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Genetics and Genomics in the Canadian Beef Industry: A Sustainable Solution

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Scholar Profile

The history of my family

My understanding of Canada has always been rooted in the belief that it is a country of opportunity. Canada is a place where, through hard work and seizing the right opportunities, you can build a prosperous life, pursue a meaningful career, raise a family, and live in safety. This perspective was deeply shaped by my family's story. In 1979, my father and his family were among the 60,000 Indochinese “boat people” who fled Vietnam by sea to escape the communist regime. After arriving in Malaysia as undocumented refugees, they were granted refuge and resettlement in Canada through the Canadian Red Cross. My mother and her family also immigrated from Vietnam, arriving through a sponsorship program. Their courage, resilience, and the opportunities they found here, continue to shape how I see Canada and the values I hold today.

After my parents immigrated from Vietnam, they began to rebuild their life in Hamilton, Ontario (also known as “The Steel City”) where I was born and raised. Despite my non-rural upbringing, I was deeply influenced by my parent’s Vietnamese culture, especially through my mother’s cooking and the values passed down through generations. Meals were made with fresh herbs, spices, seafood, and a variety of meats, and we were constantly reminded to be grateful for our food and to never waste it. These values are familiar to many immigrant families across Canada, who, like mine, share a deep appreciation for opportunity, resilience, culture, and community. For many of us, Canada represents a home of safety, education, innovation, science, and health. These values inspired me to pursue post-secondary education where I was fortunate to have an opportunity to study livestock research, which has become the focus of my career.

My background in agricultural research

My experience in agricultural research expanded when I studied at the University of Guelph during my animal biology undergraduate degree (2010-2014). I then continued to complete my MSc degree (2014-2016) in beef cattle rumen physiology and feed efficiency and then completed my PhD (2016-2020) in beef cattle genetics and genomics. Academia favours the practice of studying a very specific research topic intensely, helping me learn the experimental, philosophical, and critical thinking process to discover new insights; however, it also lends a narrow perspective on the application of research discoveries to applied technologies.

My applied experiences started after my PhD, where I worked at Agriculture and Agri-Food Canada (AAFC) in Lacombe, Alberta (2020-2022) as a postdoctoral researcher. There, I researched new technologies and methods to assess the quality of beef and pork meat and carcass characteristics. I also began to understand livestock industry challenges and priorities across the value-chain from birth to processing and consumer demands. I then worked with Genome Alberta as an agriculture program officer, where I helped manage large-scale applied-genomics funding programs. This job allowed me to expand my network, connect different stakeholders, foster partnerships, and accelerate genetics-led research programs to benefit industry and producers.

In 2022, I returned to the University of Guelph as a research associate to work at the Department of Animal Biosciences, Centre for Genetic Improvement of Livestock (CGIL). I was pleasantly surprised by how many University of Guelph Alumni, and specifically CGIL alumni, that I met travelling the world. This illustrates how CGIL represents a centre of excellence in livestock genetics research, as shown by its contributions to research and industry institutes and innovations across the world.

In January 2025, I started my role as the director of research at Livestock Research Innovation Corporation (LRIC). In this position, I'm fortunate to work at the intersection of academia, government, and industry, where I collaborate with agricultural commodity groups to advance research and innovation that benefits Ontario, Canada, and beyond. This role allows me to stay connected with the network I built through my Nuffield Canada scholarship, further enriching my work and perspective.

Why beef and genetics?

Through my experiences, I've become deeply driven to explore global best practices in beef cattle genetics, with the goal of bringing back innovative ideas to help Canadian beef producers lead in sustainability, productivity, profitability, and quality.

Beef production is often seen as the highest contributor to agricultural greenhouse gas emissions, placing the Canadian beef industry under significant pressure to improve its sustainability, while also remaining efficient and economically viable. With advancing genetic technologies and a growing reliance on data, there are exciting opportunities to uncover innovative solutions by studying genetic approaches from leading countries. These insights have the potential to deliver meaningful benefits across the entire beef value chain.

In my view, sustainability cannot exist without first ensuring productivity, profitability, and efficiency. These are the pillars that support a truly sustainable industry. While sustainability is often the focus of external scrutiny, it is crucial to recognize the long-standing and meaningful work already underway in Canada through organizations like the Beef Cattle Research Council

(BCRC), the Canadian Roundtable for Sustainable Beef (CRSB), and many commercial and research partners. These efforts deserve recognition and celebration.

The goal of my Nuffield Canada Scholarship was to delve into the genetic and genomic tools being used in Canada and globally, and to uncover new perspectives and opportunities that can shape the future of beef cattle production. I knew the program would push me out of my comfort zone both professionally and personally, and it did. What I gained from this experience went far beyond what could be learned from a textbook or computer screen. It has been the most challenging yet transformative period of my career.

I am incredibly grateful to be a Nuffield Canada Scholar and to contribute back to the Canadian beef industry. I'm fortunate to work in this sector in a role where I can help drive change, challenge the status quo, and support a forward-thinking, globally competitive beef industry.

Acknowledgements

I would like to acknowledge and express my deep gratitude to the many people and organizations who have supported me throughout my Nuffield journey:

Firstly, thank you to my husband, Spencer Gill, for encouraging me to pursue my ambitious dreams, for grounding me when things got challenging, and even joining me for parts of the adventure in New Zealand.

To my friends and colleagues at the University of Guelph and Centre for Genetic Improvement of Livestock, thank you for listening to my learnings and being a sounding board as I reflected on the ideas and discoveries throughout my travels.

Thank you to Nuffield Canada for trusting in my ability to complete the Nuffield Program. Your tireless efforts to uphold the highest standards for this program have not gone unnoticed.

To my parents, Michael Quang Lam and Chi Kim Lam, for instilling in me a deep sense of gratitude for our country and Canadian agriculture, and for their unwavering support throughout my life.

I am also grateful to the Beef Cattle Research Council research committee for accepting me as a mentee for the 2024 Research Mentorship Program. Despite the ambitious nature of completing both programs simultaneously, they complemented each other in such a positive way.

To every individual who generously spent time with me and shared their insights over my Nuffield program, I thank you.

And finally, to the Canadian beef producers, who work tirelessly to feed our families and the world each day. Thank you for your hard work and dedication.

Sponsorship

I am sincerely grateful to my Nuffield Scholarship sponsor, **Semex**, and want to extend my immense gratitude for their support. Semex's involvement went beyond sponsorship, as they connected me with their extensive network, provided valuable feedback from their team, and consistently checked in on my progress, showing genuine interest in the outcomes.

I hope that my report and ongoing initiatives will significantly contribute to advancements in genetics within the beef industry, and that it will serve as a valuable resource for all stakeholders.

Additional funding was generously provided through a local community grant from the **Grand River Agricultural Society**, and I am also deeply grateful for the financial support from my family.

Executive Summary

This report explores why genetic and genomic technologies in the Canadian beef industry are lagging behind other livestock sectors (like dairy) and international counterparts and identifies opportunities to close that gap. The goal is to highlight strategic actions that can help Canada advance further as a sustainable, efficient, and profitable beef production system.

The need to optimize genetics is especially pressing in the context of increasing global pressures including rising demands for sustainability, shifting political landscapes, and rapidly advancing technologies in data collection, biotechnology, and precision agriculture.

***Genetics and genomics are no longer optional tools; they are foundational to the future of Canadian beef production*.**

This report is intended for a wide range of readers, including producers, processors, industry leaders, researchers, policy makers, government, and consumers. It also provides value for those new to the field of cattle genetics, offering a broad overview of the benefits and current barriers to adoption.

Key findings include:
Canada lacks a cohesive, long-term national framework for beef genetics, which could complement current systems and initiatives in place.

- A coordinated national system should include:
  - A national genetic and genomic evaluation system
  - A national genotyping program
  - A beef carcass classification program
  - A knowledge transfer and translation framework
- Current activities (led by organizations such as CBIN, BCRC, and Canadian universities) are promising but disconnected.
- Lessons and models in other countries offer direction for next steps.

Key recommendations include:

- Build greater alignment and collaboration across stakeholders.
- Support the creation and funding of a national evaluation and data-sharing system.
- Develop a Canadian beef genetics strategy tailored to regional and national needs.
- Encourage adoption and knowledge-sharing at the farm level through improved tools and training.

Conclusion:
If Canada can close its genetic gap in beef, it can make larger strides towards its global leadership in sustainability, innovation, and quality. A national framework will not only enable producers to make better-informed breeding decisions, but will also strengthen Canada's position in international markets and secure the long-term resilience of its beef sector.

Disclaimer

This report has been prepared in good faith but is not intended to be a scientific study or an academic paper. It is a collection of my current thoughts and findings on discussions, research and visits undertaken during my Nuffield Farming Scholarship.

It illustrates my thought process and my quest for improvements to my knowledge base. It is not a manual with step-by-step instructions to implement procedures.

Neither Nuffield Canada, nor my sponsor, nor any other sponsoring body guarantees or warrants the accuracy, reliability, completeness or currency of the information in this publication or its usefulness in achieving any purpose.

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Table of Contents

1.0 Introduction

1.1 Objectives

The overall objective of my Nuffield study was to identify sustainable approaches for the Canadian beef industry through the application of genetic and genomic technologies. Accordingly, the objectives of this report were to:

1) Assess the current state of genetic and genomic evaluation systems within the Canadian beef industry
2) Identify key challenges and barriers to the adoption of genetic and genomic technologies
3) Explore opportunities to enhance the application of these technologies across the beef value chain
4) Propose a framework for a sustainable and integrated genetic and genomic evaluation system tailored to the long-term success of the Canadian beef industry

1.2 Research methodology

The research method undertaken for this Nuffield international travel study was aimed to learn from leading cattle-producing countries as well as the current system in Canada. This involved travelling within Canada and internationally to learn from multiple genetics and genomic evaluation organizations, genetics companies, industry professionals, and beef producers. For this international scholarship travel, a history of visits and meetings made are listed in **Appendix A - Travel Log.**

In addition to organization and company site visits, I also attended major livestock and beef genetics conferences which provided valuable opportunities for networking and for learning about globally recognized, effective models for applying genetics in the cattle industry.

Further learning took place through a combination of virtual, in-person, and on-farm meetings with geneticists, cattle industry professionals, and beef producers. These conversations, tours, and interactions often led to new connections and insights. Detailed notes and diagrams developed throughout the process have been thoughtfully incorporated into this report.

While this project engaged numerous people, places, and organizations, it represents only the beginning of an ongoing journey toward advancing the use and optimization of genetic and genomic technologies in Canada’s beef industry. Thus, the purpose of this report is to give stakeholders, including industry and government personnel, researchers, and producers, a clear overview of Canada’s genetic and genomic evaluation systems, the opportunities and challenges in their adoption, successful international examples, and actionable steps that can be pursued immediately.

1.3 Economic summary of the Canadian beef industry

The Canadian beef industry is a complex and interconnected agricultural sector, valued as a 34.2 billion-dollar (2022-2024 average) industry contributing significantly to the national economy (Canadian Cattle Association, n.d.). As a key driver of Canada's GDP, the beef supply chain plays an essential economic role. On the global stage, Canada ranks ninth among the top ten beef-producing countries and is home to approximately 1.1% of the world's 1 billion cattle (Canada Beef, 2022). In terms of beef exports, Canada ranks eighth among the top ten exporting nations (Canada Beef, 2022).

1.4 Canadian beef cattle in numbers

There are approximately 71,280 beef operations in Canada, with 11.91 million cattle (including 1.4 million dairy cattle), with Alberta accounting for approximately 43% of Canada's inventory (AAFC Cattle/Beef and Veal, 2024). Amongst the national cattle inventory, there are approximately 3.78 million beef cows contributing genetics to the next generation as part of the national cow herd (2021 Census of Agriculture). On average, Canadian farms are smaller than those of our primary trading partner, the United States. The average number of beef cattle per farm in Canada is 115 head, with the highest average herd size in the provinces of Alberta (173 head), Saskatchewan (120 head), and Manitoba (101 head) (Canfax, 2021). Herd sizes in Canada vary due to several reasons, including the variability in different farming objectives, different sectors, and regional resources.

1.5 Exports, imports, and growth opportunities

The Canadian beef industry nourishes both domestic and international consumers, with nearly half (49.7%) of total beef production (live animals and beef products) exported in 2021 (Statistics Canada, 2021). In 2024, Canada exported 797,327 head of cattle and calves valued at $2.3 billion, along with 494,298 tonnes of beef and veal worth $4.93 billion (AAFC Cattle/Beef and Veal, 2024). The United States remains Canada's largest trading partner, serving as both the primary destination for exports and the leading source of imports; an influence that significantly shapes decisions across the beef supply chain. Other growing export markets include Asia and Mexico, while imports commonly originate from New Zealand, Australia, Uruguay, and Mexico (Statistics Canada, 2021). These evolving trade relationships present ongoing opportunities for market expansion and innovation.

Understanding a country's export strength requires assessing net exports to determine if a true surplus exists. According to the Canadian Agri-Food Policy Institute (2021), Canada maintains a beef surplus and ranks among the top ten net exporters globally. The leading surplus countries include Brazil (23% more production than consumption), Australia (15%), New Zealand (12%), Argentina (8%), Uruguay (6%), Poland (5%), Paraguay (5%), and Canada (5%).

While per capita beef consumption in Canada has declined gradually since 1980 (Statistics Canada, 2025), global demand is rising, driven by population growth and increasing incomes. This trend highlights Canada's strategic opportunity to meet expanding international demand.

With this strategic advantage, Canada is well-positioned to supply high-quality beef to both domestic and international markets in a sustainable, efficient, and profitable manner. However, the beef industry remains highly complex and interconnected, presenting both challenges and opportunities as it evolves.

1.6 What sets the Canadian beef industry apart: Sustainability, quality, and innovation

Multiple factors set the Canadian beef industry apart on the global stage, including its leadership in sustainability, its reputation for premium quality, and its strategic emphasis on innovation and research.

Canada is recognized as a global leader in sustainable beef production and was one of the first countries to establish a national roundtable on sustainable beef in 2014, creating a formal network to guide conversations and commitments across the value chain (Laycraft, 2023). According to the Canadian Roundtable for Sustainable Beef (CRSB), sustainability is defined as "a socially responsible, economically viable, and environmentally sound product that prioritizes the Planet, People, Animals, and Progress" (CRSB, n.d.). In terms of environmental impact, Canada ranks 20th globally in cattle herd size but has the lowest emissions intensity among the top 25 cattle-producing countries, at 17.42 kg CO_2e per kg of beef produced (Canadian Agri-Food Policy Institute, 2023). This reflects both environmental stewardship and production efficiency. Moreover, Canadian beef cattle play a key role in conserving native grasslands that support wildlife habitat, carbon sequestration, and wetland protection (Laycraft, 2023; CRSB, n.d.). Another unique sustainability feature is that over 98% of Canadian beef farms are family-owned and operated (CBIC, 2024), often passed down through generations. These farms are deeply committed to long-term land stewardship, animal welfare, and preserving the vitality of rural communities, which contributes to the sector's resilience and social sustainability.

Canada's commitment to sustainability is closely tied to its investment in science-based innovation. Through the national beef check-off, producers contribute funding per head of cattle sold, which supports research in partnership with Agriculture and Agri-Food Canada. These funds help establish research clusters focused on genetics, feed efficiency, animal health, and environmental outcomes (Laycraft, 2023). The Beef Cattle Research Council (BCRC) plays a vital role in ensuring research is producer-driven and field-applicable. In addition, programs like the BCRC Genetic Literacy Working Group supports knowledge transfer through factsheets, infographics, and online training modules, helping producers understand and apply genetic and genomic advancements to improve sustainability and efficiency on-farm.

Canadian beef is internationally recognized for its high marbling, consistent quality, and grain-finished flavour profile (attributes that are difficult and costly to replicate in countries without similar infrastructure and feed resources). Canada's advantage lies in its access to high-quality grains, advanced feedlot systems, robust animal health protocols, and strong genetics programs. This enables producers to finish cattle efficiently and consistently to meet both domestic and international demand for premium beef. This reputation for quality underpins Canada's competitiveness in key export markets and reinforces consumer trust in the safety, traceability, and flavour of Canadian beef.

To maintain its leadership in sustainable, high-quality beef production, Canada must continue to prioritize economic efficiency alongside environmental and social goals. As echoed throughout this section, genetic and genomic technologies continue to be key tools to help producers balance productivity with sustainability. Ongoing investment in research, innovation, and knowledge transfer will ensure that Canadian beef remains both globally competitive and responsibly produced.

2.0 Genetics and genomics as a strategic driver

2.1 Genetics and genomics defined

The traditional field of genetics and more modern field of genomics have allowed researchers, scientists, and industries worldwide to discover the underlying biology of ourselves, animals and microbes (Poznansky, 2020). For clarity, the terms genetics and genomics are not interchangeable and have distinct definitions. In general biology, genetics is the study of single genes and their roles in the way traits or conditions are passed from one generation to the next, and genomics is the study of all parts of an organism's genes, known as a genome (Poznansky, 2020). However, for the context of this report, 'genetics' will be referred to the use of genetic modelling to predict breeding values that represent the genetic merit of an individual animal using its trait and pedigree information, and 'genomics' will be referred to as the same prediction except also including the use of an animal's DNA information. Importantly, the use of genomics by adding DNA information into genetic evaluations has increased Expected Progeny Difference (EPD) accuracies and accelerated genetic change (Spanger, 2024).

Genetic technology has made large strides in advancing all livestock sectors, changing the way we collect and analyze data on animals and their environments. It has revolutionized how we strategize and optimize breeding programs, which has allowed for value-added information to be brought back to producers, companies, and research programs to make breeding and management decisions. Examples of this are described in the following section. There is no doubt that genetic technology has continued to help producers achieve economic, environmental, and sustainability goals.

A comprehensive overview of the history of livestock breeding practices, from traditional selection methods to genetic modeling and advanced genomic prediction, is presented in an invited review by Dr. Stephen Miller (2023). The review also compares how genomics is evolving across different livestock species, current applications and future directions. I encourage interested readers to read this review for a deeper understanding of the field.

In the present report, we narrow the focus to explore the current genetic and genomic technologies used within the Canadian beef industry. We examine both the opportunities and challenges within the system, while also briefly highlighting broader applications of genetic and reproductive technologies that support genetic improvement and production efficiency.

2.2 Applications of genetic improvement on-farm

2.2.1 General steps to apply genetics on-farm

The successful application of genetic and genomic technologies begins with a clearly defined breeding objective. This goal serves as the foundation for all subsequent decisions and actions. While the steps involved in utilizing genetic improvement tools can vary slightly depending on the context, the general process includes the following steps (Garrick, 2024; Spangler and Berry, 2024):

1) **Establishing a breeding objective**
2) **Collecting on-farm data**, including:
    a) Pedigree information
    b) Performance measurements (e.g. growth rates, fertility traits, carcass traits)
    c) DNA samples (e.g., hair, blood, or tissue sample)
3) **Genotyping**, where DNA samples are processed to identify genetic markers (typically by commercial providers such as Neogen, Illumina, or Zoetis)
4) **Data management infrastructure**, including databases, cloud storage, and computing power
5) **Data analysis** through a national or breed-specific genetic/genomic evaluation system
6) **Interpretation of results**, often supported by extension or technical service providers
7) **Making informed breeding and management decisions** based on the evaluation outputs

Because each farm and herd is unique, step 1 is typically the responsibility of the producer, while steps 2 a) and b) are often also provided by the producer depending on the evaluation system being used. Performance measures and genetic information for every animal are not necessarily always needed by an evaluation system to make genetic predictions. Producers determine their breeding goals and collect relevant data, supported by available tools and service providers. Steps 3 through 5 are generally managed by the broader evaluation infrastructure, such as breed associations, genomic service companies, or national evaluation programs, which provide producers with Expected Progeny Difference (EPD) via a genetic evaluation or genomically-enhanced EPD (GE-EPD) via a genomic evaluation. Producers then use these insights (steps 6 and 7) to guide selection and breeding decisions that align with their breeding objective. These general steps are used in most genetic or genomic evaluation systems in the cattle industries within Canada and in the systems visited in my Nuffield study.

The application of genetic technology varies depending on the production system and breeding objective. For instance, a herd using terminal sire breeds (focused on meat yield and growth) will prioritize different traits than one using maternal breeds, which may focus on fertility, calving ease, or longevity (Simm, 1998). This is where the use of available selection indexes becomes helpful to rank animals based on multiple traits of different economic importance simultaneously.

As an example, a seedstock producer whose breeding goals are to produce potential sires and heifers to sell for breeding stock, may find it beneficial to provide pedigree, phenotypes and genotypic information to a genetic or genomic evaluation system, which would then predict the breeding values (EPDs or GE-EPDs) for each animal to help that producer make culling, breeding and sale decisions. Another example: A commercial producer may find value in collecting a DNA sample on their animals to provide genotypic data, which can be used in an evaluation system to predict the same insights utilizing the information already available in the system (genotypic and phenotypic information) from other producers.

2.2.2 The use of selection indexes

Genetic or genomic selection based on a selection index can be used to select for genetic improvement of multiple heritable traits simultaneously, while accounting for potential antagonistic trait correlations, and aligning with a specific breeding objective (e.g., maternal or terminal index). Selection indexes are a tool in which an animal is ranked based on the genetic merit (EPDs) of multiple traits (depending on the main goal of the index) which are weighted by an economic value. Apart from using a selection index, single trait selection could be applied but is not recommended, to avoid excessive selection for an individual trait or the unintended genetic progress of unfavourable correlated traits. For example, growth efficiency traits and reproductive traits have an unfavourable genetic correlation, so as producers improve growth traits there may be an unintended consequence of reproducing reproduction rates and fertility.

With the available evaluation systems and accompanying selection indexes offered by most breed associations, producers are provided with a monthly genetic evaluation report for individual animals in their herd. For example, a Canadian cow-calf producer whom I visited during my Nuffield study, uses services from the Canadian Angus Association by getting a weaning report on their calves. This report includes Average Daily Gain (ADG) index value and ADG rank within the contemporary group (defined as a group of animals that are born within a specific period and managed the same) (Canadian Angus: Performance Reports and Worksheets, n.d.). This report aids the producer in deciding which calves to use as a replacement in the breeding herd or to be sold.

A good example of a genetic evaluation system is one run by Angus Genetics Inc. (AGI; a subsidiary of the American Angus Association) which I visited in Saint Joseph, Missouri, USA, during my Nuffield study. AGI offers the World Angus Evaluation (launched in 2023), which was developed as a result of collaborative efforts between the American Angus Association, Angus Australia, and the Canadian Angus Association. The World Angus Evaluation allows for data to be leveraged by sharing data from Canada, United States, and Australia, between the associations (pedigrees, phenotypes, and genotypes) (Retallick, 2023). These large-scale systems are highly beneficial for producers who have pedigree information and/or genotype their animals due to the larger reference population, which also offers the ability to predict an animal's EPD or GE-EPD more accurately. This is especially useful when a producer can only provide some of the information (pedigree, genotype, etc.) since the system can make predictions based on related animals which do have the information available. This report offers EPD values for the producers' individual animals for multiple traits of interest in the following categories: production, management, maternal and carcass traits. Additionally, it offers economic selection index values, including the Maternal Weaned Calf Value index, the Beef Value index, etc.

2.2.3 The use of genetic and genomic evaluation systems

A wide variety of organization types offer genetic and genomic evaluations for livestock, many of which I learned about and visited through my Nuffield study. These include:

- **Breed associations**, such as the Canadian Angus Association, Canadian Hereford Association, and Canadian Shorthorn Association
- **Genetic companies**, including Semex, ABS Global, and STgenetics
- **Genotyping and biotechnology companies**, such as Neogen and Zoetis
- **Research institutes, both government-affiliated and independent**, such as the Agricultural Business Research Institute (ABRI), VistaMilk Research Centre (Ireland), and Scotland's Rural College (SRUC)
- **Producer-owned cooperatives**, like AgSights, Lactanet, and Beef + Lamb New Zealand Ltd
- **Universities**, for example, the University of Guelph's Centre for Genetic Improvement of Livestock, which provides genetic evaluations for Ontario sheep

While there is no shortage of providers and resources to support producers in applying genetic evaluations, the diversity of offerings, often with overlapping services, partnerships, or different evaluation indexes, can be overwhelming to navigate.

In the beef sector specifically, breeding systems have become increasingly corporatized with the rise of genomic technologies (Miller, 2023). The success and infrastructure developed in the dairy sector has enabled the beef industry to adopt similar breeding service models and technologies (Miller, 2023). For smaller beef herds, a genetic evaluation system like one offered by AgSights can be particularly useful, offering evaluations based on pedigree and performance data (AgSights: Beef Cattle Genetic Evaluation, n.d.). Similarly, genotyping service providers like Neogen offer breed-specific trait insights to support selection decisions (Neogen Beef Genomics, n.d.). Breed associations often collaborate with external partners, such as the Canadian Angus Association with Angus Genetics Inc. or the Canadian Shorthorn Association with International

Genetics Solutions (IGS), to deliver genetic evaluations tailored to specific breed goals, as well as offer widely used selection indexes already in place.

3.0 Current challenges in the beef industry

Based on my experience in beef genetics research and my Nuffield study travels, I report here numerous challenges that limit the effective adoption and optimization of genetic and genomic technologies which apply to the Canadian beef industry. These include, but are not limited to:

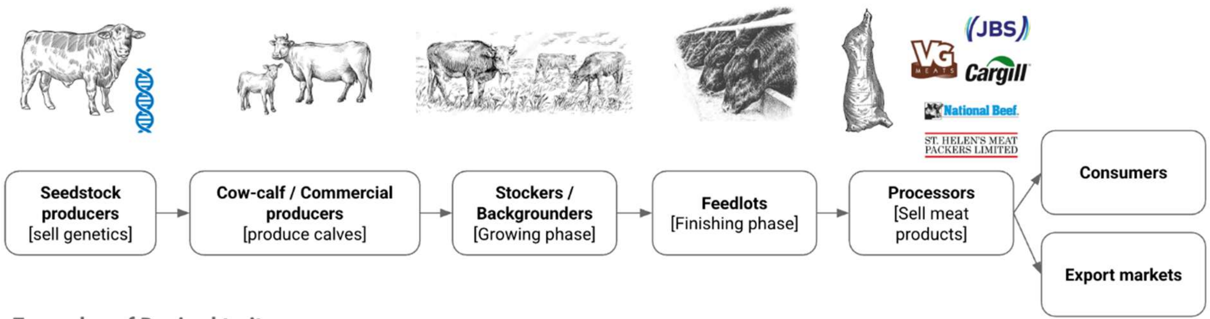
- **A fragmented or siloed production system.** Where sectors of the value chain (e.g., cow–calf producers, feeders, processors) may operate independently, compete with one another, or have differing business objectives. As a result, each sector may prioritize different traits for genetic improvement. The fragmented production system can be observed in **Figure 1**.
- **Breed-specific focus and varying objectives**. Purebred producers are often affiliated with specific Canadian breed associations, each with its own breeding goals, priorities for breed improvement, and mandates. This can lead to inconsistent or conflicting selection priorities across breeds, or between the purebred seedstock and commercial sectors.
- **The presence of multiple breeds and crossbreds.** This impacts the accuracy of genomic predictions, as high accuracy requires large reference populations with both phenotypic and genotypic data (Berry et al., 2016).
- **Limited international genetic connectedness.** There is a lack of global coordination and connectedness in genetic improvement efforts for beef, which requires strong genetic connectedness among countries (Berry et al., 2016).
- **Low levels of phenotyping/collecting animal records.** Many economically important traits, such as feed efficiency, are difficult, time-consuming, and expensive to measure. This discourages widespread on-farm phenotyping due to the high cost of equipment, labour, and training (Berry et al., 2016).
- **Lack of use of reproductive and genetic technologies**. Tools such as genotyping, artificial insemination (AI), embryo transfer, and estrus synchronization are not widely adopted in the beef sector as they are in other livestock sectors (Berry et al., 2016)
- **Variability in extension frameworks that offer resources and guidance for breeding strategies and tools**. Variable government extension models, which differ between provinces, have resulted in a lack of a cohesive and integrated national extension effort, leading to a gap that has increasingly been filled by companies, universities, and industry organizations.
- **Sometimes slim profit margins**, which prevent producers from investing in high-cost and high-risk technology or equipment, even if they offer long-term benefits (Berry et al., 2016).
- **Misalignment of trait priorities**: Traits valued by industry and government, such as feed efficiency and methane emissions, do not always align with the practical needs or preferences of producers. Furthermore, current genetic evaluation systems typically do not include these traits, limiting incentives for producers to select for them.

Additional barriers to the adoption of breeding strategies and tools were observed during my Nuffield study through interviews with beef producers in Canada, New Zealand, the United States, and Ireland. These are summarized in **Table 1**, which categorizes the challenges at the individual producer, farm, and system levels. **Figure 1** provides a summary of the beef system from birth to product and examples of desirable traits at each segment, which highlights challenges such as the silo-ed production system.

Table 1. A summary of additional challenges to adopting genetic technology in the beef industry at different levels

Level	Challenges
Individual	● Producers are hesitant to compare performance across farms ● Concerns that genetics will negatively impact cattle pricing ● Past negative experiences with genetic evaluation systems ● New producers lack a framework or support for implementation
Farm	● High-cost measures needed for "gold standard" traits ● Low profit margins limit technology adoption ● Upfront investment in equipment with delayed returns ● Common use of natural service makes AI difficult ● Breeding objectives are often focused only on the next market endpoint ● Larger farms require more labour to implement programs
System	● Fragmented beef system with differing breeding goals across sectors ● Lack of knowledge translation and transfer framework ● Political friction between breed associations ● Misaligned incentives between producers and processors ● Absence of a coordinated national research–government–industry framework for genetic evaluations

3.1 A fragmented system across the value chain



Examples of Desired traits

Scrotal circumference, sperm motility, sperm count, conformation, birth weight, weaning weight	Maternal traits, calving ease, weaning weight, fertility traits, milk traits, longevity, feed efficiency	Yearling weight, health traits, growth rate, feed efficiency	Lean meat yield, back fat, carcass weight, feed efficiency	Lean meat yield, back fat, tenderness, marbling, colour, rib eye area, carcass weight, carcass cutability	Consistency, flavour, tenderness, colour, marbling

Figure 1. A summary of the beef system from birth to product and examples of desirable traits at each segment.

3.2 The advancement of genetics in dairy

For context, genetic evaluation systems for livestock in Canada were first established in the 1990s in Canada (Miller, 2023). However, over time, the adoption and success of these systems diverged across sectors. Interestingly, while livestock sectors started with similar national genetic evaluation frameworks, differences in sectoral structure, priorities, and practices have led to the varied levels of genetic use we observe today. As an example, to understand the potential of genetic advancements in livestock, a useful comparison is one between the dairy and beef industries. Briefly, the dairy industry has made historical strides in improving milk yield and milk components using genetics. In the 1990s, the use of recorded pedigree information (genetics) and recorded traits of interest (phenotypes) of individual animals, including milk yield (litres), were collected to produce breeding values [known as Estimated Breeding Values (EBVs) in dairy and as EPDs in beef] for dairy producers to determine the genetic merit of each animal and therefore make management and breeding decisions to optimize milk production. In 2009, molecular tools allowed for genotyping (genomics) to be correlated with phenotype data, which increased the accuracy of genetic predictions and reduced the generation interval. This allowed for accelerated genetic gain in desirable milk traits, meaning we could genotype calves after birth and determine their genetic merit immediately, instead of waiting to learn about their daughters' milking potential. This data collection and genomic evaluation system is currently run by Lactanet Canada. Over the years, Lactanet continued to provide a genomic evaluation for Canadian dairy producers for multiple traits (feed efficiency, milk yield, milk protein and fat, health traits, conformation traits, fertility traits, and more recently, in collaboration with Semex, methane emissions in 2023 (Lactanet, 2023)). In addition to multiple trait predictions, different selection indexes (Pro$, Lifetime Performance Index, etc.) are available, allowing producers to rank and compare animals based on specific traits and associated economic weights that meet their breeding objectives.

Due to the challenges described in **Section 3.0**, which the dairy industry was able to implement with relatively less friction (i.e.. due to their use of AI, genotyping, low-cost trait measurements, established framework, etc.), the beef industry has not been able to make the same strides in genetic advancements, however a system was developed over time, which is described further in the following section.

3.3 How genetic advancements optimized beef-on-dairy

Another relatively new example of how genetic advancements have benefited the dairy sector is the use of AI and sexed semen to optimize 'beef-on-dairy' production to optimize the value of male calves that were traditionally classified as a by-product and diversified cash-flow source for a dairy operation. This model is illustrated in **Figure 2**; it produces male and female dairy calves, with the females having the potential to serve as replacement heifers within the herd or be sold to other dairy farms as their replacement heifers. Any male calves were considered lower-value and were often sold as veal. This process has been happening for decades but has gained attention due to the optimization of genetics.

The recent advancement that has progressed the beef-on-dairy value chain is the use and optimization of sexed beef semen, which has added value to these calves for finishing as beef and not just as veal. Purposefully bred beef-on-dairy calves are suggested to have better marbling, average daily gain, yield grade, quality grade, carcass cutability, and health as stated by Dr. Kee Jim (Jeffers-Bezan, 2024) than the non-genetically optimized beef-on-dairy calves. Other benefits include that they are born year-round, keeping feedlots full, and sometimes known to take up 23% occupancy of the feedlot in the United States (Dairy Herd Management, 2024) and 17 to 22% occupancy in Canada (Jeffers-Bezan, 2024), offering a stable source of animals, that fill gaps for feedlots. With high demand in the cattle cycle, beef on dairy is needed for ground beef demand as well.

The optimization of genetics in the beef-on-dairy model within the dairy industry is a strong example of how genetic technologies, such as sexed semen, AI, and genomic selection, can be successfully applied to enhance a longstanding production system. While beef-on-dairy crossbreeding has been historically practiced in the Canadian dairy sector, recent advances in genetics have significantly improved its efficiency and outcomes. This demonstrates the potential for applying genetic and genomic tools to optimize other segments of the beef industry.

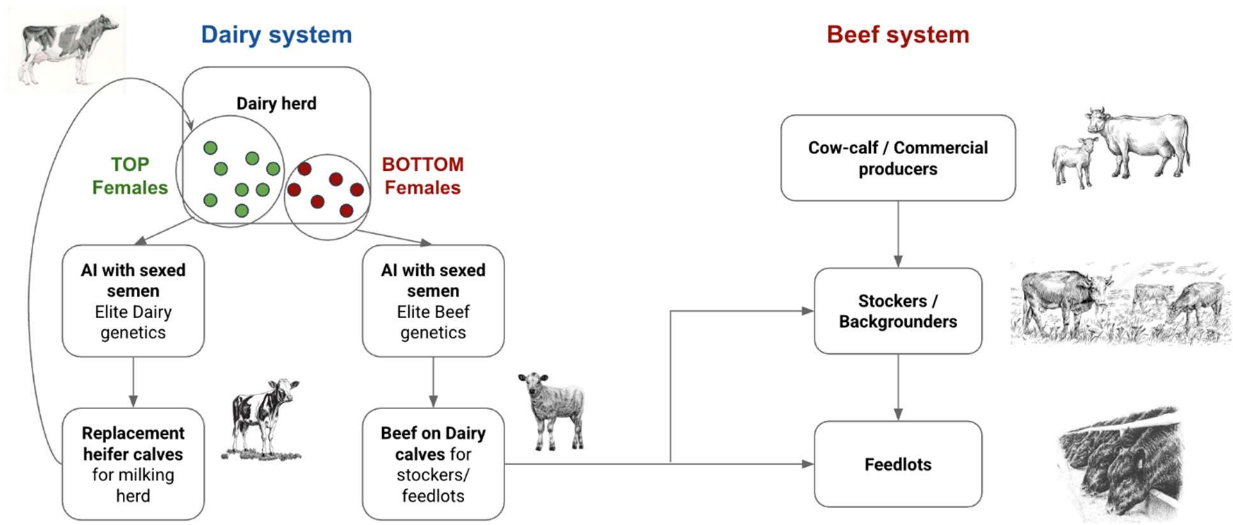


Figure 2. A summary of the production and flow of beef on dairy calves into the beef system.
Top Females = Highest genetic merit females
Bottom Females = Lowest genetic merit females
AI = artificial insemination
Sexed semen = semen sourced from genetically and phenotypically elite bulls which are sexed for majority male or female sperm

3.4 Beef-on-dairy, an opportunity for the beef industry

Despite hearing concerns raised within the beef community, many participants interviewed in my Nuffield study viewed beef-on-dairy as an opportunity for the beef industry rather than a threat. Proponents highlighted several benefits:

- **Conventional beef calves are not being replaced.** While beef-on-dairy calves have traditionally been treated as a by-product of the dairy system in Canada, recent improvements in their performance mean these animals are now of higher quality. Importantly, they are not replacing conventional beef calves in the supply chain. In other words, the supply remains the same, but the quality has improved.
- **Enhanced accuracy of breeding values for beef sires.** Incorporating beef-on-dairy animals into genetic evaluation systems can actually enhance the accuracy of breeding values for beef sires. Although there may be limited value in genotyping terminal beef-on-dairy calves themselves, the data they contribute can strengthen broader genetic evaluations.
- **Increased value in purebred beef sires for bull semen.** Since purebred beef sires are used to generate beef-on-dairy calves, this presents a valuable marketing opportunity for beef seedstock producers to promote and sell high-performing bull semen specifically suited for the dairy industry.

Table 2. Summary of points on considerations for the beef-on-dairy model

Why beef-on-dairy is not a major concern	Considerations as a competitor
● Helps keep feedlots full with a consistent supply of calves ● Dairy branding as meat producers may be confusing or counterproductive from a marketing standpoint ● The number of dairy cows in Canada is limited, beef-on-dairy supply is capped by quota ● Less heifer replacements for dairy farms that source replacements from other farms ● Potential increased costs to processors due to high incidence of liver abscesses and differing breed types ● Genetics derived from elite beef bulls, providing an additional market for high quality seedstock	● Supply and demand - reduced prices on yearling calves and fed cattle ● Beef-on-dairy calves show improved marbling compared to pure dairy calves ● Beef-on-dairy calves are more uniform and consistent in the feedlot and can be purchased in larger consistent groups ● Continued optimized genetics in crosses with dairy ● Dairy replacements will continue to have optimized genetics from elite dairy heifers

One of the major concerns heard early on in my Nuffield study was the possibility that beef-on-dairy animals may perform better than beef-on-beef animals. Regarding performance comparison of beef-on-dairy with beef-on-beef animals, despite many research studies existing that evaluate beef-on-dairy performance, few have actually compared them with beef-on-beef animals. Based on a statistical analysis of cross sectional data from cattle of different breeds and crossbreeds, beef-on-dairy animals were inferior in terms of carcass metrics such as carcass weight and conformation score, when compared to beef-on-beef animals (Twomey, 2020). More research is being done on comparing the beef-on-dairy and beef-on-beef animals in relation to genetics (Berry, 2021), health, and early life nutrition (Whelan, 2025). Regarding potential health and carcass quality, there is potential that beef-on-dairy calves may have more difficulty adjusting to high energy diets compared to beef-on-beef animals, as liver abscesses have been observed in more than 50% of beef-on-dairy carcasses at the processing stage, which is costing packers more time and labour to remove the liver and other effected cuts and time for additional inspection steps; from this, the production line slows, costing packers money (Leach, 2024). Despite this, with the available genetics framework in place for dairies, targeted nutritional and genetic practices could be applied to improve the health and carcass cut quality of beef-on-dairy animals. Considering all factors, since the actual supply of beef-on-dairy calves entering the beef supply chain remains consistent, the concern for high carcass quality from these animals is not a major concern for beef producers. Nonetheless, this example illustrates how the dairy industry, despite facing challenges related to cut quality and animal health, can make targeted adjustments within its established genetic framework to enhance the performance of beef-on-dairy calves. Implementing similar changes within the beef industry would present a much greater challenge.

Genetics continues to advance, with the dairy industry in Canada using well-established systems and collaborating with industry and research partners to optimize the beef-on-dairy cross. More recently, in Canada, Lactanet partnered with AGI to develop tools to optimize beef-on-dairy genetics, by leveraging genotype data from Angus bulls from Canada, the United States, and Australia (Slater, 2024). This makes the beef-on-dairy model appealing for Angus breeders in the beef industry, since Angus sires used for breeding would be potential sires for use in the beef-on-dairy model. This is the beginning of an opportunity for the beef industry to view this model as an opportunity to profit from beef sires that are optimal for the beef-on-dairy cross, as well as an opportunity to improve beef genetics for another breeding goal (beef-on-dairy) for profit. In countries such as Ireland and New Zealand which I visited during my Nuffield study, beef-on-dairy animals often represent the primary source of beef production. Their pasture-based systems are optimized for grass-fed animals rather than high-energy feedlot diets, yet both countries continue to thrive, producing high-quality beef largely from beef-on-dairy cattle.

3.5 How the dairy industry has been able to optimize beef-on-dairy using genetic technology

Given the Canadian dairy industry's globally recognized success in developing an effective genetic and genomic evaluation framework, I interviewed Lactanet to gain insight into how this success was achieved. Multiple factors have allowed the Canadian dairy industry to excel in the adoption and application of genetic technology. This includes:

1) The routine recording of milk traits and collection of milk samples by Lactanet.
2) The adamant collection of samples for genotyping by producers, and the established practice of it in industry.
3) The widespread use of artificial insemination using genetically elite semen from bulls sourced from AI companies.
4) The abundant resources, consultants, and knowledge transfer surrounding the genetic information obtained for the successful application of the value-added information.
5) The digitization of records and data management, alongside sensor technology.
6) The use of embryo transfer. Dairy cattle are also easier to collect samples from and AI due to their docile nature and operational facilities.

While the Canadian dairy industry continues to lead the way in adopting and applying genetic technologies, the Canadian beef industry could draw on these practices as examples to guide future innovation and more fully harness the potential of genetic tools for herd improvement.

4.0 Opportunities for genetic technology in the beef industry

4.1 The benefits of using breeding and genetic tools

Multiple benefits come alongside selective breeding and using genetic tools effectively. This includes:

- **Helping producers achieve cumulative gains over time**. Genetic change is cumulative over time - this is because traits are heritable, and the next generation picks up from where the last generation ended (whereas using strategies like feed additives or management could be only immediate benefits with continued use).
- **Gains can be permanent**. When phenotypic gains occur from genetic selection, the progress is permanent since the genetics are inherited (passed down to the next generation), whereas environmental improvements can disappear when conditions change (e.g., nutritional gains could stop when the practice stops).
- **Genetic selection is proven to deliver (across species).** Genetic progress is demonstrated in other livestock industries including the dairy industry through aggressive selection for milk yield.
- **Genetics can be stacked with farm management.** Genetics should not be the only solution but should be stacked with other tools such as management and nutritional practices. Depending on the production system needs and goals, sometimes genetics (a longer-term solution in beef) is not as effective as nutritional intervention or management (potential immediate effects).
- **No direct additional costs to producers**. If a producer is already adopting breeding strategies, there are no additional costs related to genetic tools and systems.
- **Improving many traits concurrently.** Through the use of selection indexes, traits can be improved simultaneously, accounting for trait correlations, and weighted based on economic importance.

One of the main overarching goals of using genetic technology is to enhance profitability through making better management decisions with the information from genetic evaluations (help make better culling, sale, buying and retaining decisions) and therefore optimize profit, efficiency, and sustainability. Benefits also come alongside genotyping specifically, including parentage analysis, genetic condition results (specific to a breed), and breed specific tests (e.g., crossbred Wagyu test). Additionally, better record keeping with apps and digitized records are often an additional benefit, keeping on-farm records accurate, accessible, safely stored, and easily shared.

One of the main benefits of working with a genetic and genomic evaluation system is that it is always advancing in phenotypes, genotypes, and research. Genetic and genomic evaluation systems which are integrated with a research, industry, or company framework that seeks to continue adding new traits, collecting phenotypes, and genotyping animals, leads to significant benefits for producers (Spangler and Berry, 2024). One example is the ability to predict novel traits, such as ‘functional longevity’. With such a large collaborative effort and database available, the AGI Inc. coalition can support the testing of new traits of interest. For example, the recent launch of “functional longevity” trait in May 2025, which predicts on average, the number of calves a sire’s daughter is expected to produce by 6 years of age compared with other sires’ daughters in the population (American Angus Association, 2023). The main breeding goal for many cow-calf producers is to select sires that will produce daughters that remain in the herd and produce a calf every year, thus, cow-herd traits like functional longevity are of great value to the sector (American Angus Association, 2023). As of June 2025, AGI recently released three new maternal EPDs to help predict longevity and udder quality in Angus cattle. Depending on the provider's framework, producers are able to voice traits of interest and through collecting phenotypes, genotypes and testing models, novel traits can be incorporated into current systems. Likewise, selection indexes can be updated and developed. As exemplified above by the World Angus Evaluation, the collaboration of organizations can lead to substantial benefits and advances in genetic tools. Combining resources and expertise across the world and associations which share research interests,allows the beef industry to move forward with better tools. Another example of collaboration is one in the Canadian dairy industry in which we see a well-established research-industry network between the University of Guelph, Lactanet, and Semex, where research is conducted to support the goals of both Lactanet and Semex. Another example I observed was when I visited Ireland and witnessed the collaborative working relationship between Teagasc, VistaMilk, and ICBF, which served as a strong government-research framework for genetic solutions for both dairy and beef cattle.

4.2 How much does genetics really contribute?

When considering how much of a specific trait is actually going to be passed on to the offspring, we are considering the measure of ‘heritability’, which is the proportion of that trait which will be passed on/inherited. Each trait has a different heritability and is often classified as low, medium, or high heritability, as seen in **Table 3.** This is important to consider when ‘stacking’ genetics, management, and nutritional strategies and determining the best approaches to improve a trait.

In **Table 3**, the BCRC summarizes traits by heritability, range (based on past research studies), and suggestions to improve that trait by genetics, management or a combination of both (BCRC Heritability Table, 2024). We observe that the most desirable traits across the sector are mostly medium to high heritability, indicating that using breeding strategies can improve such traits. Therefore, genetic selection is an effective tool to do so, with the potential of adding nutritional and management tools optimized to particular genetics. It is important to note that lowly heritable traits still have potential to use genetics as part of an improvement strategy.

It is important to consider the heritability of traits of interest to determine if genetics is the right tool to enhance this trait in a herd. For a producer, it is not necessary to know fine details of exact heritabilities, but more important to seek information about available selection indexes from genetic and genomic evaluation providers (e.g., from the breed association, genetics company, etc.) to determine the most suitable index that aligns with their breeding objectives. It is best to avoid single trait selection, which is not ideal, as selection pressure on a single trait can result in fast genetic gain, but does not consider potential undesirable trait correlations (e.g., fertility traits are negatively associated with feed efficiency traits). Selection indexes are designed to account for these countering relationships and allow for multi-trait selection.

Table 3. Summary of desirable traits and their heritability range based on past research studies (BCRC Heritability Table, 2024)

HERITABILITY IN BEEF CATTLE

BCRC BEEF CATTLE RESEARCH COUNCIL

Traits for Herd Selection Decisions	Cow, Calf, Fertility or Bull Trait	Range of Heritability	Improved by Genetics or Management?
Highly Heritable Traits			
Carcass quality	Calf	0.4 – 0.7	Genetics & Management
Carcass Weight	Calf	0.43	Genetics
% Retail Cuts, Yield Grade	Calf	0.5	Genetics
Marbling	Calf	0.12 – 0.88	Genetics
Tenderness	Calf	0.27 – 0.47	Genetics
Final feedlot weight	Calf	0.6	Genetics
Dry Matter Intake (DMI)	Calf	0.53 – 0.84	Genetics
Mature Weight	Cow and Calf	0.53 – 0.79	Genetics
Moderately Heritable Traits			
Calving ease	Fertility	0.03 – 0.2	Genetics
Temperament (Docility)	All	0.11 – 0.46	Genetics & Management (breed variable)
Mothering ability	Fertility	0.19 - 0.39	Genetics
Foot conformation	All	0.16 - 0.37	Genetics
Udder conformation (teat size and suspension)	Cow	0.2 - 0.5	Genetics
Milking ability	Cow	0.15 – 0.4	Genetics
Weaning weight	Calf	0.24 – 0.3	Genetics & Management
Feedlot gain	Calf	0.34	Genetics & Management
Pasture gain	Calf	0.3	Genetics & Management
Feed efficiency	Calf	0.28 - 0.4	Genetics & Management
Semen quality	Bull	Moderate	Genetics & Management
Insemination success	Bull	Moderate	Genetics & Management
Yearling weight	Calf	0.18 – 0.33	Genetics & Management
Low Heritability Traits			
Calving interval	Fertility	Low to moderate	Some genetics, mostly management
Heifer Pregnancy (age at first calving)	Fertility	Low to moderate	Some genetics, mostly management
Stayability/longevity	Fertility	0.05 – 0.14	Some genetics, mostly management
Bull fertility	Fertility	Low to moderate	Genetics
Non-heritable Traits			
Foot issues (rot, sand crack, heel wart)	All		Management
Poor performance	All		Management
Health	All		Management
Difficulty rebreeding	Cow		Management

4.3 Current traits in evaluation systems

Major traits of interest to cow-calf producers include fertility traits, and for feedlot producers include feed efficiency and feedlot gain. Other traits of societal importance include methane emissions. Interestingly, current evaluation system providers in North America do not include the gold standard measure of feed efficiency [residual feed intake (RFI); kg/day] in their predictions. As described in challenges for the beef industry, these desirable traits are often costly and difficult to measure. This poses challenges to incorporate some novel traits such as feed efficiency, methane emissions, new fertility traits, and regional-specific traits.

4.4 Breeding and reproductive management tools

Beyond genetic evaluations, a range of breeding and reproductive management tools are available to support genetic improvement in the beef industry. Common practices include genotyping, embryo transfer, and estrous synchronization, each offering distinct benefits as illustrated in **Figure 3**. When these tools are strategically combined, producers can achieve greater optimization of profitability, time, and labour efficiency across their operations.

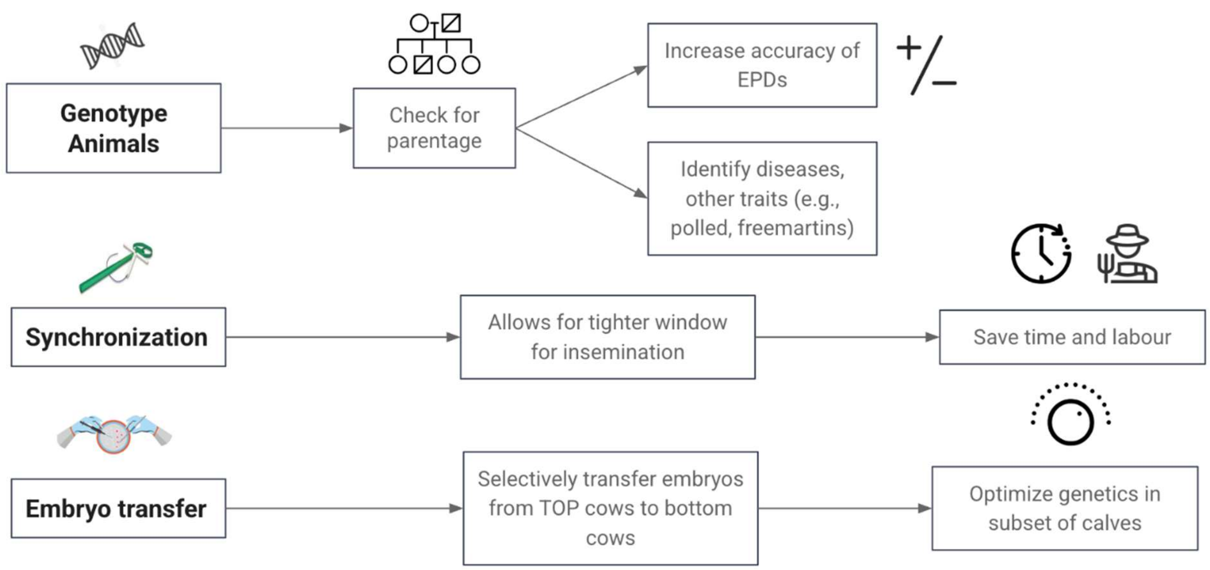


Figure 3. Examples of additional breeding and reproductive management tools used to optimize profitability, time, performance, and labour efficiency in beef production.

4.5 The use of Sexed Semen

The use of sexed semen is a relatively recent reproductive technology, as discussed in the beef-on-dairy example in **Section 3.3**. It requires AI and enables precision breeding, allowing producers to pair cows with elite bull semen based on specific breeds, traits, and the desired sex of the calf. This approach allows for the targeted production of heifer or bull calves suited to different market end-points. **Figure 4** illustrates possible scenarios where sexed semen supports precision breeding with customized goals, aligned with appropriate selection indexes, to help optimize genetic value and economic return.

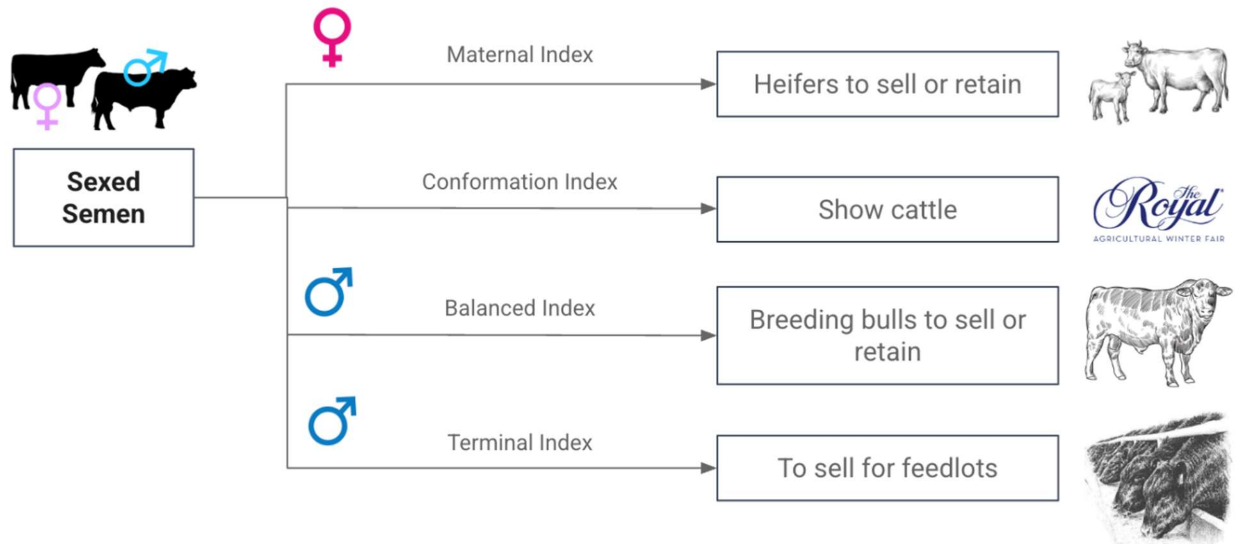
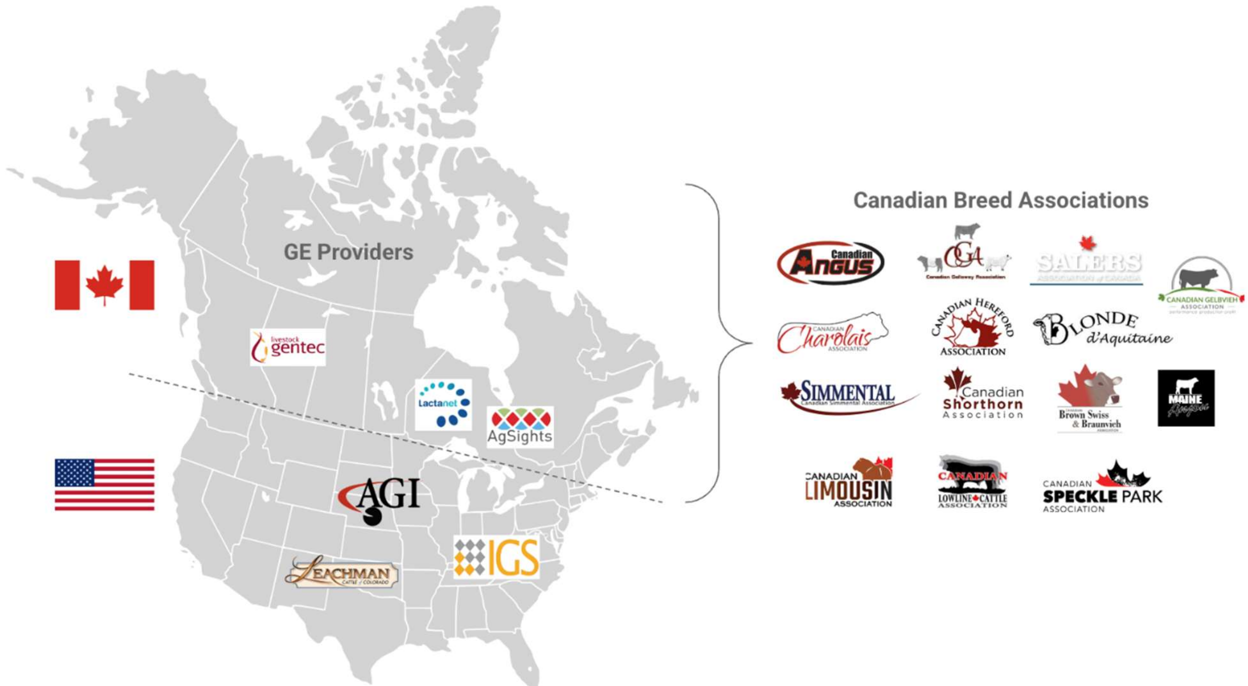


Figure 4. Examples of strategic applications of sexed semen for different breeding goals

5.0 Genetic and genomic evaluation systems

5.1 Current evaluation systems in Canada

Multiple genetic and genomic evaluation systems are used by Canadian breed associations, many of which subcontract their evaluations to specialized companies or organizations. These service providers include both Canadian and U.S.-based entities. **Figure 5** outlines the current evaluation providers for each breed association as of 2025, with the majority partnering with either Angus Genetics Inc. (AGI) (a subsidiary of the American Angus Association) or International Genetic Solutions (IGS) (**see Figure 5 ii**)).



i) Upper image. Current major evaluation providers (left map), and all Canadian breed associations under the Canadian Beef Breeds Council (CBBC) (Members and Associate Members, n.d.) (right logos).

ii) Lower image. Arrows indicate which evaluation provider is being used by which breed association. '?' indicates the provider is unknown.

Figure 5. i) and ii) Current genetic & genomic evaluation providers for Canadian breed associations.

List of example GE providers: Livestock Gentec, Lactanet, AgSights, Angus Genetics Inc, American Hereford Association, Leachman Cattle, International Genetic Solutions

List of Canadian beef breed associations (Members and Associate Members, n.d.)**:** Canadian Angus Association, Canadian Charolais Association, Canadian Brown Swiss and Braunvieh Association, Canadian Blonde d'Aquitaine Association, Canadian Hereford Association, Canadian Simmental Association, Canadian Limousin Association, Canadian Shorthorn Association, Canadian Gelbvieh Association, Canadian Speckle Park Association, Salers Association of Canada, Canadian Lowline Cattle Association, Canadian Galloway Association, Canadian Main Anjou Association

5.2 How does this work for a Canadian beef breed association?

The flow of data and the roles of various stakeholders are essential to understanding how genetic and genomic evaluations are generated within a typical beef breed association. **Figure 6** illustrates this process using the Canadian Simmental Association as an example, though the steps are broadly applicable to most breed associations.

It's important to note that all evaluations are only as strong as the data behind them. The accuracy of predictions improves with better-quality phenotypic records and pedigree information (Spangler and Berry, 2024). Including genomic data can further enhance prediction accuracy, but it does not replace the need for phenotypic data collection (Spangler and Berry, 2024).

In the example shown in **Figure 6**, producers submit both phenotypic records and a DNA sample (e.g., a hair sample) following instructions from their breed association. These submissions may be made online, by phone, or through the mail. Genotyping is typically conducted by a service provider like Neogen, and both phenotypic and genotypic data are then sent to the evaluation provider, in this case, IGS. IGS geneticists incorporate the data into their models and generate across-breed EPDs and GE-EPDs, which are returned to the breed association.

This evaluation service costs Canadian breed associations approximately $30,000 CAD per year (as of 2023). However, insights from my Nuffield study, including conversations with members from Canadian beef breed associations, suggest that while associations pay for these advanced evaluations through registration fees, uptake by producers remains low, representing a missed opportunity for Canadian beef producers to harness the full value of genetic tools.

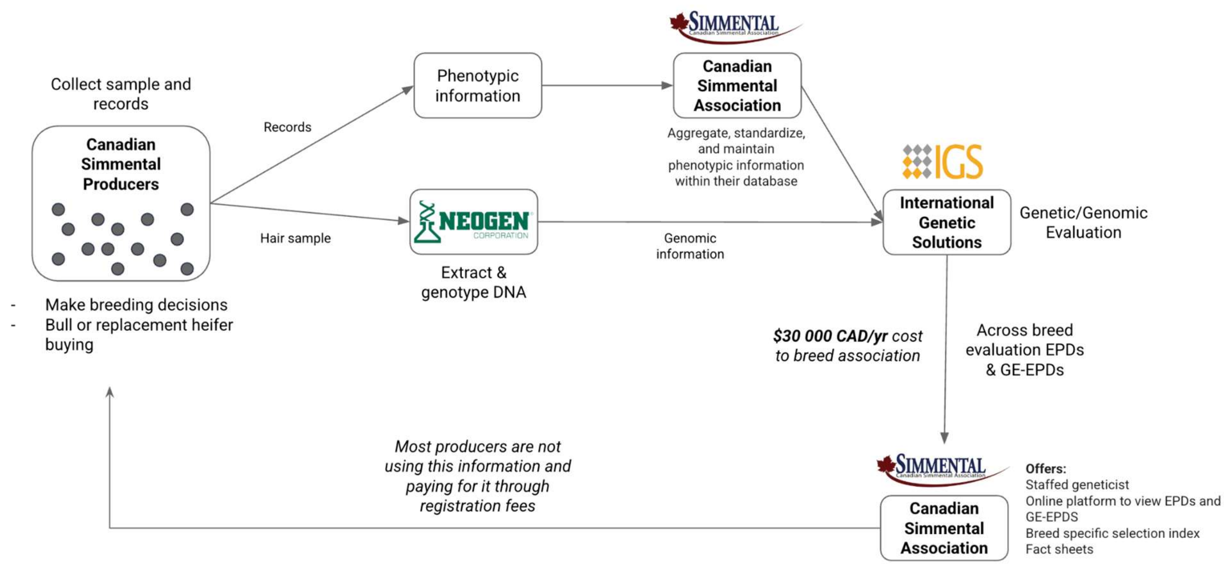


Figure 6. The current flow of information (phenotypic and genotypic) and its processing for value-added information to producers.

5.3 A comparison of the two major providers for breed associations

The two major providers for beef genetic evaluation services in North America are AGI and IGS. Both providers offer extremely valuable services and resources for producers in multiple ways, including providing multi-country and multi-breed genetic evaluations using data (pedigree, phenotypes, and genotypes) from combined reference populations among their clients, as well as offering predictions on multiple traits and selection indexes. A comparison of available traits in the genomic evaluation, selection indexes, frequency of results, and total animals in the reference population is shared in **Table 4**.

Table 4. A comparison between the two main genomic evaluation providers for Canadian beef breed associations.

Major genomic evaluation providers	Type	Trait EPDs* evaluated	Selection indexes available	Frequency of predictions per year	Reference population size
AGI (Angus Genetics Inc)	Independent breed evaluations	CED, BW, WW, YW, RADG, DMI, YH, SC, Doc, Claw, Angle, HP, CEM, Milk, MW, MH, CW, REA, FT, Marb **Added as of 2025**: FL, Teat, UDDR	1 (Canadian Profit Index)	Monthly (Canadian Angus Assoc.) 9x/year (Canadian Charolais Assoc.)	1.83 million Multi-country evaluation: CA, US, AU

IGS (International Genetic Solutions)	Across breed evaluations	CE, BW, WW, YW, Milk, MCE, Stayability, Docility, CW, REA, Fat and Marb	3	Weekly (multiple breeds)	22 million Multi-country evaluation

* Trait abbreviations described in Glossary

Both AGI and IGS are highly effective providers of genomic evaluations used by Canadian beef breed associations. Their services offer robust genetic evaluations built on extensive reference populations, advanced tools, and strong technical frameworks.

AGI: Supporting Larger Canadian Breed Associations
The Canadian Angus Association (CAA), the largest beef breed association in Canada, partners with AGI. This collaboration is both strategic and practical, enabling CAA to leverage the extensive reference population, phenotypic and genotypic databases, and research infrastructure developed by the American Angus Association.

CAA sends data to AGI monthly, which supports monthly evaluation updates. Through this partnership, CAA also benefits from a Canadian-specific selection index [the Canadian Profit Index (CPI)] tailored to domestic production goals. The Canadian Charolais Association also works with AGI to deliver their breed's evaluations, highlighting AGI's expanding role in Canadian beef genomics.

IGS: A Collaborative Option for Smaller Breed Associations
Smaller Canadian breed associations typically partner with IGS, which operates as an across-breed evaluation system. This collaboration allows multiple smaller associations to pool their resources, grow their reference populations, and reduce costs, making genomic evaluations more accessible and sustainable.

However, some IGS features may not fully align with Canadian production needs. For example, the Fescue Tolerance ($F) index, while relevant in certain U.S. regions, holds limited value in Canadian environments.

Cultural and Structural Considerations
Insights from my Nuffield study highlighted key cultural and structural differences between the U.S. and Canadian beef sectors regarding the application of genetic tools. In the U.S., I observed a stronger culture of data collection, DNA testing, and phenotype recording, driven by a shared commitment to genetic improvement. Genetic marketing was also highly visible, which was reflected in advertisements, family breeding programs, and bull sale catalogues, making genetics a central part of seedstock marketing.

In contrast, Canadian producers noted that only a small subset of operations consistently apply genetic tools, which may reflect differences in market structure, communication, and incentives. Members of these organizations often voice their desired needs, including region- or climatespecific traits. As Canada is typically a smaller member, its influence in shaping decisions around genetic advancements is often limited. Additionally, the outsourcing of Canadian evaluations to U.S.-based providers, while beneficial, may influence perceptions of ownership and reduce the visibility of genetics innovation domestically. This also helps explain why some Canadian breeders purchase seedstock from the U.S., where the marketing of elite genetics is more established.

6.0 Sustainable solutions

A sustainable system

As outlined in **Section 1.6**, the CRSB defines sustainability as "a socially responsible, economically viable, and environmentally sound product that prioritizes the Planet, People, Animals, and Progress." A sustainable beef production system, therefore, must integrate social, economic, and environmental goals while balancing the impact on people, animals, and the planet, and driving continuous progress.

Building on the long-term goals established by the American Angus Association and insights gained through the Nuffield program, **Figure 7** proposes a framework that positions genetics as a key lever for sustainable progress in Canadian beef production.

Breed improvement, with the breeding goal to be more economically, socially, and environmentally sustainable, can be advanced by selecting for traits that contribute to environmental and economic sustainability (such as reduced emissions, improved feed efficiency, and higher carcass quality). These improvements can translate into greater profitability for producers. Over successive generations, the consistent application of genetic tools can help establish a culture of genetic improvement, leading to greater producer confidence, adoption, and long-term success. Such a framework would not only enhance production efficiency but also build trust across the supply chain. When sustainability-focused genetic advancements are embedded into marketing, storytelling, and value propositions, consumers will be more likely to connect with and support Canadian beef products. Over time, this alignment of genetics, sustainability, and consumer values can strengthen the competitiveness and reputation of Canadian beef on both domestic and international markets.

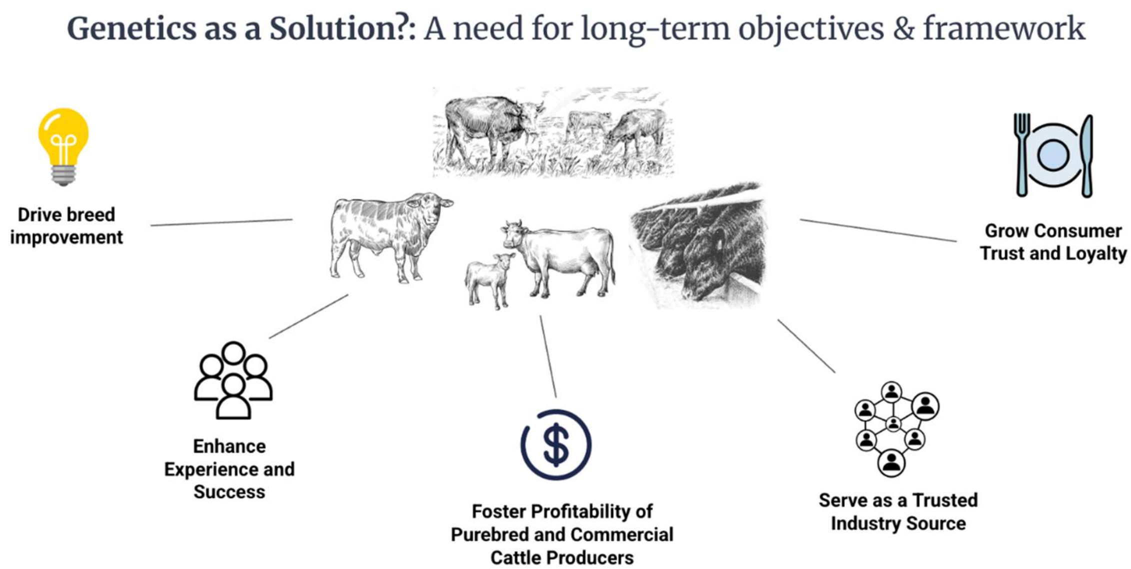


Figure 7. Five key long-term objectives that would be achieved from the successful adoption and optimization of genetic technology in the beef industry.

Insights from my Nuffield study have identified two foundational elements that could play critical roles in building a sustainable framework to support long-term objectives in the Canadian beef industry:

1) **A national genetic and genomic evaluation system**
    a) A national genotyping program
    b) A national beef carcass classification system
2) **A framework for knowledge translation and transfer**

Together, these components can serve as the backbone of a coordinated national effort. However, their success depends on a parallel framework for knowledge translation and transfer, one that ensures producers, industry stakeholders, and consumers can understand, access, and apply the value generated by these tools. By aligning technical infrastructure with effective communication and adoption strategies, Canada can create a system that supports both productivity and sustainability in beef production.

6.1 A national genetic and genomic evaluation system

Currently, Canada does not have a national genetic and genomic evaluation system including data from cattle across the country, and there is an opportunity to develop one. A national system would offer benefits to commercial producers in addition to the current evaluation systems in place which are mostly used at the seedstock level.

Ireland, which I visited during my Nuffield travels, demonstrates a successful example of a national evaluation system (a collaborative effort between ICBF, VistaMilk, and Teagasc), where a national evaluation system is in place for providing dairy and beef producers with genetic and genomic evaluations. Visiting VistaMilk and Teagasc during my Nuffield study made it clear that collaboration across research, industry, and government to drive forward genetic improvement in cattle as a whole country can be very effective and successful. Understandably, this is much easier with a smaller country like Ireland, where many stakeholders have worked together for a long time and communication and collaboration are known to be fundamental for success.

A national system in Canada could have access to Canadian beef cattle data (pedigrees, genotypes, and phenotypes) and provide services including: EBV and GE-EBV values for beef producers with a Canadian base and sub-selection indexes using Canadian economic weights and system (based on lean yield, rather than the 'grid' system by the United States). This could be a sustainable solution that would be offered *in addition to* and *not in replacement* of the current evaluation providers that breed associations work with. Multiple opportunities and limitations exist in implementing a National Evaluation System, including:

Opportunities that could arise from implementing a national evaluation system

- Establishment of a centralized national system to support coordinated genetic evaluation and decision-making across the industry.
- Improved genetic progress in both purebred and crossbred animals, benefiting the entire national herd.
- A stronger voice for Canadian breed associations to influence trait development relevant to their specific breeding goals.
- Ability to research and integrate Canada-specific traits that reflect regional environments, production systems, and market demands.
- Support for the emergence and growth of new or niche breed associations, such as Wagyu.
- International comparability through models like the Multiple Across Countries Evaluation (MACE), enabling benchmarking and global relevance.
- Development of uniquely Canadian indexes and sub-indexes that use the Canadian grading system and dollar value
- Leverage Canada's breed diversity to design targeted breeding strategies that meet a range of market and environmental needs.
- Use of Canadian farms to showcase best practices and validate technologies on local herds.
- Enhance research capacity and relevance, with better access to actual Canadian beef cattle phenotypic and genotypic data.
- Support for the next generation of producers, offering an established genetic framework.

Challenges in implementing a national evaluation system

- A smaller national reference population may initially limit the accuracy of genetic evaluations compared to larger, established international databases.
- Producer hesitation or resistance to change, particularly when current systems are working well for their operations.

- Dependence on cooperation from breed associations, including willingness to collaborate and share historical pedigree and performance data.
- Difficulty in coordinating data from multiple sources including breed associations and commercial herd management systems

Through interviewing organizations and genetics providers in Canada during my Nuffield study, I was happy to learn that there are stakeholders in Canada interested in establishing a national evaluation system and are already working on ongoing initiatives. One of those initiatives is through the Canadian Beef Improvement Network (CBIN), which is leading a project aimed at consolidating historical genotype and phenotype data from Canadian beef breed associations to enable a national genetic evaluation system. In parallel, efforts by CBIN are also underway to incorporate data from research herds into the system. This would allow commercial producers to access insights into hard-to-measure traits, such as feed efficiency or methane emissions, that are typically only collected within research settings. By integrating this information, the initiative supports broader adoption of advanced genetic tools and improved decision-making across the beef industry.

6.1.2 A national genotyping program

Alongside the opportunity to implement a national evaluation system is a national genotyping program, which would bring benefits to the evaluation system (Berry & Spangler, 2024). Current genotyping practices in the Canadian beef industry are often carried out to support breed association evaluation systems, rather than being routinely applied to all animals within a herd. The benefit of implementing a national genotyping program would allow genomic information from all beef animals at birth to be incorporated into the evaluation system, and thereby increase the accuracy of genetic predictions substantially, assuming phenotypes are continued to be collected. Additional opportunities and limitations of a national genomic testing scheme are described in detail by Berry & Spangler (2024) and briefly listed below:

Opportunities

- Moving the national herd towards DNA calf registration
- Full traceability of animals
- Serve as a low-cost genotyping program with return-on-investment
- higher accuracy and reliability of genetic predictions, especially for low heritability traits
- Information from the genotype information can bring immediate insights to make management decisions (e.g., eliminate parentage errors, breed-specific disorders, etc.)
- Producers receive genomic evaluations at the earliest opportunity
- The ability to determine management decisions/end points earlier

Limitations

- Requires collection of a biological sample (but is likely to be easy to do or already part of routine practice for some producers)
- Requires funding for infrastructure and staff for genotyping services to handle samples

- May require collaborative efforts between government, industry, and researchers to implement first stages of program

Ireland is an example of leading in the collection of genetic data from cattle at a national level through a mandatory tissue collection for genotyping. This program has been recently implemented in Ireland and requires producers to genotype their herd at a subsidized cost through a cost-sharing model. All calves are required to be genotyped, regardless of sex or breed. This has immense benefits for animal traceability/movement in the system to processing points.

In addition to CBIN's efforts to establish a national evaluation system, CBIN is also exploring the development of a streamlined genotyping program to expand the genetic database. This initiative would support the genotyping of animals that have not yet been tested. For example, herds enrolled in the program may be eligible to genotype their remaining or future animals, helping to fill data gaps and strengthen the national reference population.

6.1.3 A national beef carcass classification system

Aligned with the development of national systems, a key component of a sustainable and successful beef industry is the implementation of a national beef carcass classification system. During my Nuffield study, I heard from multiple stakeholders across the beef industry that one of the most difficult data types to link back to individual beef animals is carcass and meat quality information. However, this linkage is essential because we must be able to measure what we want to improve. Countries like the United Kingdom and Ireland have successfully implemented such programs, enabling genetic improvement in traits that matter most to consumers and export markets.

In Canada, a national carcass classification system would allow integration of carcass and meat quality data with national genotyping program IDs, enabling genomic evaluation of these economically important traits. Currently, the EPD predictions for carcass traits are based on live-animal ultrasound measurements rather than measurements collected at the processing plant, which is a low-throughput method and relatively expensive to implement. Direct selection of economically-relevant carcass traits could drive more rapid genetic progress in meat quality, yield, and carcass trait characteristics as millions of carcass records could be generated each year.

Such a system would create new opportunities across the value chain. Packers and processors could implement value-based marketing strategies, such as premiums for animals that meet specific quality grades or yield thresholds. Cow-calf producers could benefit from linking genetic scores to carcass outcomes, similar to programs already initiated by entities like AGI, which uses the AngusLink Genetic Merit scorecard (Genetic Merit Scorecard, n.d.), allowing them to create incentives for breeding for superior genetics in a simple approach.

6.2 A framework of knowledge transfer and translation supporting the system

Bringing research technologies to become accessible to producers on-farm has been commonly termed as 'knowledge transfer and translation', known as KTT. This step is arguably the most important part of the framework and often the most challenging. KTT encompasses all the activities that allow research to become applied tools on the field. Without a strong KTT framework supporting the national evaluation system, there will continue to be barriers to accessibility and optimized use of the technology.

KTT activities, which help producers harness the full potential and capabilities of genetic tools, are often done by universities or research institutes (e.g., Beef@Guelph, Dairy@Guelph, KTT funded grants), AI companies (e.g., Semex, ABS Genetics, STGenetics), and national (BCRC) and provincial bodies (e.g., Ontario Ministry of Agriculture, Food and Agribusiness and Ministry of Rural Affairs, Saskatchewan Ministry of Agriculture, etc.). With provincial, regional, environmental, economic, operational, and regulatory differences among provinces, there is a need for provincially focused teams and consultants which offer a targeted approach. However, crosstalk between provinces may be lacking and repeated efforts for KTT is common. Nationally, the BCRC serves as a strong stakeholder which, in addition to launching research calls, allocating funding, and disseminating research findings to the whole industry, ensures research activities they are working with lead to practical outcomes for producers and stakeholders throughout the value-chain. BCRC also hosts webinars, develops infographics, protocols, and factsheets to disseminate knowledge and research findings. Specifically considering KTT for genetics, BCRC in collaboration with CBBC, Alberta Beef Producers, Saskatchewan Ministry of Agriculture, University of Guelph, and Maritime Beef, have organized a collaborative extension initiative to improve genetic selection for cow-calf producers.

An area that could be further strengthened in the Canadian beef industry is investment in qualified personnel to effectively disseminate knowledge, provide consultation, and translate research findings into practical applications for producers. This could be achieved by funding dedicated extension faculty at universities, with the majority of their responsibilities focused on extension work, similar to the model in the United States. Alternatively, investment could be directed toward expanding the number of agricultural consultants, following examples such as the Saskatchewan Ministry of Agriculture's advisory services. Another complementary approach is the development of credited courses within agricultural programs at colleges and universities that teach early career individuals the value of KTT, as well as practical approaches to doing it effectively. In addition, co-op programs that engage students directly with industry stakeholders can provide hands-on experience and a deeper understanding of the sector. These experiences can prepare graduates to pursue careers that actively support and strengthen KTT within the industry.

7.0 The need for genetic technology now

7.1 Political, economic, and environmental pressures

There are growing political, economic, and environmental pressures that highlight the urgent need for the adoption of genetic technologies in the Canadian beef industry. One of the most pressing economic indicators is the current stage of the beef cattle cycle. Both Canada and the United States are experiencing their lowest cattle inventories since 1987 (Pederson, 2024). As the cycle progresses, the national herd size is expected to expand again. These transitional periods often present a unique opportunity for producers to re-evaluate their strategies, adopt new technologies, and make long-term improvements, including the integration of genetics into their operations.

On the political front, upcoming changes to U.S. Country of Origin Labelling (COOL) policies will also impact the industry. Beginning in January 2026, only beef products that are born, raised, slaughtered, and processed entirely within the United States will qualify for the "Made in the USA" label. This policy shift could disrupt the highly integrated Canada-U.S. live cattle and beef trade by reducing the competitiveness of Canadian cattle in the U.S. market (The Canadian Press, 2024). With this added pressure, Canadian producers may need to differentiate their products and enhance value through other means, with genetic improvement being a potential key lever.

Canada is actively enabling carbon credit generation for reduced methane in beef production, with policies in effect expected in 2025. Carbon credit policies for reduced methane emissions for beef could mean revenue generation for producers that reduce greenhouse gas emissions through practices such as nutritional, genetic selection, or manure management.

7.2 Incentives to adopt technology

One pressing question is: What are the incentives for producers to adopt genetic and sustainability-related technologies? While there may not always be a direct financial payment tied to adoption, market-driven incentives are becoming increasingly influential. For example, processors and food service companies, such as fast-food chains, are placing greater emphasis on sourcing 'sustainable beef' to meet their corporate sustainability goals. This creates demand for producers who can meet those criteria.

A monetary incentive exists through the CRSB, which offers payments to producers who achieve certification under its sustainability standards. These payments are typically made on a per-herd basis. Additionally, export markets, such as the European Union, may have specific sustainability or traceability requirements that producers must meet in order to access those markets, further encouraging the adoption of verified practices.

8.0 Future traits and technologies to explore

Through my Nuffield experience, it became clear that multiple entities around the world are actively working to address current challenges in their herds while also anticipating future needs by identifying traits they may need to select for.

One example is the growing focus on heat tolerance. Several groups are researching the slick gene and coat colour, which could reduce the negative impacts of heat stress on production and performance. Efforts to improve animal welfare and reduce labour costs are also driving interest in polled genetics, eliminating the need for dehorning. Another example is facial eczema, a significant challenge in New Zealand, where researchers are exploring genetic solutions to eliminate the disease.

Several traits are emerging in other countries that could become future priorities for Canada's beef research landscape, including water intake, meat quality, carcass traits collected at processing, reduced age at slaughter, rumen microbiome features, and indirect measures of feed efficiency and methane emission traits. However, one of the main barriers to incorporating these traits into genetic evaluations is that many are complex traits (influenced by multiple genes), making them difficult or expensive to measure. To address this, researchers are exploring novel sensing technologies. For example, infrared cameras and CO_2 measurements are being tested as lower-cost, less labour-intensive ways to estimate feed efficiency. If these technologies prove successful, they could enable more widespread and routine data collection for inclusion in genetic evaluations.

In the dairy systems I visited during my Nuffield study, particularly in Ireland, there is also growing interest in including environmental traits, such as nitrogen excretion and carbon sequestration potential, into breeding programs. This is an approach that may become increasingly relevant for beef systems as sustainability targets evolve.

9.0 Conclusion

As highlighted throughout this report, the Canadian beef industry is a complex and deeply interconnected system that demands a comprehensive approach to unlock new opportunities and optimize production practices. A key starting point is the pursuit of a truly sustainable solution, one that not only provides value-added genetic tools for producers but also fosters the knowledge transfer, data infrastructure, and research capacity necessary to support their adoption and long-term success.

Achieving this vision will require collaboration across the entire value chain, from producers and researchers to industry associations, processors, and policymakers. **Section 10** summarizes recommendations for these latter stakeholders based on the findings from my Nuffield study, while **Appendix B – Key Insights and Call to Action** highlights the main insights and immediate actions that can be taken by all stakeholders in the Canadian beef sector. Only through coordinated, cross-sector efforts can we fully realize the potential of genetics and innovation to strengthen the resilience, competitiveness, and sustainability of the Canadian beef industry.

10.0 Recommendations

For Producers: Connect with breed associations, CBIN, and genetics companies to access tools and support. Explore BCRC resources, including factsheets and workshops, to understand how collecting DNA, phenotypes, and pedigree information can improve genetic progress and herd management.

For Breed Associations: Collaborate across organizations, as more data leads to better insights and predictions. Encourage staff and board members to attend conferences like the Beef Improvement Federation Symposium to stay current and connected to emerging research in cattle genetics.

For Policymakers and Government: Support research funding and investment in livestock genetics. Develop incentive structures that encourage packers and processors to share data with producers, strengthening the entire value chain. Invest in provincial-focused consultant frameworks or extension faculty.

For Researchers: Engage producers throughout the research process, from idea generation to application, to ensure outcomes are relevant and practical. Attend events like the Beef Improvement Federation Symposium to stay grounded in industry needs and emerging science.

11.0 Glossary

Accuracy
Value which ranges from 0-1. Higher accuracy is more favourable. The value reflects the confidence in the genetic merit prediction (how close the EPD prediction is to the true breeding value). Accuracy is dependent on several different factors including trait heritability, number of phenotypic records on the individual and its relatives, and number of records on any traits that are genetically correlated.

Beef on dairy (also known as beef x dairy, dairy-beef, B on D, BxD)
A beef cross dairy calf, which is a calf produced through the use of beef breed cattle semen to impregnate a dairy cow, classified as a by-product from a dairy operation.

Breeding value
The genetic merit of an animal.

Expected Progeny Difference (EPD)
Predicted transmitting ability (PTA), a prediction of the genetic merit of an animal based on multiple sources of the animal's information (its own performance, the performance of its relatives).

Genetic evaluation
Provides a ranking for individual animals based on their genetic merit, offering insight to which traits the animal will pass on to its offspring.

Genetics (general definition)
The study of single genes and their roles in the way traits or conditions are passed from one generation to the next.

Genetics (in context of the report)
The use of genetic modelling to predict breeding values that represent the genetic merit of an individual animal using its trait and pedigree information.

Genomically-Enhanced Expected Progeny Difference (GE-EPD)
An EPD which also uses genomic information.

Genomics (general definition)
The study of all parts of an organism's genes, known as a genome.

Genomics (in context of the report)
The use of genetic modelling to predict breeding values that represent the genetic merit of an individual animal using its trait and pedigree information and DNA information.

Genotype or Genotypic data
The DNA or genetic information of an individual animal (also known as 'DNA testing', 'genotyping', and 'genomic testing').

Phenotype
See 'trait'.

Reference population
Animals with both genotypes and phenotypes used to train the genomic prediction models.

Reliability
How repeatable the predicted breeding values are. Higher reliability is more favourable.

Residual Feed Intake (RFI; kg/day)
A measure of how much an individual animal actually consumes relative to what the animal is expected to consume based on its body size and growth rate. RFI is known as the 'gold standard' measure of feed efficiency as RFI is the most accurate, reliable, and widely accepted method for research.

Selection Index
An overall score of the genetic merit for a specific production system which combines information on several traits. The emphasis of each trait in the index depends on the strength of its association with traits in the breeding goal and their relative economic value.

Sexed semen
Semen sourced from genetically and phenotypically elite bulls which are sexed for majority male or female sperm.

Trait
A measure of an animal's performance, also known as 'phenotype' (eg. Body weight, calving ease, body condition score).

Trait EPD abbreviations

The trait EPD acronym definitions were retrieved from EPD & $Value Definitions (n.d.) and only report the traits included in the Canadian Angus Association report. The full definitions and measurement units of all production, maternal, management, and carcass trait EPDs are available at EPD & $Value Definitions (n.d.).

Angle - Foot Angle EPD
BW - Birth Weight EPD
CED - Calving Ease Direct
CEM - Calving Ease Maternal
Claw - Claw Set EPD
CW - Carcass Weight EPD
DMI - Dry Matter Intake EPD
Doc - Docility EPD
Fat - Fat Thickness EPD
FL – Functional longevity EPD
HP - Heifer Pregnancy
Marb or MARB - Marbling EPD
MH - Mature Height EPD
Milk - Maternal Milk EPD
MW - Mature Weight EPD
RADG - Residual Average Daily Gain EPD
RE or REA - Ribeye Area EPD
SC - Scrotal Circumference EPD
Teat – teat size EPD
UDDR – Udder suspension EPD

WW - Weaning Weight EPD
YH - Yearling Height EPD
YW - Yearling Weight EPD

Other Abbreviations

AGI – Angus Genetics Inc
AI – Artificial insemination
BCRC – Beef Cattle Research Council
CBBC – Canadian Beef Breeds Council
CBIN – Canadian Beef Improvement Network
CRSB – Canadian Roundtable for Sustainable Beef
COOL – Country of origin labelling
EBV – Estimated Breeding Value
EPD – Expected Progeny Difference
GE-EPD – Genomically-Enhanced Expected Progeny Difference
IGS – International Genetic Solutions
KTT – Knowledge transfer and translation
RFI - Residual feed intake

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13.0 Appendices

13.1 Appendix A – Travel Log

NUFFIELD RESEARCH PROJECT TRAVEL LOG AND KEY INSIGHTS OVERVIEW

The following is a summary travel log and statement of key insights.

Country	Destination	Travel Dates	Travel Focus
Canada, Ontario	Nuffield Canada AGM	November 2022	Introduction and orientation to Canadian Scholars.
Canada, British Columbia	Nuffield Canada Contemporary Scholars Conference	March 2023	Introduction and orientation to global scholars.
New Zealand, Newstead	Livestock Improvement Corporation	February 2024	Overview of LIC research, main challenges and opportunities for New Zealand dairy genetics.
New Zealand	Agri-Zero	February 2024	Overview of Agri-Zero and scope of company, main topics of interest related to technologies for reducing and measuring agricultural greenhouse gas emissions.
New Zealand, Aukland	Fonterra	February 2024	Overview of Fonterra, main challenges and opportunities for New Zealand dairy producers and processors.
New Zealand	New Zealand Dairy farmers	February 2024	Tours and discussion with fellow Nuffield New Zealand Scholars, including Kylie Leonard, learning New Zealand dairy operations, main challenges and opportunities with New Zealand dairy systems and pasture based systems.
New Zealand	Beef & Lamb NZ	February 2024	Discussions on major challenges and opportunities for beef and lamb genetics in New Zealand.
New Zealand, Aukland	Massey University	February 2024	Discussions on major challenges and opportunities for beef genetics research in New Zealand.
New Zealand, Lincoln	Lincoln University	February 2024	Discussions on major challenges and opportunities for beef genetics research in New Zealand.
Canada, Ontario	Semex Alliance Inc	May 2024	Discussions on the opportunity and success on AI technologies including

			sexed semen in the dairy industry.
Canada, Ontario	Lactanet	April 2024	Discussions on the integrated operations of research, industry, cooperatives, and non-profit institutes/organizations. Discussion on the history of applying genetics and genomics in the Canadian dairy industry.
Canada, Ontario	AgSights	September 2023	Discussions on current genetic evaluation systems for beef producers and the emerging technologies for data collection and management for beef operations.
Canada, Ontario	Bruce County beef farms	September 2023	Tours and discussions with local Ontario beef producers and their application of genetic technologies.
Canada, Ontario	Shorthorn beef farms	June 2024	Tours and discussions with local Ontario beef producers and their application of genetic technologies.
Canada, Ontario	VG Meats	May 2024	Discussions on the challenges and opportunities of incorporating data from processing plants related to meat quality and carcass characteristics.
Canada, Alberta	Canadian Beef Improvement Network	August 2024	Discussions on CBIN initiatives for driving forward genetic and genomic applications for Canadian beef producers.
United States, Alabama	Auburn University Alabama	March 2024	Tours of the Auburn University Beef teaching lab, Meat Lab, and attending the Forage and Grass Field day. Learning about extension frameworks for beef and crop producers.
United States, Wisconsin	ABS Global	April 2024	Discussions on current initiatives in dairy genetics. Learning opportunities and challenges in dairy and beef genetics.
United States, South Dakota	C-Lock	April 2024	Tour of C-Lock, manufacturing of methane testing GreenFeed machines, learning insights on producer demands and upcoming novel sensing technology.
United States, Missouri	American Angus Association – Angus Genetics Inc	April 2024	Meetings and discussion with the AGI team on novel maternal traits.
United States, Indiana	Purdue University	April 2024	Visited Dr. Luiz Brito and Dr. Hinayah Rojas, presented Nuffield findings and

			engaged in discussion with their research team.
Ireland, Trim	Teagasc, ICBF	March 2024	Visited Dr. David Kenny and Dr. Stuart Kirwin, discussions on Teagasc research initiatives and toured research centres.
Ireland, Galway	University of Galway	March 2024	Visited Dr. Sinead Waters and engaged in discussion with a research lab on rumen microbiome topics.
Ireland, Cork	Teagasc	March 2024	Visited Dr. Donagh Berry and toured Teagasc research centre and VistaMilk and engaged in discussion with his research team.
Additional travels related to BCRC Researcher Mentorship Program and position at the University of Guelph			
Canada, Alberta	American Society of Animal Science - Western Society of Animal Science - Canadian Society of Animal Science - ASAS-WSAS-ASAS 2024	July 2024	Presented research findings on identification of SNP markers associated with feed efficiency (research conducted at UofG CGIL). Expanded network, learned ongoing research initiatives in livestock genetics and other fields.
United States, Tennessee	Beef Improvement Federation Symposium 2024	June 2024	Attended symposium and learned about ongoing research initiatives, current and future beef industry challenges in North America. Met producers who have been applying genetics for decades.
Canada, Saskatchewan	Canadian Beef Industry Conference 2024	August 2024	Attended conference as a BCRC Research Mentee, attended KTT workshop, served as judge for graduate student research poster competition.
Canada, Alberta	Beef Cattle Research Council Research Mentorship Program Orientation	October 2023	Met fellow 2023 BCRC Research Mentorship Program mentees, expanded network with BCRC, learned fundamentals about Canadian beef industry, visited Alberta beef ranches and farms.

13.2 Appendix B – Key Insights And Call To Action

The following are key insights arising from the Nuffield Research Project:

- Adoption and optimization of genetic technology in the Canadian beef industry is lagging behind other countries.
- Genetic technology is available and rapidly advancing, however, a framework that allows producers to efficiently access and apply these tools is needed.
- Alliance of breed associations has been challenging in the past but may be possible today.
- Canadian beef producers need a solution that is robust enough to fit diverse breeding objectives/herd sizes/regional differences/diverse market end-points.

The Nuffield Scholar sees the following 'call to action' as imperative:

- There is substantial value in adding a National evaluation using Canadian data from Canadian producers.
- A national evaluation can serve as the starting platform to initiate a national genotyping program and a national carcass evaluation system.
- All stakeholders are encouraged to form an alliance to move forward activities together and more effectively and efficiently.