved under different management systems
4. Promote management practices that maintain legumes in mixed grass stands and provide producers with information on safe and effective ways to graze legumes in pastures
5. Communicate variety testing trial results to help producers make informed variety and seed selection decisions
6. Develop and communicate cost-benefit analysis of different harvest strategies
7. Promote best practices for irrigation for forage and feed production



4. Environmental Sustainability

Beef Industry 10-Year Goals Related to Environmental Sustainability

- ⇒ **Safeguard the existing 1.5 billion tonnes of carbon stored on lands managed with beef cattle**
- ⇒ **Sequester an additional 3.4 million tonnes of carbon each year**
- ⇒ **Reduce primary production of GHG emission intensity by 33% by 2030**
- ⇒ **Maintain the 35 million acres of native grassland in the care of beef producers**
- ⇒ **Maintain a network of natural landscapes and healthy functioning ecosystems through well-managed grazing systems that maintain sustainable plant communities and healthy rangelands**
- ⇒ **Promote practices that maximize water quality and retention to deliver healthier landscapes, resilience to drought and flood events and groundwater recharge as appropriate to the region's precipitation**
- ⇒ **Improve water use efficiency in the beef value chain**

The beef industry's environmental sustainability research and technology transfer portfolio continues to grow and expand. While the outcomes identified in this section of the strategy are specifically environmentally focused, it is important to note that other aspects of this strategy pertaining to efficiency and productivity gains related to forage and feed productivity, animal health, performance and growth efficiency, beef quality and food safety all contribute significantly to reducing the environmental footprint of Canadian beef through improved soil and watershed health, carbon sequestration, improved resource use efficiency and reduced food loss and waste.

Most efforts to reduce beef industry greenhouse gas (GHG) emissions have focused on the feedlot sector, largely due to the greater ease in effectively developing and implementing effective feed-based strategies and technologies. The forage-based cow-calf sector remains an essentially untapped (though challenging) opportunity to further reduce Canada's beef-associated GHG emissions.

Of the agricultural land cattle inhabit, 85% is unsuited for crop production, often due to climatic risks, topography, soil quality and other factors that discourage cultivation. Crop producers may accept these risks and convert forage acres to annual cropland during times of high grain and oilseed prices, resulting in irreversible environmental damage. By 2003, conversion of native grasslands to croplands resulted in the loss of over 97% of tall grass prairie and 71% of mixed grass prairie. The loss of native grasslands has led to a 57% drop in grassland bird species since the 1970s, with some species declining by as much as 87%. It is estimated that 1.5 billion tonnes of carbon are stored in lands that have been managed for beef cattle. Grazing cattle on these landscapes not only helps prevent land conversion and preserves both habitat and carbon stored but helps these grassland ecosystems to thrive.

IV. Outcomes and Priorities by Program Area, cont.

4. Environmental Sustainability, cont.

10-Year Environmental Sustainability Goals for Canada's Beef Industry: Grasslands play a major role in the ability to sequester and store carbon, support healthy watersheds and maintain biodiversity and other important ecological services. Ensuring producers can produce forages in an economically viable way ensures that marginal lands stay in grasslands and continue to sequester carbon and provide value to the producer and the environment. Continued improvements in productivity efficiency within the Canadian cattle cow-calf, feeding and processing sectors will contribute to further reductions in greenhouse gas and resource use intensity.

The Role of Research & Technology Transfer in Advancing These Goals: In addition to environmentally specific research and extension activities outlined here, achieving these ambitious 10-year goals will entail significant effort and investment across a range of other research and extension specialities including feed and forage productivity, animal health and nutritional management, beef quality and food safety.

2021 National Beef Research and Technology Transfer Priority Survey: Water use, quality and management was a priority for both the beef industry and non-governmental organizations surveyed. Nutrient management and soil health and quality were seen as priorities across industry sectors.

2021 Environmental Sustainability Productivity Focus Group: Target environmental sustainability research outcomes and priorities were further developed and refined through focus groups consisting of 33 producers, industry stakeholders, researchers and funder representatives.

Environmental Sustainability Outcomes and Priorities

Outcome 1: Develop cost-effective ways to reduce greenhouse gas emissions, maintain or improve biodiversity, increase soil carbon or improve water infiltration on pastures and rangeland

Research Priorities:

1. Validate grazing practices that improve water infiltration, forage yield and soil organic matter in Canadian conditions across a variety of ecoregions
2. Evaluate the roles of the soil microbiome and plant-soil interactions in short-, medium- and long-term soil carbon storage and sequestration, plant yield and water holding capacity
3. Develop simple outcomes- and systems-based approaches for producers to understand and quantify the costs and benefits of environmental best management practices
4. Investigate cost-effective ways to reduce greenhouse gas emissions on pasture- or forage-based systems
5. Quantify N and P excretion rates in grazing animals, N impacts on GHG emissions and P runoff and leaching impacts on water quality/eutrophication in central and eastern Canada.
6. Develop or repurpose materials with the potential to reduce the amount of single-use plastics along the forage, cattle and beef production and supply chains

Extension Priorities:

1. Develop and promote best management practices for improved environmental sustainability
2. Encourage the adoption of best management practices that support biodiversity and species at risk habitat preservation

IV. Outcomes and Priorities by Program Area, cont.

4. Environmental Sustainability, cont.

Outcome 2: Develop cost-effective ways to reduce feedlot greenhouse gas emissions and evaluate the impacts of manure nutrients on pasture and cropping systems

Research Priorities:

1. Evaluate supplements, strategies and practices used to reduce greenhouse gas emissions in the feedlot using a systems approach
2. Quantify the effectiveness of forages to mitigate the nutrient mobility associated with extended winter grazing practices
3. Develop manure handling and processing technologies and strategies that enable manure to be transported and spread more cost-effectively

Extension Priorities:

1. Determine the cost benefit of utilizing manure on crop land
2. Promote best manure and odour management practices

Outcome 3: Identify cost-effective ways to improve air, water and soil outcomes associated with beef packing and processing facilities

Research Priorities:

1. Develop and validate cost effective cleaning technologies that reduce water and sanitizer use in packing plants
2. Identify and develop new revenue streams that also reduce environmental impacts by utilizing carcass by-products
3. Develop technologies that reduce odors associated with packing plants
4. Develop strategies and technologies that reduce food waste in the packing plant

Extension Priorities:

1. Encourage the adoption of cost-effective technologies that have known environmental benefits



IV. Outcomes and Priorities by Program Area, cont.

5. Animal Health, Welfare and Antimicrobial Resistance

Canada is world renowned for producing healthy beef cattle in a pristine environment and for having a strong commitment to animal health, welfare and antimicrobial stewardship. These attributes are becoming increasingly important among both domestic and export customers and consumers. There are also clear linkages between improvements in animal health and welfare and increased productivity, which is fundamental for the long-term competitiveness and sustainability of all sectors of the Canadian beef industry.

For cow-calf producers, good reproductive rates are critical to profitability regardless of calf prices. Cows that do not wean calves every year use resources that could be used to support more productive cattle. Increasing pre-weaning survival rates from 85% (current) to 92% would be worth over \$160 million to Canada's beef industry. Feedlots face significant costs associated with mortality, treatment and reduced performance due to respiratory disease, digestive disorders and lameness. Animal welfare is closely linked with animal health, particularly as calves transition through weaning and into the feedlot.

Identifying and implementing alternative production practices and treatment strategies that cost-effectively support animal health and welfare while reducing antimicrobial use will benefit both industry sustainability and public confidence. Surveillance serves a critical role, both in identifying emerging issues as well as monitoring producer adoption of technology and recommended management practices.



IV. Outcomes and Priorities by Program Area, cont.

5. Animal Health, Welfare & Antimicrobial Resistance, cont.

Beef Industry 10-Year Goals Related to Animal Health, Welfare and Antimicrobial Resistance

- ⇒ **Ensure the five freedoms of animal wellbeing by increasing adoption of on-farm management practices**
 - * **Attain 92% reproductive efficiency in Canadian beef production (85% in 2018)**
 - * **Adopt management and breeding choices that support animal welfare (e.g. calving ease, polled genes, pain relief)**
 - * **Establish and maintain a surveillance system to monitor cattle production practices across Canada**
- ⇒ **Ensure the effectiveness of existing and future antimicrobials is preserved to support human and animal health and welfare**
 - * **Develop, monitor and disseminate best practices regarding antimicrobial use**
 - * **Quantify and describe baseline antibiotic use practices in Canadian feedlot production**
 - * **Determine and monitor antibiotic resistance profiles in bacteria of concern in feedlot cattle**

10-Year Animal Health, Welfare & Antimicrobial Resistance Goals for Canada's Beef Industry: The Canadian beef industry is committed to protecting the health and welfare of the cattle under our care. These goals will push industry to continue striving for excellence. Canada's beef industry is a global leader in recognizing the importance of appropriate beef cattle health and care practices, having developed the first Code of Practice for the Care and Handling of Beef Cattle more than 20 years before the World Organisation for Animal Health adopted an animal welfare chapter to the Terrestrial Animal Health Code.

Advancing animal health, welfare and responsible antimicrobial use are of increasing interest to the retail and foodservice sectors, consumers and the public (social sustainability) and also contributes to improved reproductive and growth performance (economic sustainability), which in turn have significant impacts on resource use and greenhouse gas emission intensity (environmental sustainability).

The Role of Research & Technology Transfer in Advancing These Goals: The seeming simplicity of these goals is deceptive. Incremental improvements in animal health, welfare and antimicrobial stewardship will require significant research effort across a wide range of specialities, including beef cattle nutrition, grazing and pasture management, genetics, physiology, microbiology, virology, parasitology and development of diagnostic tests, vaccines and other antimicrobial alternatives. Significant investment is also needed around surveillance for emerging diseases and antimicrobial resistance to ensure the health and safety of human health and food production.

2021 National Beef Research and Technology Transfer Priority Survey: Reproductive efficiency was a high priority among seedstock, cow-calf producers and veterinarians. All sectors highlighted disease prevention and improved management practices and other tools to reduce the need for antimicrobials. Feedlot operators and veterinarians identified respiratory disease and production-limiting disease surveillance. Veterinarians pointed to the importance of research focusing on improved diagnostics, pain management and lameness.

2021 Animal Health, Welfare & Antimicrobial Resistance Focus Group: Target animal health, welfare and antimicrobial resistance research outcomes and priorities were further developed and refined through focus groups consisting of 31 individuals (producers, industry stakeholders, researchers and funder representatives).

IV. Outcomes and Priorities by Program Area, cont.

5. Animal Health, Welfare & Antimicrobial Resistance Outcomes and Priorities

Outcome 1: 92% of cows wean a calf each year through cost-effective improvements in nutritional and overall management

Research Priorities:

1. Refine nutritional and related management strategies to improve rebreeding success, calf survival and herd retention in replacement females
2. More precisely define micronutrient requirements and develop regionally-appropriate supplementation recommendations for breeding cattle of different ages throughout the production cycle
3. Assess the impacts of water quality on reproductive performance, health and calf growth performance
4. Clarify how management practices impact reproductive performance in cattle that differ in their genetic potential for growth, efficiency and carcass traits

Extension Priorities:

1. Identify and promote the suite of production practices that, when utilized together, provide consistent and cost-effective improvements in reproductive performance and longevity and reduced preweaning mortality
2. Encourage producers to participate in training and/or record-keeping programs requiring the collection of on-farm food safety, animal welfare, biosecurity and production records (e.g. VBP+) allowing them to compare their operations to industry benchmarks
3. Develop and promote best management practices to ensure breeding bull fertility and reproductive soundness
4. Promote the benefits of crossbreeding on reproductive performance, herd retention and longevity of the cow herd

Outcome 2: Develop and promote the adoption of cost-effective management practices and technologies that reduce the need for and preserve the effectiveness of antibiotics

Research Priorities:

1. Continued development of alternative health products and management practices to maintain animal health and reduce the need for antibiotic treatment
2. Controlled trials to independently assess or validate the cost-effectiveness of promising traditional or alternative animal health products and/or management strategies
3. Identify key management practices and preconditioning program component(s) that are most critical to reducing respiratory disease in the feedlot
4. Understand how stress (e.g. transportation, marketing, commingling, social dynamics) impacts the ability of cattle to acclimate to new environments
5. Assess how nutritional and health management (e.g. vaccination) of the cow herd impacts calf health pre- and post-weaning

Extension Priorities:

1. Promote the adoption of production and health practices that have been shown to effectively reduce the need to use antimicrobials in cattle

IV. Outcomes and Priorities by Program Area, cont.

5. Animal Health, Welfare & Antimicrobial Resistance, cont.

Outcome 3: Effective surveillance of production-limiting diseases, production practices, antimicrobial use and antimicrobial resistance

Research Priorities:

1. Support the ongoing collection of antimicrobial use and resistance information in beef production systems and environments
2. Support the ongoing surveillance of management practices and animal health and productivity information at the cow-calf and feedlot levels across Canada

Extension Priorities:

1. Use information collected by surveillance programs to inform extension, communication, future research needs and the impact of interventions or changes in management practices
2. Encourage surveillance and/or recordkeeping/benchmarking initiatives to communicate, collaborate and share data to inform veterinary and producer benchmarking comparisons and practice change
3. Investigate information needs and opportunities to encourage telemedicine, enhanced veterinarian-client-patient relationships and skills to support accurate diagnosis and sampling and to inform surveillance efforts on cow-calf operations
4. Encourage veterinarians and producers to participate in and submit data to ongoing surveillance and/or recordkeeping/benchmarking initiatives



IV. Outcomes and Priorities by Program Area, cont.

5. Animal Health, Welfare & Antimicrobial Resistance, cont.

Outcome 4: Improved prevention and mitigation of animal disease issues

Research Priorities:

1. Develop vaccines and delivery systems to cost-effectively prevent economically important production-limiting diseases
2. Develop management strategies and approaches to cost-effectively maintain calf health through the weaning process into the feedlot
3. Develop point-of-care and other diagnostic tools that rapidly, accurately and cost-effectively identify infectious disease, immune/vaccination status, antimicrobial susceptibility/resistance or nutritional status
4. Improved understanding of the etiology and pathophysiology of common production-limiting diseases that lack effective vaccines or treatment
5. Use new techniques and traditional microbiology to understand the role of the microbiome(s), their development and interactions and how they can be manipulated to help prevent, mitigate and manage major diseases
6. Take advantage of opportunities presented by artificial intelligence and other technologies to develop cost-effective and accurate tools to predict disease in individuals or groups of animals before clinical signs become apparent
7. Identify and quantify biosecurity and animal health risks associated with transport rest stops and other commingling sites

Extension Priorities:

1. Promote and monitor the adoption of prevention-based herd health programs addressing a range of genetic, nutritional, vaccine, and other tools to maintain herd health, welfare and productivity
2. Develop and promote tools to help veterinarians, nutritionists, other professionals and cow-calf producers design and implement appropriate and cost-effective biosecurity, vaccination, health and nutritional management programs
3. Develop and promote best practices regarding the collection and sharing of individual animal health and production information between cow-calf producers and feedlot operators
4. Develop and promote best practices for the transportation, storage, handling, mixing and timely administration of vaccines to improve their effectiveness
5. Promote and monitor the development of veterinary-client-patient relationships among cow-calf producers
6. Develop and promote cost-effective biosecurity protocols to minimize the introduction and spread of disease in cow-calf and cattle feeding operations

IV. Outcomes and Priorities by Program Area, cont.

5. Animal Health, Welfare & Antimicrobial Resistance, cont.

Outcome 5: Improved prevention and mitigation of animal welfare issues

Research Priorities:

1. Improved understanding of the physiological and economic impacts of stresses associated with weaning and acclimation to the feedlot, and develop cost-effective strategies to improve behavioral, health and productivity outcomes
2. Develop cost-effective and easily-administered options to alleviate procedural pain associated with castration, branding and dehorning
3. Develop cost-effective chronic pain management strategies
4. Identify factors contributing to lameness, develop cost-effective preventions, treatment options, and methods to control or limit environmental spread of the pathogens involved

Extension Priorities:

1. Encourage and empower producers to understand and comply with the requirements and recommendations in The Code of Practice for the Care and Handling of Beef Cattle, including:
 - timely euthanasia
 - nutritional management
 - confirming death immediately after euthanizing
 - avoiding and minimizing acute and chronic pain
 - minimizing stress during weaning
 - optimizing transportation decisions to prevent injury and stress
2. Promote and monitor the adoption of cost-effective pain mitigation strategies
3. Develop, promote and monitor the adoption of tools to help producers accurately differentiate, diagnose and treat different causes of lameness
4. Promote and monitor the adoption of polled genetics and early and proper dehorning and castration
5. Promote and monitor awareness of the Code of Practice for the Care and Handling of Beef Cattle among veterinarians, producers and industry employees



IV. Outcomes and Priorities by Program Area, cont.

6. Beef Quality

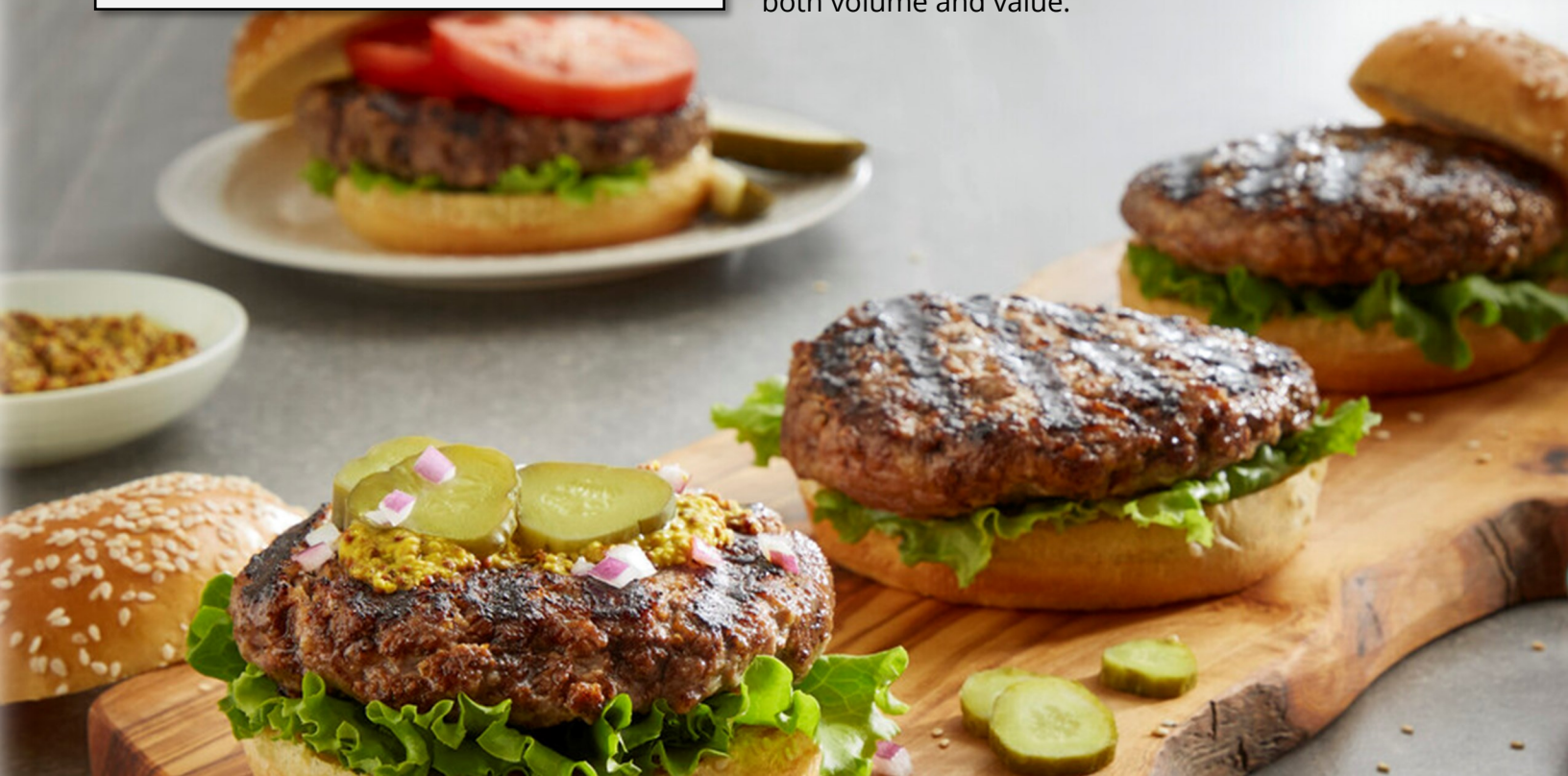
Beef Industry 10-Year Goals Related to **Beef Quality**

- ⇒ **Establish the inherent quality and value of Canadian beef in domestic and export markets, which supports comparative equivalency or superiority to alternatives**
- ⇒ **Increase the value of AAA and Prime carcasses to be equivalent with the United States by building demand for all cuts on the carcass**
- ⇒ **Remove internal regulatory impediments to innovation, export and commercial trade and the competitiveness of Canadian beef in domestic and international markets**

Consumer beef purchasing decisions are both individual and complex. Although health, food safety, environmental and ethical concerns are frequently cited as important consumer concerns, the two most important considerations continue to be price and quality. Research and development play a crucial role in supporting beef quality.

Canadians are rediscovering Canadian beef. Following a 34% decline over 36 years, per capita beef consumption has increased by 7% over the past six years. Canada's beef demand index measures how willing Canadian consumers are to pay for beef at various prices, with values over 100 reflecting increased consumer demand for beef. Over a 23-year period between 1990 and 2013, the beef demand index only exceeded 110 twice (in 1990 and again in 2003), but since 2014 the index has exceeded 110 for seven consecutive years.

Canada exports 45% of the beef we produce, making issues related to market access and international end-user and consumer demands as important as domestic beef demand. Fortunately, renewed consumer interest in Canadian beef also extends to export markets. Since 2015, Canada's beef exports have increased by over 16 thousand tonnes valued at \$122 million per year, representing 10% increases in both volume and value.



IV. Outcomes and Priorities by Program Area, cont.

6. Beef Quality, cont.

10-Year Beef Quality Goals for Canada's Beef Industry: We need to ensure that the domestic and international consumers who purchase high value and nutrient-dense Canadian beef are satisfied with their eating experience. Canada needs to clearly establish and validate the quality and value attributes of Canadian beef, seek to further improve the quality of Canadian beef and ensure that Canada's beef industry has access to safe and effective technologies with the potential to improve or guarantee eating quality.

The Role of Research & Technology Transfer in Advancing These Goals: Achieving industry's 10-year goals will require contributions from all stages of the supply chain and commitment from seedstock, cow-calf and feedlot producers, beef processors and the retail and foodservice sectors to measure and monitor progress. Following are key drivers that are of priority to achieving the industry's 10-year beef quality goals.

Indicators to Monitor Success:

Refresh the National Beef Quality Audit Indicators

- To reflect increased further processing
- To incorporate modern imaging technology and real-time feedback
- International and domestic quality perceptions audits to demonstrate equivalent or superiority of Canadian beef

Develop a shelf-life standard for Canada

- Monitor the development of best management practices related to the proper management of export packaging to ensure self life (domestic and international)

Innovation to Spur Investment:

Investment in quality assessment technology

- Number of new beef quality innovations tested, approved, introduced and adopted in Canada and the United States
- Technology that can assist in reducing food waste through the supply chain

Regulatory Impediments:

- Encourage enhanced regulatory capacity to certify product based on attributes in a timely manner
- Identify regulatory and market barriers to practices that support beef quality at a commercial scale

2021 National Beef Research and Technology Transfer Priority Survey: Priorities that were rated as "extremely important" or "very important" by beef producers include improved product consistency and quality, benchmarking consumer satisfaction with Canadian beef, comparing the nutritional value of beef with respect to other animal and plant protein and identifying what differentiates Canadian beef and beef production from international competitors.

2021 Beef Quality Focus Group: Target beef quality research outcomes and priorities were further developed and refined through in-depth individual interviews and focus groups consisting of 23 individuals (producers, industry stakeholders, researchers and funder representatives).



IV. Outcomes and Priorities by Program Area, cont.

6. Beef Quality, cont.

Beef Quality Outcomes and Priorities

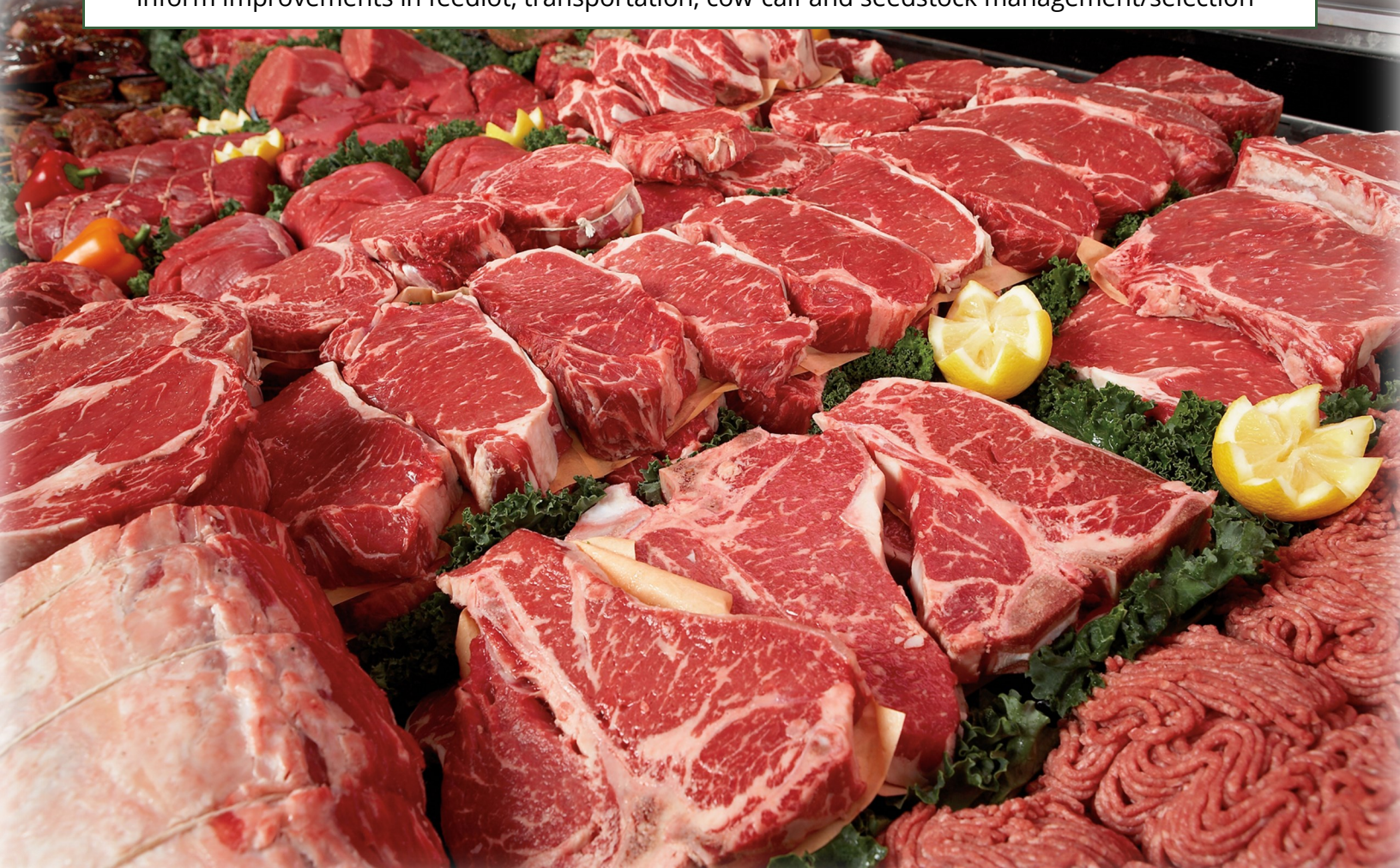
Outcome 1: Improved customer satisfaction with Canadian beef

Research Priorities:

1. Modernize and conduct a National Beef Quality Audit that reflects the industry's evolution from carcass-based to cut-based marketing
2. Develop and implement processes and technology to capture carcass quality defect data at processing plants in real-time
3. Demonstrate the effectiveness of genetic markers to improve the uniformity and profitability of fed cattle
4. Develop and/or independently validate packaging technologies to extend and improve shelf life of beef

Extension Priorities:

1. Communicate National Beef Quality Audit results pertaining to production-related issues to producers in a timely and effective manner to drive practice change
2. Producer communication and awareness regarding the use of genetic tools to improve carcass and beef quality
3. Data from individual animal carcass and offal images collected at processing plants are available to inform improvements in feedlot, transportation, cow-calf and seedstock management/selection



IV. Outcomes and Priorities by Program Area, cont.

6. Beef Quality, cont.

Outcome 2: Define, validate and enhance the emotional and functional attributes of Canadian beef in domestic and international markets

Research Priorities:

1. Develop objective measures to assess the eating quality of specific primals / cuts desired in high-value export markets
2. Develop and conduct industry-led domestic and international surveys to audit customer/consumer preferences and perceptions of Canadian beef quality attributes and track changes relative to previous studies
3. Develop and conduct industry-led consumer sensory comparisons and cut performance of equivalent Canadian and competitors' products in domestic and international markets
4. Identify critical control points and develop best practices enabling processors, customers and importers to ensure maximum shelf life of Canadian beef to ensure food safety and quality and reduce food waste
5. Compare the shelf life of Canadian vs. competing beef in key export markets
6. Quantify the value difference between fresh and frozen beef for Canadian retailers, considering differences in wholesale price and cutting performance

Extension Priorities:

1. Communicate fact-based information regarding the equivalence or superiority of Canadian beef to comparable U.S. and Australian grades among domestic and international customers
2. Use the results of domestic and international benchmarking surveys to increase the quantity of Canadian product that meets domestic and international customer/consumer preferences
3. Encourage adoption of best practices by processors and domestic and international customers to ensure maximum shelf life and customer satisfaction with Canadian beef



IV. Outcomes and Priorities by Program Area, cont.

7. Food Safety

Food safety is essential to maintain domestic and international consumer confidence and beef demand. Research has played an important role in developing improved food safety interventions that effectively combat multiple pathogens and methods to quantify the effectiveness of these interventions. The adoption of this research has led to significant improvements in the safety of Canadian beef.

Commercial implementation of interventions like lactic acid washes and carcass pasteurization have significantly reduced pathogen contamination on the carcass. More recent efforts have focused on effectively cleaning equipment, conveyor belts, knives, gloves, etc. to avoid re-contaminating beef on the fabrication line. Not all food safety interventions that have been demonstrated to be effective within the Canadian beef supply chain have been approved in key international markets. In some cases, additional research may be necessary to help address specific concerns and regulatory and technical barriers to trade.

Starting in 2015, the Public Health Agency of Canada (PHAC) FoodNet Canada system has collected data on the prevalence of enteric pathogens including (Shigatoxigenic *E. coli*, or STEC) in manure, irrigation water and retail meat, as well as human disease incidence rates in sentinel sites in B.C., Alberta, Ontario and Quebec. STEC have been found in up to half of the feedlots sampled and a third of irrigation water samples collected, but in fewer than 3% of retail beef samples.

The Canadian Food Inspection Agency's National Microbiological Monitoring Program (NMMP) samples beef at federally inspected processing plants as well as warehouses, distribution centres, and wholesalers. *E. coli* O157 was identified in fewer than 0.2% of domestic ground beef and veal samples tested between 2014-15 and 2017-18.

FoodNet Canada sentinel sites (described above) also report that incidence rates of endemic STEC-associated illness per 100,000 Canadians have remained steady between 1.86 (2016) and 3.88 (2019). These incidence rates are lower than for Campylobacteriosis (18.33 to 20.82 per 100,000) or Salmonellosis (9.17 to 14.96), two enteric diseases that are rarely linked to beef but that have comparable rates of emergency room visits and hospitalization, and higher rates of antimicrobial prescription than STEC.

Similarly, the Public Health Agency of Canada's National Enteric Surveillance Program has reported annual national *E. coli* O157:H7 incidence rates between 0.95 (in 2017) to 1.28 (in 2014) per 100,000 Canadians. Similar to FoodNet Canada results, STEC incidence rates are much lower than for Campylobacteriosis (3.52 to 4.73 per 100,000) or Salmonellosis (19.70 to 21.45)

It is worth noting that while STEC is often perceived to be a beef issue, recent recalls and cases of human illness are just as likely to be linked to other foods (e.g. pork, salad, and flour). The CFIA issued 28 STEC-related food recalls and warnings from 2017 through 2020, half of which involved beef. Four of these recalls were associated with reports of human illness, but none involved beef.

Beef Industry 10-Year Goals Related to Food Safety

- ⇒ **Remove internal regulatory impediments to innovation, export and commercial trade and the competitiveness of Canadian beef in domestic and international markets**
- ⇒ **Support the development, regulatory approval and adoption of improved food safety interventions and technologies throughout the supply chain**

IV. Outcomes and Priorities by Program Area, cont.

7. Food Safety, cont.

Research has underpinned these improvements in the safety of Canadian beef, but food safety is an evolving target. Known pathogens may evolve resistance to current interventions, necessitating new interventions. New pathogens may emerge for which current interventions are ineffective. It is essential that we maintain and support research programming and capacity to proactively identify and respond to these potential threats before Canada's reputation for food safety can be questioned.

Removing domestic and international regulatory impediments is critical to maintaining a competitive industry. Canada's regulatory bodies must have the dedicated capacity required to complete analysis and research to inform science-based approvals of effective new food safety measures, technologies and certifications in a timely manner. This will

help protect the health of Canadians by encouraging and ensuring marketplace responsiveness to new innovations and reporting demands. As our major trading partner, ensuring that the US accepts Canadian food safety test results as equivalent with their own is a significant priority to facilitate cross-border shipments and reduce the food waste and downgrading of fresh product that results from shipping delays and returned loads. Research to develop and validate more rapid, accurate and cost-effective testing protocols and technologies would greatly facilitate trade.

10-Year Food Safety Goals for Canada's Beef Industry: Canada needs to reinforce and build on the significant food safety improvements we have achieved in recent years to support continued consumer confidence and beef demand in domestic and international markets.

The Role of Research & Technology Transfer in Advancing These Goals: Achieving industry's 10-year goals will require contributions from all stages of the cattle and beef production chain to measure and maintain progress. Following are key drivers that are of priority to achieving the industry's 10-year food safety goals.

Indicators to Monitor Success:

- Develop a shelf-life standard for Canada
- Monitor the development of best management practices related to the proper management of export packaging to ensure food safety (domestic and international)

Innovation to Spur Investment:

- Investment in quality assessment technology
- Technology that can assist in reducing food waste through the supply chain

Regulatory impediments:

- Encourage enhanced regulatory capacity to certify product based on attributes in a timely manner
- Identify regulatory and market barriers to practices that support beef quality at a commercial scale
- Harmonization with the United States around access to pathogen control innovations, interventions and testing



IV. Outcomes and Priorities by Program Area, cont.

7. Food Safety, cont.

2021 National Beef Research and Technology Transfer Priority Survey: Verifying the effectiveness of packing equipment cleaning processes was a priority for cattle sector respondents. Feedlot respondents also identified the development of technologies targeting multiple pathogens in cattle and beef production and processing facilities as a high priority.

2021 Food Safety Focus Group: Target food safety research outcomes and priorities were further developed and refined through in-depth individual interviews and focus groups consisting of 23 individuals (producers, industry stakeholders, researchers and funder representatives).

Food Safety Outcomes and Priorities

Outcome 1: Ensured food safety along the beef supply chain

Research Priorities:

1. Develop and implement cost-effective technologies targeting multiple pathogens in cattle and beef production and processing facilities, including heat- and acid-resistant *E. coli* and biofilm forming bacteria
2. Identify key spots in processing plants that are prone to contamination and difficult to clean, and develop alternative designs, surfaces and cleaning strategies to facilitate effective cleaning
3. Proactively (re)assess the prevalence of *Salmonella* in Canadian slaughter cattle, carcasses and beef, and develop strategies to effectively reduce food safety risks

Extension Priorities:

1. Educate retail and foodservice meat cutters about the importance of temperature and appropriate cleaning (knives, gloves, equipment) in ensuring food safety for consumers
2. Encourage the consistent adoption of known best practices to minimize the risk of pathogen contamination in beef processing plants related to the proper and thorough cleaning of conveyor belts, personal equipment, processing and grinding equipment, etc.

Outcome 2: Validate the efficacy and safety of new technologies in support of the rational regulatory approval and adoption of improved food safety interventions throughout the supply chain

Research Priorities:

1. Develop cost-effective and “green” cleaning technologies that reduce the need for (hot) water, sanitizers and labor in large and small processing facilities
2. Conduct research to proactively identify and resolve potential market access concerns for Canadian beef

Extension Priorities:

1. Proactively identify likely regulatory barriers / concerns in key beef markets so they can be resolved before market access is impaired

V. Research Strategy Alignment with 2030 Industry Goals

Canadian Beef Advisors Industry Goal Areas to 2030							
BCRC Program Areas & Outcomes	Greenhouse Gas & Carbon Sequestration	Animal Health & Welfare	Land Use & Bio-diversity	Water	Beef Quality & Food Safety	Human Health & Safety	Technology
Feed Efficiency & Utilization							
1. Improve feed efficiency through identification of genetic differences and animal breeding	X						
2. Improve feed grain and silage yields through plant breeding, agronomic practices and harvest strategies	X			X			
3. Investigate feed processing, by-products, additives, supplements or other feeding strategies that optimize productivity and profitability	X						
Forage & Grassland Productivity							
1. Cost-effectively improve the agronomic performance, yields, nutritional quality and palatability of annual and perennial tame species for grazing or stored forages	X		X	X			
2. Better understand the impact of grazing management on plant, animal, and soil interactions and how the overall system contributes to plant and animal health and productivity	X		X	X			
3. Identify cost-effective ways to improve air, water and soil outcomes associated with beef packing and processing facilities	X		X	X			
Environmental Sustainability							
1. Develop cost-effective ways to reduce greenhouse gas emissions, maintain or improve biodiversity, increase soil carbon, or improve water infiltration on pastures and rangeland	X		X	X			
2. Develop cost-effective ways to reduce feedlot greenhouse gas emissions and evaluate the impacts of manure nutrients on pasture and cropping systems	X		X	X			
3. Identify cost-effective ways to improve air, water and soil outcomes associated with beef packing and processing facilities	X			X	X		

V. Research Strategy Alignment with 2030 Industry Goals, cont.

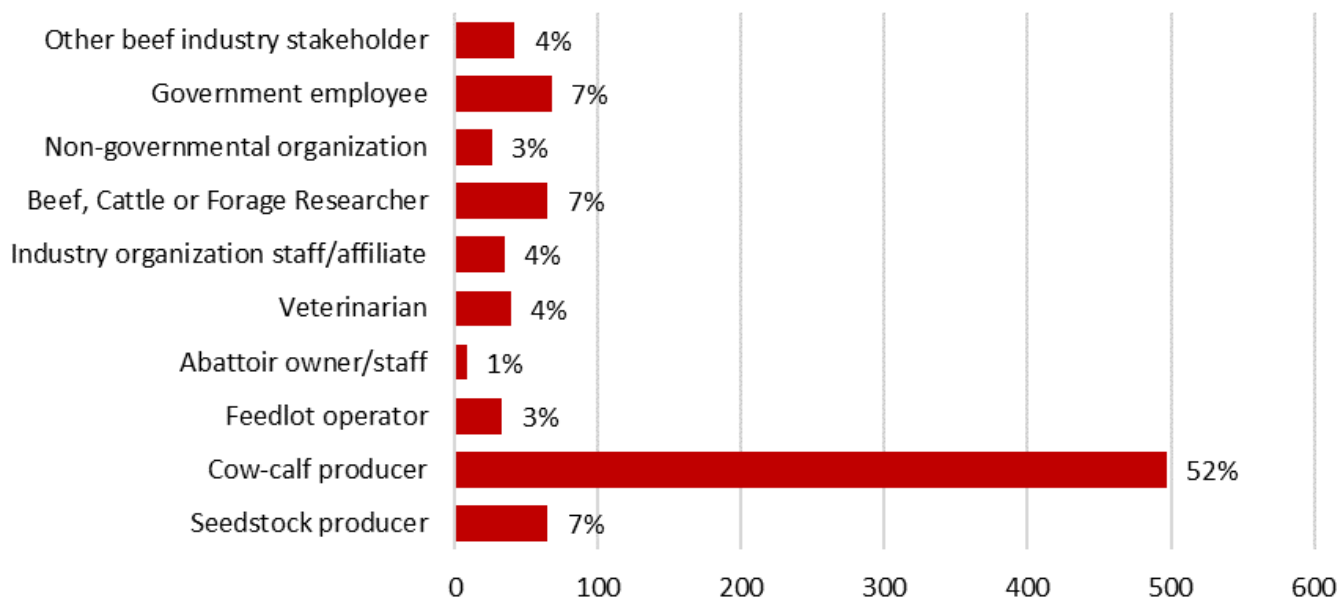
Canadian Beef Advisors Industry Goal Areas to 2030							
BCRC Program Areas & Outcomes	Greenhouse Gas & Carbon Sequestration	Animal Health & Welfare	Land Use & Bio-diversity	Water	Beef Quality & Food Safety	Human Health & Safety	Technology
Animal Health & Welfare							
1. 92% of cows wean a calf each year through cost-effective improvements in nutritional and overall management	X	X					
2. Improved prevention and mitigation of animal disease issues	X	X					
3. Improved prevention and mitigation of animal welfare issues		X					
4. Effective surveillance of production limiting diseases, production practices and antimicrobial use and antimicrobial resistance		X					
5. Develop and promote the adoption of cost-effective management practices and technologies that reduce the need for and preserve the effectiveness of antibiotics		X					
Beef Quality							
1. Improved customer satisfaction with Canadian Beef					X		
2. Define, validate, and enhance the emotional and functional attributes of Canadian beef in domestic and international markets					X		
Food Safety							
1. Ensured food safety along the beef supply chain					X		
2. Validate the efficacy and safety of new technologies in support of the rational regulatory approval and adoption of improved food safety interventions throughout the supply chain					X		

V1. Appendices

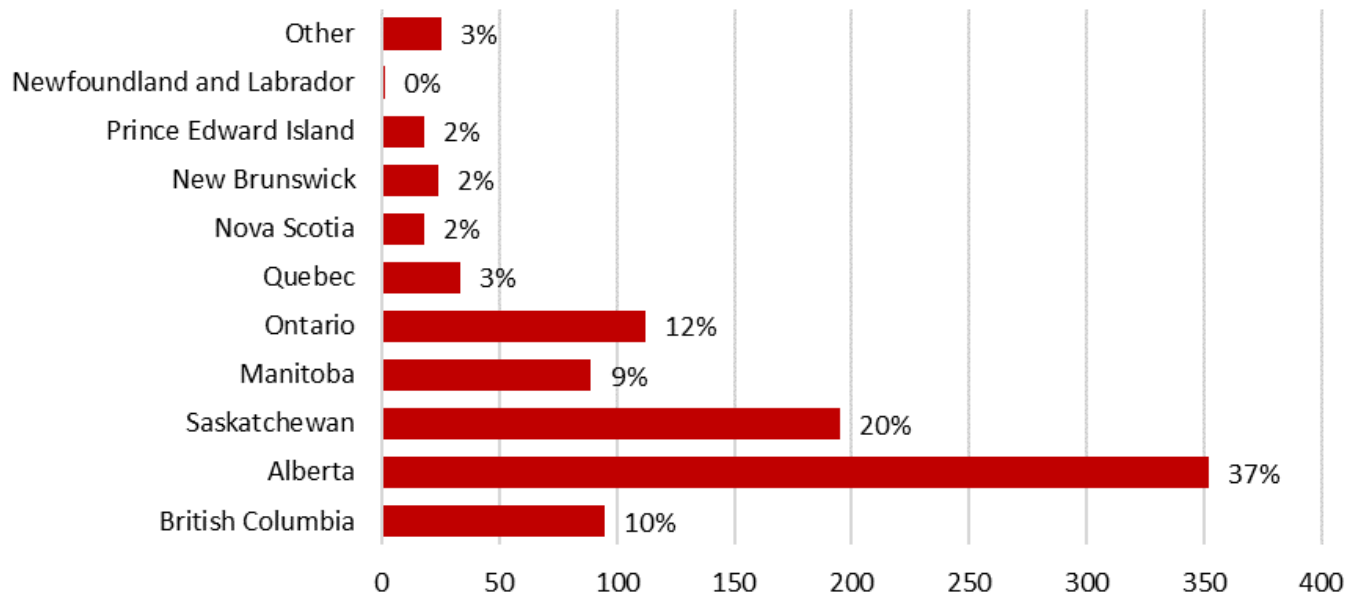
1. 2021 Beef Stakeholder Prioritization Survey Results

An open online survey was conducted through www.beefresearch.ca between January 5 and March 5, 2021, to obtain feedback regarding industry research priorities. A total of 962 responses were obtained, with 878 responses represented by the occupations listed in the graph below. Sectoral and geographical demographics of survey respondents are shown in the following graphs.

Respondent demographics: % by sector or occupation



Respondent demographics: % by province



V1. Appendices, cont.

1. 2021 Beef Stakeholder Prioritization Survey Results, cont.

The following tables are based on feedback provided by the respondents most directly involved in primary production (i.e. seedstock, cow-calf, feedlot producers). Veterinary responses are included for the animal health issues, and responses from non-governmental organizations are included for the environmental issues. Priorities rated as “extremely or very important” by more than 75% of respondents are highlighted in green. Priorities rated as “slightly or not important” by more than 25% of respondents are noted in red.

Survey Responses: Feed Efficiency and Utilization Issues

	Seedstock (65 responses)			Cow-Calf (497 responses)			Feedlot (33 responses)		
	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important
Barley yield	18%	47%	29%	33%	37%	22%	56%	41%	4%
Corn yield	10%	47%	37%	25%	34%	31%	33%	52%	11%
Identification and evaluation of alternate feeds and feeding strategies	51%	40%	8%	70%	22%	7%	63%	37%	0%
Feed quality impact on feed efficiency	71%	25%	4%	71%	22%	5%	86%	11%	4%
Feedlot management impact on feed efficiency	63%	17%	17%	51%	32%	10%	93%	4%	4%
Genetic markers for feed efficiency that work regardless of breed/ composition	77%	13%	8%	65%	26%	7%	70%	22%	7%
Differences in wintering costs between efficient and inefficient cows	75%	19%	6%	76%	17%	6%	59%	41%	0%
Improved utilization of low-quality feeds and forages	63%	27%	10%	74%	21%	5%	61%	36%	4%

Survey Responses: Forage and Grassland Productivity Issues

	Seedstock (65 responses)			Cow-Calf (497 responses)			Feedlot (33 responses)		
	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important
Forage yield	72%	25%	4%	78%	18%	4%	81%	19%	0%
Forage stand longevity	74%	21%	6%	79%	17%	3%	65%	31%	4%
Forage drought resistance	66%	26%	8%	73%	20%	6%	62%	31%	8%
Salinity and acid tolerance	35%	35%	22%	42%	35%	19%	35%	54%	12%
Flood resistant forages	30%	50%	18%	36%	34%	28%	23%	54%	23%
Forage quality	79%	19%	2%	81%	16%	3%	77%	19%	4%
Fertilization (organic and chemical)	59%	31%	10%	62%	25%	12%	63%	33%	4%
Stand establishment and management (monoculture and mixture)	55%	30%	13%	70%	25%	4%	50%	38%	12%
Stand rejuvenation (monoculture and mixture)	70%	21%	9%	75%	21%	4%	50%	46%	4%
Development of new varieties and species mix	63%	31%	6%	66%	24%	10%	54%	42%	4%
Invasive species, weed and brush control	62%	26%	12%	67%	25%	8%	50%	38%	12%
Feed storage systems	47%	25%	25%	45%	37%	17%	63%	30%	7%
Grazing management strategies	60%	34%	6%	79%	17%	4%	50%	46%	4%
Winter feeding strategies	66%	23%	11%	81%	15%	4%	52%	37%	11%

V1. Appendices, cont.

1. 2021 Beef Stakeholder Prioritization Survey Results, cont.

Survey Responses: Environmental & Sustainability Issues

	Seedstock (65 responses)			Cow-Calf (497 responses)			Feedlot (33 responses)			NGOs (26 responses)		
	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important
Greenhouse Gas (GHG) reduction	50%	25%	25%	53%	25%	20%	61%	29%	11%	73%	9%	18%
Carbon sequestration	62%	23%	10%	64%	21%	12%	57%	29%	14%	68%	14%	18%
Biodiversity	58%	21%	17%	67%	24%	6%	59%	37%	4%	71%	24%	5%
Water use/ quality/quantity management	64%	28%	8%	76%	19%	5%	81%	15%	4%	77%	14%	9%
Nutrient (manure and fertilizer) management in	75%	15%	9%	74%	23%	3%	74%	22%	4%	71%	19%	10%
Soil quality (e.g. microbial activity, compaction, organic matter)	72%	19%	9%	82%	15%	3%	86%	11%	4%	68%	23%	9%
Environmental implications of converting land use between perennial grassland and annual crops	60%	30%	9%	72%	21%	7%	70%	22%	7%	71%	10%	19%

Survey Responses: Animal Health Issues

	Seedstock (65 responses)			Cow-Calf (497 responses)			Feedlot (33 responses)			Veterinarians (39 responses)		
	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important
Reproductive efficiency	81%	16%	4%	81%	15%	4%	74%	22%	4%	76%	10%	14%
Cow nutrition	73%	23%	4%	80%	16%	4%	64%	32%	4%	53%	37%	10%
Neonatal diseases	67%	25%	9%	66%	22%	11%	62%	35%	4%	67%	30%	3%
Pinkeye	16%	39%	45%	25%	40%	35%	38%	42%	19%	3%	55%	41%
Immunology and vaccinations	75%	19%	5%	79%	16%	4%	100%	0%	0%	87%	13%	0%
Bovine respiratory disease (BRD)	67%	24%	9%	62%	27%	10%	92%	8%	0%	83%	7%	10%
Diseases associated with feedlot rations	35%	40%	23%	43%	36%	19%	55%	34%	10%	40%	43%	17%
Parasite control	61%	30%	9%	62%	28%	10%	67%	22%	11%	47%	43%	10%
Antimicrobial use and resistance	59%	30%	11%	63%	24%	10%	69%	14%	17%	80%	17%	3%
Practices and tools to reduce antibiotic use	88%	11%	2%	80%	15%	5%	86%	14%	0%	93%	7%	0%
Disease surveillance	61%	30%	5%	64%	27%	8%	77%	19%	4%	80%	17%	3%
Diagnostics tests	64%	29%	7%	63%	27%	10%	73%	23%	4%	77%	20%	3%

V1. Appendices, cont.

1. 2021 Beef Stakeholder Prioritization Survey Results, cont.

Survey Responses: Animal Welfare Issues

	Seedstock (65 responses)			Cow-Calf (497 responses)			Feedlot (33 responses)			Veterinarians (39 responses)		
	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important
Painful practices	52%	32%	16%	52%	34%	14%	66%	28%	7%	86%	10%	3%
Stress mitigation (acute and chronic)	64%	31%	5%	57%	31%	10%	59%	41%	0%	62%	21%	17%
Transportation	50%	32%	18%	52%	35%	13%	57%	32%	11%	62%	31%	7%
Weaning	56%	29%	15%	56%	31%	13%	70%	26%	4%	55%	31%	14%
Extreme weather	41%	36%	23%	38%	41%	20%	57%	32%	11%	34%	45%	21%
Lameness	52%	27%	21%	51%	35%	14%	59%	41%	0%	76%	17%	7%

Survey Responses: Beef Quality Issues

	Seedstock (65 responses)			Cow-Calf (497 responses)			Feedlot (33 responses)		
	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important
Increased product consistency and quality	78%	15%	4%	74%	20%	5%	93%	7%	0%
New product development and cut utilization	61%	22%	7%	57%	27%	11%	68%	29%	4%
Benchmark consumer satisfaction with Canadian beef	67%	19%	11%	74%	19%	5%	86%	14%	0%
Reduce losses associated with carcass defects and meat quality issues	55%	28%	11%	64%	26%	7%	66%	31%	3%
Update nutritional information on beef with comparison to other protein options	70%	20%	7%	75%	19%	5%	75%	18%	7%
Identify what makes Canadian beef better (or different) to help in domestic and international marketing programs	74%	19%	7%	81%	13%	4%	86%	11%	4%
Validate the effectiveness and value of genetic markers for tenderness in commercial cattle	56%	31%	11%	54%	30%	13%	69%	21%	7%
Re-evaluate electrical stimulation recommendations to reflect increased carcass weights	12%	40%	21%	21%	29%	16%	35%	35%	8%
Validate objective in-plant measures of tenderness	49%	30%	9%	43%	32%	13%	61%	29%	4%
Identify potential interactions between tenderness genotype and animal management practices	74%	17%	8%	55%	30%	11%	68%	25%	4%
Develop packaging and other technologies to improve shelf life	43%	36%	11%	45%	31%	19%	64%	25%	11%

V1. Appendices, cont.

1. 2021 Beef Stakeholder Prioritization Survey Results, cont.

Survey Responses: Food Safety Issues									
	Seedstock (65 responses)			Cow-Calf (497 responses)			Feedlot (33 responses)		
	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important
Develop technologies targeting multiple pathogens in cattle and beef production and processing facilities	64%	26%	6%	68%	23%	4%	79%	14%	0%
Verify the effectiveness of packing equipment cleaning processes	75%	20%	4%	70%	19%	5%	82%	18%	0%
Surveillance to detect, characterize and quantify the relative human health risk of (re) emerging pathogens	65%	27%	6%	70%	18%	7%	61%	36%	0%
Develop effective interventions to eliminate pathogens for beef	70%	24%	4%	67%	24%	3%	71%	25%	0%
Surveillance of antimicrobial resistance in beef	65%	27%	8%	68%	24%	4%	76%	21%	0%
Other	33%	33%	0%	12%	5%	0%	50%	0%	0%

V1. Appendices, cont.

1. 2021 Beef Stakeholder Prioritization Survey Results, cont.

Survey Responses: Technology Transfer Issues

How **often** do you use the following communication channels to learn about science-based information?

	Seedstock (65 responses)			Cow-Calf (497 responses)			Feedlot (33 responses)		
	Daily/ Weekly	Monthly to 7x/year	Fewer than 3x/year	Daily/ Weekly	Monthly to 7x/year	Fewer than 3x/year	Daily/ Weekly	Monthly to 7x/year	Fewer than 3x/year
Beefresearch.ca	19%	36%	45%	34%	43%	24%	25%	50%	25%
Other Websites and blogs	26%	55%	19%	38%	43%	19%	22%	56%	22%
Social Media	44%	21%	35%	45%	17%	38%	37%	26%	37%
Conferences/Seminars/ Workshops (in-person)	0%	32%	68%	3%	25%	72%	0%	21%	79%
Webinars/virtual conferences	4%	38%	58%	11%	44%	45%	4%	41%	56%
Veterinarians	10%	69%	21%	5%	70%	24%	25%	57%	18%
Professional consultants	0%	36%	64%	3%	20%	77%	25%	29%	46%
Livestock or forage extension specialists	4%	30%	66%	5%	31%	63%	0%	19%	81%
Magazines and newspapers	37%	52%	12%	43%	48%	8%	50%	43%	7%
Other printed materials	21%	52%	27%	22%	56%	22%	22%	67%	11%
Videos	25%	33%	42%	23%	48%	29%	15%	59%	26%
Radio (AM, FM or XM)	37%	21%	42%	34%	20%	46%	44%	15%	41%
Podcasts	6%	25%	70%	15%	29%	56%	18%	25%	57%
Smartphone apps	28%	18%	54%	30%	21%	48%	33%	26%	41%
Other	50%	0%	50%	8%	18%	74%	50%	0%	50%

How **influential** are the following sources of science-based information (or how heavily do you rely on the following) in your professional decision making?

	Seedstock (65 responses)			Cow-Calf (497 responses)			Feedlot (33 responses)		
	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important	Extremely or Very Important	Moderate Importance	Slightly or Not Important
BCRC	38%	40%	18%	44%	36%	19%	52%	41%	7%
Media	22%	51%	27%	35%	41%	24%	39%	46%	14%
Government Extension	25%	21%	54%	28%	35%	33%	19%	52%	26%
University Extension	31%	35%	33%	26%	31%	38%	37%	30%	30%
Researchers	47%	28%	25%	45%	33%	20%	54%	29%	18%
Producer Assoc.	40%	38%	23%	38%	37%	23%	52%	33%	15%
Peers	64%	25%	11%	48%	35%	17%	48%	33%	19%
Veterinarians	69%	25%	6%	74%	19%	7%	75%	14%	11%
Professional consultants	37%	17%	40%	23%	22%	45%	54%	25%	21%
Calculators/Decision Tools	19%	26%	45%	23%	32%	41%	30%	37%	30%

2. Strategy Development Stakeholder Participants

Producers

Jacob Bueckert, AB
Iva Harberg, AB
Ryan Kasko, AB
Steve Kenyon, AB
Miles Wowk, AB
Dean Acton, NB
Spencer Acton, NB
Steve Eby, ON
Joe Hill, ON
Stanley Christensen, QC
Alain Philippe, QC
Lynn Grant, SK
Lance Leachman, SK
Leanne Thompson, SK
Duane Thompson, SK

Agriculture and Agri-Food Canada

Mueen Aslam, AB
Vern Baron, AB
Karen Beauchemin, AB
François Eudes, AB
Rob Gruninger, AB
Oscar Lopez-Campos, AB
Holly Mayer, AB
Tim McAllister, AB
Nuria Prieto-Benavides, AB
Karen Schwartzkopf-Genswein, AB
Sheila Torgunrud, AB
Alexander Trevor, AB
Xianqin Yang, AB
Jamie Hewitt, MB
Tanya Dykens, NB
John Cutler, ON
Yousef Papadopoulos, ON
Sullivan Sarahvan, ON
Bill Houston, SK
Jillian Bainard, SK
François Bédard, SK
Alex Lefebvre, QC

Agricultural Research & Extension Council of Alberta

Allan Hall

Alberta Beef Health Services

Joyce Van Donkersgoed

Alberta Beef Producers

Brad Dubeau
Karin Schmid

Alberta Cattle Feeders' Association

Janice Tranberg

Alberta Wheat & Barley Commissions

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Atlantic Beef

Russ Mallard

B&L Farm Services Ltd.

Jamie O'Shea, ON

Barenbrug

Luke Wilson, Iowa

BC Cattle Industry Development Council

Devin Chursinoff

BC Cattlemen's Association

Bree Patterson
Jon Solecki
Werner Stump

BC Forage Council

Serena Black

BC Ministry of Agriculture

Lavona Liggins

Beef Cattle Research Council

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Craig Lehr, AB
Fred Lozeman, AB
Joanne Solverson, AB
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Ryan Beierbach, SK
Steve Pylot, SK
Matt Bowman, Chair, ON

Beef Farmers of Ontario

Evan Chaffe
Jaclyn Horenberg
Adam Shea
Jim Johnston

BeefSmart Consulting Inc.

Bree Kelln, SK

Canada Beef

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Michael Young, AB
Joyce Parslow, ON

Canadian Angus Association

Myles Immerkar, AB

Canadian Beef Breeds Council

Michael Latimer, AB

Canadian Beef Check-Off Agency

Melinda German, AB

Canadian Cattlemen Magazine

Lisa Guenther, SK

Canadian Cattlemen's Association

Dennis Laycraft, AB
Dave Moss, AB
Larry Thomas, AB

Canadian Food Inspection Agency

Appelt Martin, ON

Canadian Forage & Grassland Association

Cedric McLeod, NB

Canadian Hereford Association

Stephen Scott, AB

Canadian Meat Council

Kim O'Neil, ON

Canadian Roundtable for Sustainable Beef

Monica Hadarits, ON

Canfax Research Services

Brenna Grant, AB

Cargill

Tyson Brown, KS

Cattleland Feedyards Ltd.

Mick Taylor, AB

Chinook Applied Research Association

Dianne Westerlund, AB

CL Ranches Ltd.

Cherie Copithorne-Barnes, AB

Coaldale Vet Clinic

Steve Hendrick, AB

Cows and Fish

Norine Ambrose, AB

Dairy Farmers of Canada

Emie Désilets

Dairy Producer

JP Brouwer, AB

DeNovo Ag

Daryl Chubb, AB

Ducks Unlimited Canada

Kristine Tapley

Emissions Reduction Alberta

Isabella Tarasco

Feedlot Health Management Services Ltd.

Calvin Booker, AB
Matt May, AB

V1. Appendices, cont.

2. Strategy Development Stakeholder Participants, cont.

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Gowan's Feed Consulting

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Harmony Beef

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JBS Foods Canada

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JJM Nutrition

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Jones Feed Mills Ltd.

Chris Meadows, ON

Korova/Rimrock Feeders

Kendra Donnelly, AB

Lakeland College

Josie Van Lent, AB

Livestock and Forage Centre of Excellence

Colin Palmer, SK

Livestock Gentec

John Basarab, AB

Livestock Research Innovation Corporation

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Manitoba Agriculture, Food and Rural Initiatives

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Manitoba Agriculture & Resource Development

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Manitoba Beef & Forage Initiatives

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Manitoba Beef Producers

Carson Callum

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Amy Higgins

Metzger Vet

Ron Stevenson, ON

Namaka Farms

Bryan Thiessen, AB

National Farm Animal Care Council/Beef Farmers of Ontario

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Nature Conservancy of Canada

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Nova Scotia Cattle Producers

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Olds College

Sean Thompson, AB

Ontario Corn Fed Beef

John Baker

Ontario Ministry of Agriculture, Food and Rural Affairs

Christine O'Reilly
Mike Relf
Megan Van Schaik

Producteurs de bovins du Québec

Nathalie Cote

Public Health Agency of Canada

Sheryl Gow

Results Driven Agriculture Research

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D'Arcy Hilgartner, AB
Brian Karisa, AB
Trevor Prout, AB
Nancy Tout, AB

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Saskatchewan Cattlemen's Association

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Marianne Possberg

Saskatchewan Forage Council

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Smart Agriculture and Food at Alberta Innovates

Natisha Stashko, AB

South of the Divide Conservation Action Program

Tom Harrison, SK

University of Alberta

Ed Bork
Heather Bruce
Changxi Li

University of Calgary Veterinary Medicine

Claire Windeyer

University of Guelph

Ben Bohrer, ON
Claudia Wagner Riddle, ON
Kim Schneider, ON
Katie Wood, ON

University of Guelph – Ontario Veterinary College

Jessica Gordon

University of Manitoba

Getahun Legesse
Emma McGeough
Kim Ominski

University of Saskatchewan

Angela Bedard-Haughn
Bill Biliget
Eric Lamb
Bart Lardner
Greg Penner
Gabriel Ribeiro

University of Saskatchewan – Western College of Veterinary Medicine

John Campbell
Murray Jelinski
Diego Moya
Cheryl Waldner

Vaccine and Infectious Disease Organization

Jose Perez-Casal, SK
Philip Griebel, SK

Verified Beef Production Plus

Shannon Argent, AB

Veterinary Agri-Health Services Ltd.

Mike Jelinski, AB

Viresco Solutions Inc.

Jonathon Alcock, AB
Karen Haugen-Kozyra, AB

World Wildlife Fund

Martha Kauffman

3. Extension Priorities & Technology Transfer Strategies

Renewal of the Five-Year Canadian Beef Research and Technology Transfer Strategy (Research & Extension Strategy) includes setting out Canada’s beef research and technology transfer priorities. The Research and Extension Strategy is instrumental in guiding industry and government investments at both national and provincial levels across multiple funding agencies and is critical to informing the Beef Cattle Research Council’s next Science Cluster and overall program development.

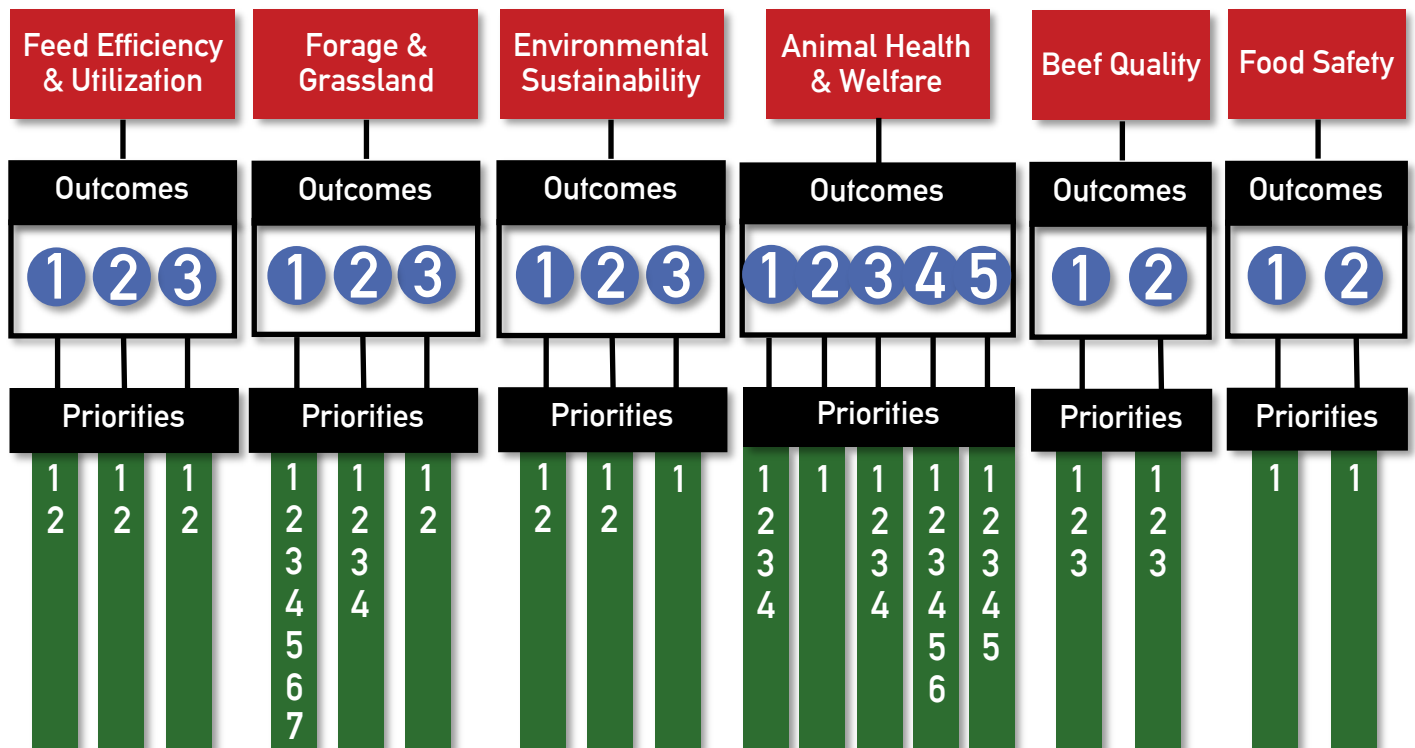
To ensure the Research and Extension Strategy development process is truly collaborative, an extensive group of value-chain stakeholders including producers, researchers, government, service providers and funding agencies were consulted. This included virtual focus group sessions which were held in each of the research program areas featured in red below.

During these focus group sessions, specific technology transfer priorities were drafted for each of the program areas. Following those initial discussions, a technology transfer focus group session was held in April 2021 to review the draft priorities, provide clarity where needed and identify any gaps.

When reviewing priorities, the technology transfer focus group participants were asked to allocate 100 points among various outcomes under the first four program areas. For each of the ranked outcomes, respondents were then asked to select only one “top priority.”

Note: Beef quality and food safety outcomes were not reviewed the by technology transfer focus group participants due to limited time and being more applicable to other industry sectors not directly linked to producer-focused extension efforts.

Click on a program area heading or outcome number below to jump to the related data in the following pages.



3. Extension Priorities & Technology Transfer Strategies, cont.

Key themes and general recommendations from the focus group discussion included:

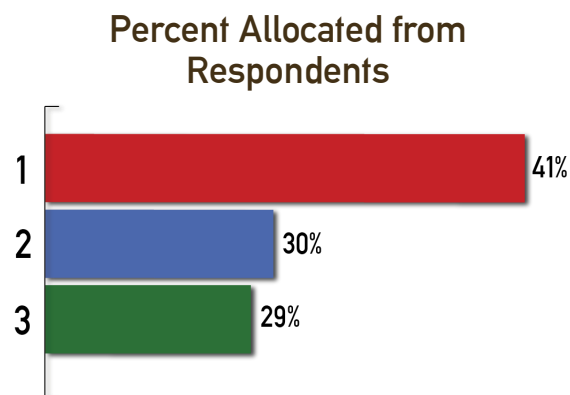
- Focus extension efforts on practical and fundamental training related to best management practices and skills, providing current and updated information and avoiding assumptions that past techniques remain the best approach.
- Avoid “one size fits all” recommendations and tools. Extension strategies need to be tailored to the needs of each segment of the target audience.
- Be cognizant of trade-offs and potential negative implications related to adoption of a practice or technology.
- Recognize costs and limitations that producers face and explore options that circumvent or mitigate barriers.
- Priority of producers’ motivations and incentives differ. Profitability may not always be the driving factor. Other considerations may include access to inputs, technology or equipment and capital availability.
- Communications about beneficial management practices need to include conversations around profitability, labour, time savings, animal welfare and cash flow, as each of these may or may not be top of mind for producers when making decisions.
- Access to high-speed internet and lack of cell service is a limiting factor in many rural areas.
- Development of consistent messaging among extension agents and with industry professionals/experts is essential.

3. Extension Priorities & Technology Transfer Strategies, cont.

Feed Efficiency & Utilization Outcomes

Focus group participants were asked, "If you had \$100 (or 100 points) to allocate among the following outcomes, how would you choose to distribute them?"

- 1 Improve feed grain and silage yields through plant breeding, agronomic practices and harvest strategies
- 2 Investigate feed processing, by-products, additives, supplements or other feeding strategies that optimize productivity and profitability
- 3 Improved feed efficiency through identification of genetic differences and animal breeding



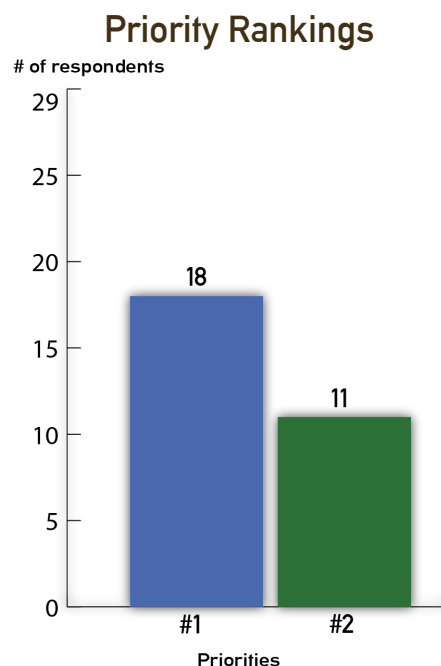
Based on various allocations of 100 from 27 respondents

- 1 Improve feed grain and silage yields through plant breeding, agronomic practices and harvest strategies

- **Priority 1:** Improve producer awareness and adoption of regionally appropriate varieties for feed grain and silage
- **Priority 2:** Improve producer awareness and adoption of optimal agronomic, harvest and storage practices for feed grains and silage production

Focus group discussion and recommendations on top priority:

- Increase awareness of regional variety trials that do exist.
- Encourage closer working relationships with agronomists.
- Encourage best practices related to conserved forage storage and silage production (e.g., balancing yield vs. quality).
- Utilize applicable dairy industry resources, with an understanding of the differences in beef cattle nutritional requirements.



Respondents were asked to select only one "top priority" per outcome. Total number of respondents was 29.

3. Extension Priorities & Technology Transfer Strategies, cont.

Feed Efficiency & Utilization Outcomes, cont.

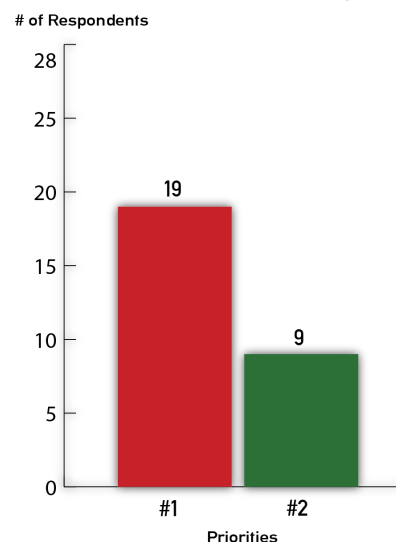
2 Investigate feed processing, by-products, additives, supplements or other feeding strategies that optimize productivity and profitability

- **Priority 1:** Promote the adoption of best management practices for utilizing by-products, additives, supplements and other feed processing and feeding strategies
- **Priority 2:** Evaluate the economic feasibility of feed processing, by-products, additives and supplements or other feeding strategies

Focus group discussion and recommendations on top priority:

- Focus on overall management practices including:
 - ⇒ proper storage and spoilage prevention and
 - ⇒ feed quality considerations when purchasing products such as risk of toxins and antinutritional factors.
- Food safety needs to be considered (i.e., if by-products are registered for use as animal feeds).
- Evaluation of all factors when deciding to use these products, including nutritional value, food safety, risks, benefits and economics (i.e., development of a decision tree).

Priority Rankings



Respondents were asked to select only one "top priority" per outcome. Total number of respondents was 28.

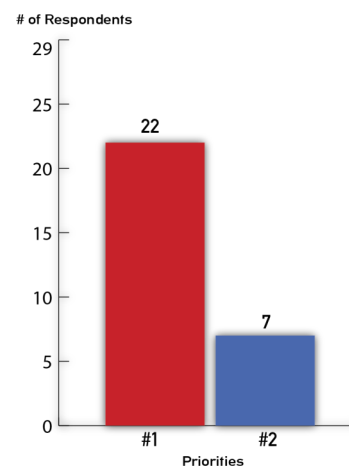
3 Improved feed efficiency through identification of genetic differences and animal breeding

- **Priority 1:** Identify barriers to adoption of genetic tools
- **Priority 2:** Improve feed efficiency through genetic selection in breeds for which breeding values for feed efficiency exist

Focus group discussion and recommendations on top priority:

- Lack of effective communication (and market signals) through the value chain limit adoption and changes in practices.
- Extension efforts need to be focused on both the seedstock and cow-calf industries with separate goals and resources; focus groups with both seedstock and cow-calf producers regarding reasons for use, or not, of genetic tools would be helpful.
- Simplified resources or tools are needed, including a focus on interpretation of data (e.g., understanding EPDs).
- Focus on the benefits for the cow-calf sector in selecting animals for feed efficiency.

Priority Rankings



Respondents were asked to select only one "top priority" per outcome. Total number of respondents was 29.

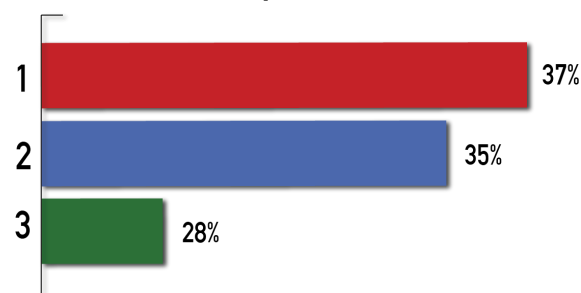
3. Extension Priorities & Technology Transfer Strategies, cont.

Forage & Grassland Productivity Outcomes

Focus group participants were asked, "If you had \$100 (or 100 points) to allocate among the following outcomes, how would you choose to distribute them?"

- 1** Improve the management and productivity of native/naturalized pastures to enhance profitability and discourage land conversion
- 2** Better understand the impact of grazing management on plant, animal and soil interactions and how the overall system contributes to plant and animal health and productivity
- 3** Cost-effectively improve the agronomic performance, yields, nutritional quality and palatability of annual and perennial tame species for grazing or stored forages

Percent Allocated from Respondents



Based on various allocations of 100 from 29 respondents

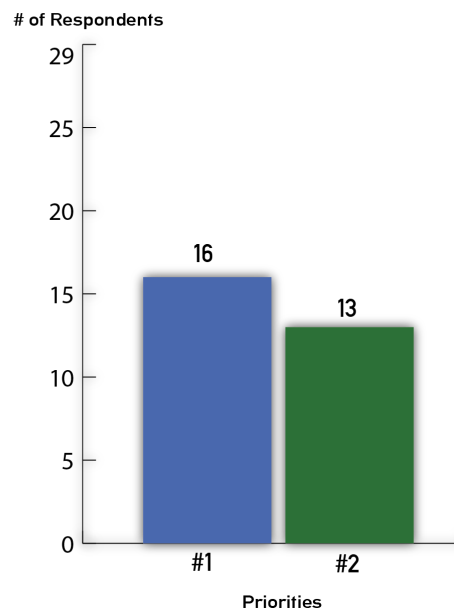
- 1** Improve the management and productivity of native/naturalized pastures to enhance profitability and discourage land conversion

- **Priority 1:** Promote grazing management practices that optimize the productivity of native plant species
- **Priority 2:** Promote best management practices to help producers control invasive plants

Focus group discussion and recommendations on top priority:

- Focus on whole farm/operation productivity, not just the outputs of a single pasture or field, including all measures of productivity (e.g., economic, production, biodiversity); all acres need to have "optimized" productivity if native areas are going to be retained .
- Encourage low-cost, low-input methods to maintain grasslands and avoid risk of conversion to cropland.
- Recognize different outcomes for native pastures, depending on individual goals, and the resulting trade offs (e.g., increasing productivity may negatively effect biodiversity)

Priority Rankings



Respondents were asked to select only one "top priority" per outcome. Total number of respondents was 29.

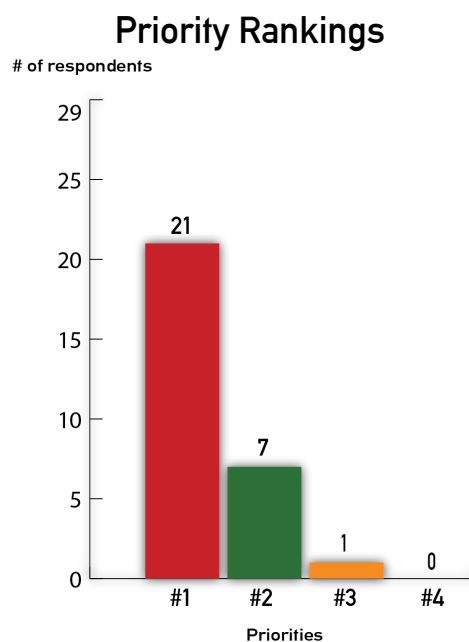
3. Extension Priorities & Technology Transfer Strategies, cont.

Forage & Grassland Productivity Outcomes, cont.

2 Better understand the impact of grazing management on plant, animal and soil interactions and how the overall system contributes to plant and animal health and productivity

- **Priority 1:** Encourage the development and adoption of forage and grazing management plans and practices that encourage long term plant, soil and animal health and productivity
- **Priority 2:** Encourage the adoption of cost of production analysis to assist in decision making
- **Priority 3:** Promote the use of resources and tools to evaluate grazing management practices
- **Priority 4:** Encourage the adoption of management practices that extend the grazing season
- **Priority 5:** Identify and promote best management practices for incorporating grazing on cropland

[Priority 5 was added after the April focus group and, therefore, is not represented in the ranking or graph.]



Respondents were asked to select only one "top priority" per outcome. Total number of respondents was 29.

Focus group discussion and recommendations on top priority:

- Encourage implementation of improved management plans including steps to transition from the current system.
- Consider barriers to implementing a grazing management plan. Focus on individual components, regional applicability and uniqueness of each operation (e.g., development of templates or decision trees).
- Peer-to-peer learning is essential, including examples and producer stories to demonstrate creation and use of grazing plans.

3. Extension Priorities & Technology Transfer Strategies, cont.

Forage & Grassland Productivity Outcomes, cont.

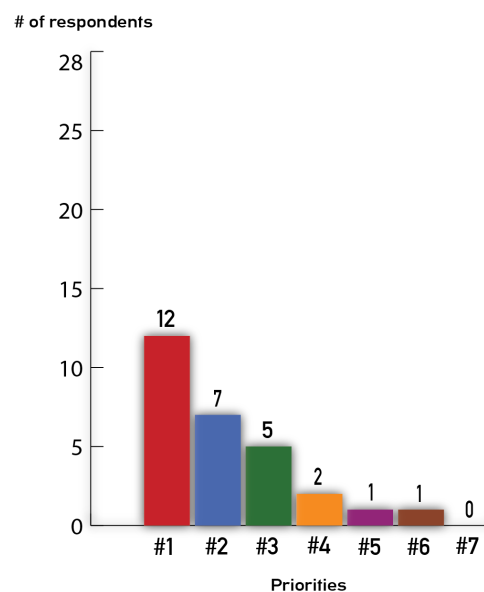
3 Cost-effectively improve the agronomic performance, yields, nutritional quality and palatability of annual and perennial tame species for grazing or stored forages

- Priority 1:** Promote regionally appropriate management practices that encourage long-term stand maintenance and profitability
- Priority 2:** Identify simple, cost-effective strategies to rejuvenate tame pastures when required
- Priority 3:** Communicate the potential forage yield and animal carrying capacity improvements that can be cost-effectively achieved under different management systems
- Priority 4:** Promote management practices that maintain legumes in mixed grass stands and provide producers with information on safe and effective ways to graze legumes in pastures
- Priority 5:** Communicate variety testing trial results to help producers make informed variety and seed selection decisions
- Priority 6:** Develop and communicate cost benefit analysis of different harvest strategies
- Priority 7:** Promote best practices for irrigation for forage and feed production

Focus group discussion and recommendations on top priority:

- Understanding the needs and challenges of a specific region or individual operation is essential, including regionality of challenging landscapes (i.e., brush encroachment, extreme drought).
- Management basics need to continue to be a focus.
- Consider economic scenarios reflecting long-term return on pasture management practices vs. short-term gains; cash flow is often a key driver for decision making.
- Focus on the value of recordkeeping and logistics of data collection for pastures and forage stands.

Priority Rankings



Respondents were asked to select only one "top priority" per outcome. Total number of respondents was 28.

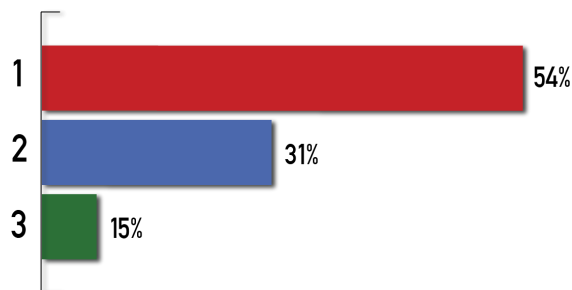
3. Extension Priorities & Technology Transfer Strategies, cont.

Environmental Sustainability Outcomes

Focus group participants were asked, "If you had \$100 (or 100 points) to allocate among the following outcomes, how would you choose to distribute them?"

- 1 Develop cost-effective ways to reduce greenhouse gas emissions, maintain or improve biodiversity, increase soil carbon, or improve water infiltration on pastures and range
- 2 Develop cost-effective ways to reduce feedlot greenhouse gas emissions and evaluate the impacts of manure nutrients on pasture and cropping systems
- 3 Identify cost-effective ways to improve air, water and soil outcomes associated with beef packing and processing facilities

Percent Allocated from Respondents



Based on various allocations of 100 from 27 respondents

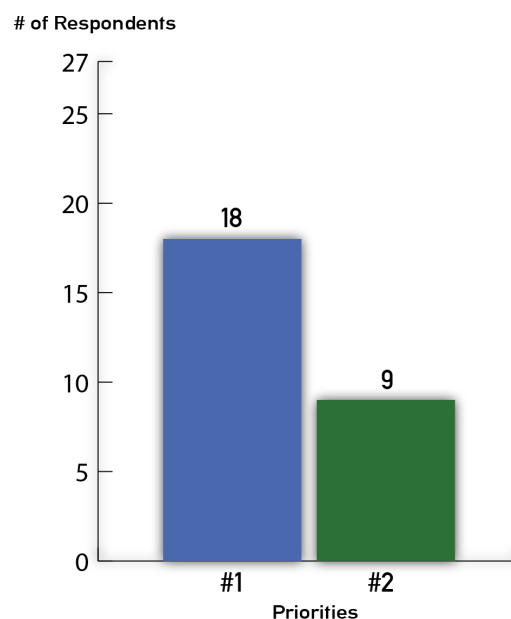
- 1 Develop cost-effective ways to reduce greenhouse gas emissions, maintain or improve biodiversity, increase soil carbon or improve water infiltration on pastures and rangeland

- **Priority 1:** Develop and promote best management practices for improved environmental sustainability
- **Priority 2:** Encourage the adoption of best management practices that support biodiversity and species-at-risk habitat preservation

Focus group discussion and recommendations on top priority:

- Recognize and understand individual producers' and users' different goals and priorities.
- Goals need to be outcome-based and not prescriptive.
- Barriers to implementation of beneficial management practices include time, labour and costs; peer-to-peer communication helps others realize economic benefits as well as "what not to do."
- Consider whole farm/operation management (i.e., riparian and non-riparian areas).
- Promote existing resources (e.g., tools and learning materials).

Priority Rankings



Respondents were asked to select only one "top priority" per outcome. Total number of respondents was 27.

3. Extension Priorities & Technology Transfer Strategies, cont.

Environmental Sustainability Outcomes, cont.

2 Develop cost-effective ways to reduce feedlot greenhouse gas emissions and evaluate the impacts of manure nutrients on pasture and cropping systems

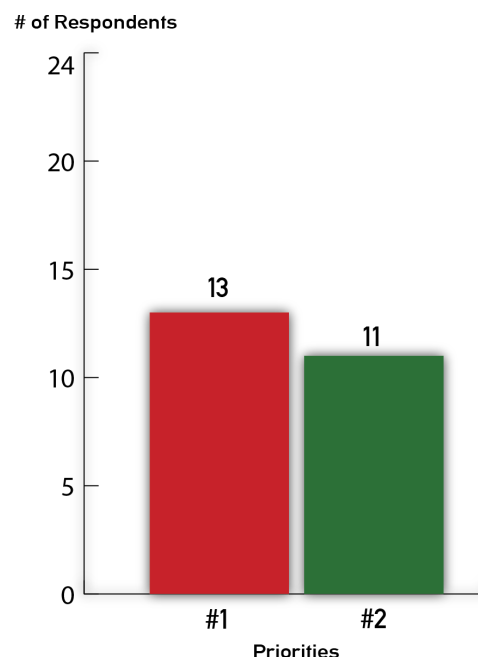
■ **Priority 1:** Determine the cost benefit of utilizing manure on crop land

■ **Priority 2:** Promote best manure and odour management practices

Focus group discussion and recommendations on top priority:

- Consider opportunities for integration between beef and cropping sectors (i.e., cost benefit of displacing commercial fertilizer with manure or value of incorporating livestock onto crop lands).
- Regional differences must be considered (e.g., crop type and nutrient requirements).
- Focus on helping producers determine if utilizing manure is a viable option for their operation (e.g., decision trees and tools).
- Legislation is often a limiting factor, therefore extension efforts must consider regional regulations.

Priority Rankings



Respondents were asked to select only one "top priority" per outcome. Total number of respondents was 24.

3 Identify cost-effective ways to improve air, water and soil outcomes associated with beef packing and processing facilities

■ **Priority 1:** Encourage the adoption of cost-effective technologies that have known environmental benefits

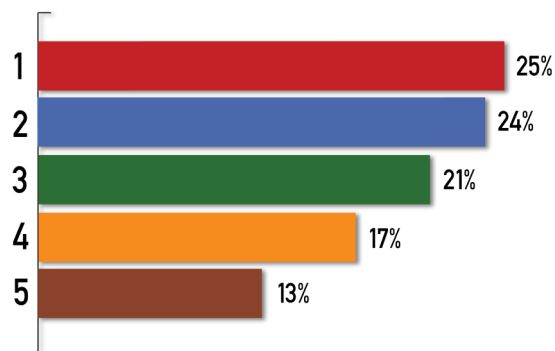
3. Extension Priorities & Technology Transfer Strategies, cont.

Animal Health, Welfare & Antimicrobial Resistance Outcomes

Focus group participants were asked, "If you had \$100 (or 100 points) to allocate among the following outcomes, how would you choose to distribute them?"

- 1 92% of cows wean a calf each year through cost-effective improvements in nutritional and overall management
- 2 Develop and promote the adoption of management practices and technologies that reduce the need for and preserve the effectiveness of antibiotics
- 3 Effective surveillance of production-limiting diseases, production practices, and antimicrobial use and antimicrobial resistance
- 4 Improved prevention and mitigation of animal disease issues
- 5 Improved prevention and mitigation of animal welfare issues

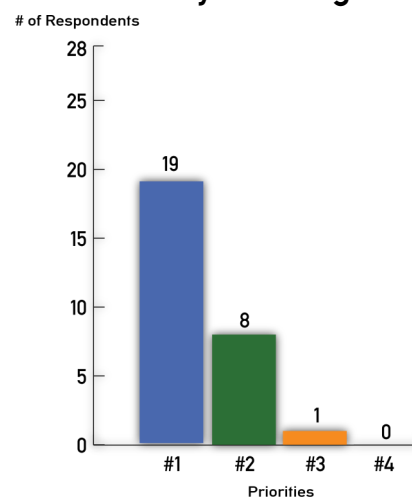
Percent Allocated from Respondents



Based on various allocations of 100 from 29 respondents

- 1 92% of cows wean a calf each year through cost-effective improvements in nutritional and overall management

Priority Rankings



Participants were asked to select one "top priority" for the outcome. Total number of respondents was 28.

- **Priority 1:** Identify and promote the suite of production practices that provide improvements in reproductive performance and longevity and reduced preweaning mortality
- **Priority 2:** Encourage producers to participate in training and/or record-keeping programs allowing them to compare their operations to industry benchmarks
- **Priority 3:** Develop and promote best management practices to ensure breeding bull fertility and reproductive soundness
- **Priority 4:** Promote the benefits of crossbreeding on reproductive performance, herd retention and longevity of the cow herd

Focus group discussion and recommendations on top priority:

- Reproductive efficiency is the main driver of profitability and competitiveness of cow-calf operations.
- 92% is an ambitious overall industry goal but, at an individual operation level, one must focus on the optimal percentage for that operation. Producers need to consider the benefits and tradeoffs of implementing new practices to reach goals.
- Common limitations include labour and nutritional quality of grazed forage, but a number of management considerations support this goal including crossbreeding, bull fertility and cow-to-bull ratio.
- Individual farm goal setting and record analysis encourages producers to concentrate on actions that support achieving goals and facilitates identification and measurement of progress.

3. Extension Priorities & Technology Transfer Strategies, cont.

Animal Health, Welfare & Antimicrobial Resistance Outcomes, cont.

2 Develop and promote the adoption of cost-effective management practices and technologies that reduce the need for and preserve the effectiveness of antibiotics

- **Priority 1:** Promote the adoption of production and health practices that have been shown to effectively reduce the need to use antimicrobials in cattle

Key themes and recommendations from focus group discussion included:

- Lack of a clear definition of “preconditioning” as well as limited market demand and measurable value or benefits have been barriers to adoption; measures and understanding of the motivations and barriers (e.g., labour, facilities) to preconditioning are needed.
- Consider the specific individual components of preconditioning and explore opportunities (pre/post weaning) to focus on those practices that result in animal welfare improvements and economic benefits to the cow-calf producer.
- Consider the role that common practices like crossbreeding play in improving overall herd health.

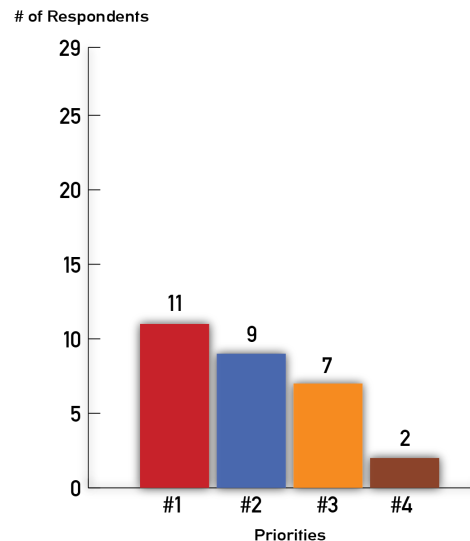
3 Effective surveillance of production-limiting diseases, production practices, and antimicrobial use and antimicrobial resistance

- **Priority 1:** Use information collected by surveillance programs to inform extension, communication, future research needs and the impact of interventions or changes in management practices
- **Priority 2:** Encourage surveillance and/or recordkeeping/benchmarking initiatives to communicate, collaborate and share data to inform veterinary and producer benchmarking comparisons and practice change
- **Priority 3:** Investigate information needs and opportunities to encourage telemedicine, enhanced veterinarian-client-patient relationships and skills to support accurate diagnosis and sampling and to inform surveillance efforts on cow-calf operations
- **Priority 4:** Encourage veterinarians and producers to participate in and submit data to ongoing surveillance and/or recordkeeping/benchmarking initiatives

Focus group discussion and recommendations on top priority:

- Focus efforts on the importance of recordkeeping and practical steps to encourage these activities (e.g., development of a decision tree for information collection and management of data).
- Recognizing and understanding motivations and barriers to recordkeeping is essential in communications. For example, data collection may be limited by lack of infrastructure (i.e., scale or handling facilities).
- Include local and regional benchmarks to assist in decision making.

Priority Rankings



Participants were asked to select one “top priority” for the outcome.
Total number of respondents was 29.

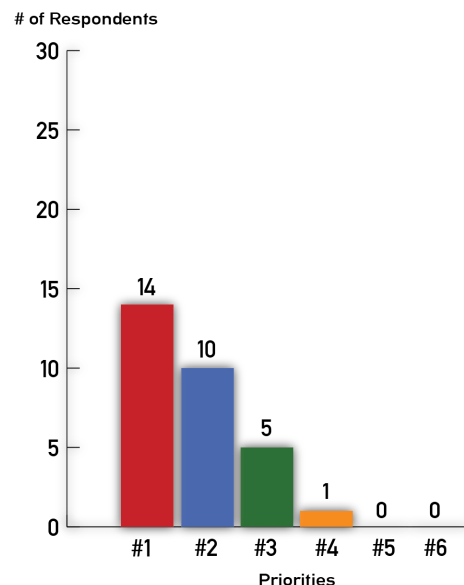
3. Extension Priorities & Technology Transfer Strategies, cont.

Animal Health, Welfare & Antimicrobial Resistance Outcomes, cont.

4 Improved prevention and mitigation of animal disease issues

- **Priority 1:** Promote and monitor the adoption of prevention-based herd health programs addressing a range of genetic, nutritional, vaccine and other tools to maintain herd health, welfare and productivity
- **Priority 2:** Develop and promote tools to help veterinarians, nutritionists, other professionals and cow-calf producers design and implement appropriate and cost-effective biosecurity, vaccination, health and nutritional management programs
- **Priority 3:** Develop and promote best practices regarding the collection and sharing of individual animal health and production information between cow-calf producers and feedlot operators
- **Priority 4:** Develop and promote best practices for the transportation, storage, handling, mixing and timely administration of vaccines to improve their effectiveness
- **Priority 5:** Promote and monitor the development of veterinary-client-patient relationships among cow-calf producers
- **Priority 6:** Develop and promote cost-effective biosecurity protocols to minimize the introduction and spread of disease in cow-calf and cattle feeding operations

Priority Rankings



*Participants were asked to select one "top priority" for the outcome.
Total number of respondents was 30.*

Focus group discussion and recommendations on top priority:

- Focus might be best placed on providing tools to help producers, veterinarians, registered veterinarian technicians and extension agents develop management plans specific to each individual operation. This may include examples of individual success stories.
- Developing national veterinary continuing education programs could support this priority area.
- Tools and resources must be user-friendly, including for veterinarians who are providing expertise within time constraints and limited opportunities for paid consultation time.
- Sharing success stories from producers and veterinarians who both have seen benefit from a closer working relationship may encourage adoption.

3. Extension Priorities & Technology Transfer Strategies, cont.

Animal Health, Welfare & Antimicrobial Resistance Outcomes, cont.

5 Improved prevention and mitigation of animal welfare issues

■ **Priority 1:** Encourage and empower producers to understand and comply with the requirements and recommendations in The Code of Practice for the Care and Handling of Beef Cattle, including:

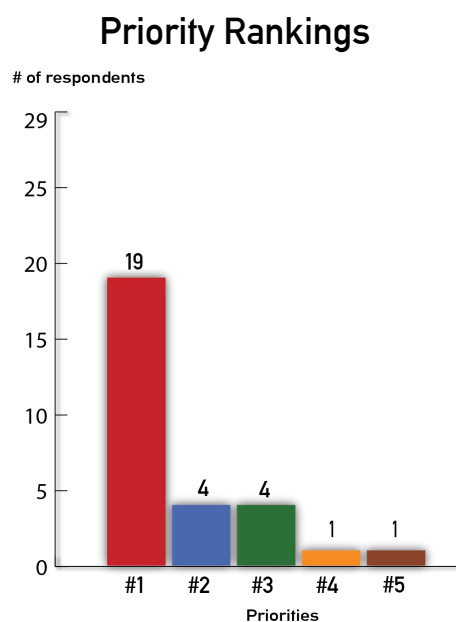
- timely euthanasia
- nutritional management
- confirming death immediately after euthanizing
- avoiding and minimizing acute and chronic pain
- minimizing stress during weaning
- optimizing transportation decisions to prevent injury and stress

■ **Priority 2:** Promote and monitor the adoption of cost-effective pain mitigation strategies

■ **Priority 3:** Develop, promote and monitor the adoption of tools to help producers accurately differentiate, diagnose and treat different causes of lameness

■ **Priority 4:** Promote and monitor the adoption of polled genetics and early and proper dehorning and castration

■ **Priority 5:** Promote and monitor awareness of the Code of Practice for the Care and Handling of Beef Cattle among veterinarians, producers and industry employees



Participants were asked to select one "top priority" for the outcome. Total number of respondents was 29.

Focus group discussion and recommendations on top priority:

- Awareness of the Code of Practice among producers is a challenge.
- Promote the value and benefits of implementing Code of Practice recommendations.
- Given that there are differences across Codes (e.g., dairy vs. beef), it is important that producers and veterinarians who are involved in both sectors are aware of these differences.
- Increase education about timely euthanasia as a treatment option rather than as a last resort.
- Treating lameness on pasture is challenging; improved treatment protocols could be developed.
- Develop and promote additional guidelines for the use of dart guns.
- Expand and create resources for training new employees.
- Renewed communication about the cost benefit of dehorning and castration.
- Focus on the benefits and advantages of low-stress handling, including when labour is a limiting factor.

3. Extension Priorities & Technology Transfer Strategies, cont.

Beef Quality Outcomes

1 Improved customer satisfaction with Canadian beef

Beef Quality and Food Safety outcomes were not reviewed by the Technology Transfer focus group participants due to limited time and being more applicable to processing and other industry sectors not directly linked to traditional extension efforts.

- **Priority 1:** Communicate National Beef Quality Audit results pertaining to production-related issues to producers in a timely and effective manner to drive practice change
- **Priority 2:** Producer communication and awareness regarding the use of genetic tools to improve carcass and beef quality
- **Priority 3:** Data from individual animal carcass and offal images collected at processing plants are available to inform improvements in feedlot, transportation, cow-calf and seedstock management/selection

2 Define, validate and enhance the emotional and functional attributes of Canadian beef in domestic and international markets

- **Priority 1:** Communicate fact-based information regarding the equivalence or superiority of Canadian beef to comparable U.S. and Australian grades among domestic and international customers
 - **Priority 2:** Use the results of domestic and international benchmarking surveys to increase the quantity of Canadian product that meets domestic and international customer/consumer preferences
 - **Priority 3:** Encourage adoption of best practices by processors and domestic and international customers to ensure maximum shelf life and customer satisfaction with Canadian beef
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Food Safety Outcomes

1 Ensured food safety along the beef supply chain

- **Priority 1:** Educate retail and foodservice meat cutters about the importance of temperature and appropriate cleaning (knives, gloves, equipment) in ensuring food safety for consumers
- **Priority 2:** Encourage the consistent adoption of known best practices to minimize the risk of pathogen contamination in beef processing plants related to the proper and thorough cleaning of conveyor belts, personal equipment, processing and grinding equipment, etc.

2 Validate the efficacy and safety of new technologies in support of the rational regulatory approval and adoption of improved food safety interventions throughout the supply chain

- **Priority 1:** Proactively identify likely regulatory barriers/concerns in key beef markets so they can be resolved before market access is impaired