



# A GENOMICS STRATEGY FOR BRITISH COLUMBIA'S **AGRIFOOD & AGRICULTURE SECTOR**



**Genome**  
British Columbia

Leading ▶ Investing ▶ Connecting



2019

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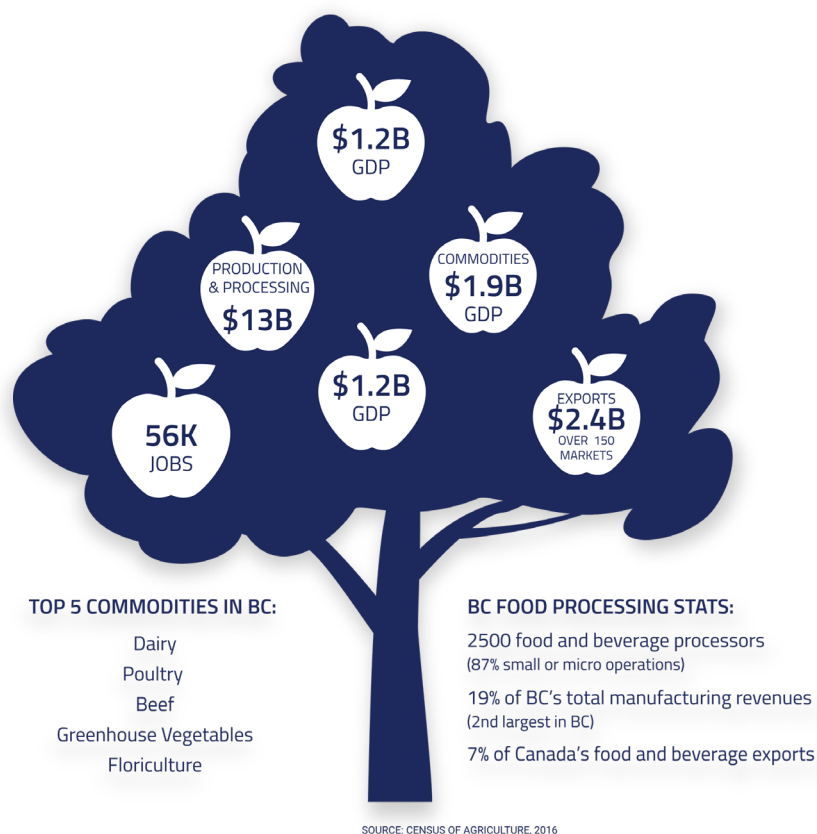
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## 1. Importance of the sector to the BC economy

Primary agricultural production and food & beverage manufacturing – together known as the ‘agrifood’ sector – are an integral part of the health, social, and economic well being of BC. Agriculture farm cash receipts and food & beverage processing sales grew by \$847M (~6%) between 2015 and 2017. Together they contributed \$13B in 2017 to BC’s economy,<sup>1</sup> while directly employing over 56,600 people.<sup>2, 3</sup>

BC’s diverse and vibrant agriculture sector includes primary production from farmers, growers and ranchers. It is made up of nearly 17,500 farms utilizing 2.6 million hectares of land; producing over 200 agriculture products and contributing \$1.9 billion to the provincial GDP in 2017.<sup>2</sup> Dairy products, chickens, greenhouse vegetables, floriculture and beef were the top five commodities. In addition, 2,800 food & beverage manufacturing establishments generated \$3 billion in GDP for BC in the same year from \$9.8 billion in sales.<sup>3</sup> Food & beverage manufacturing is the second largest processing sector in BC, and it ranks fourth in Canada among all provinces for sales. Meat/poultry products, wineries/breweries/distillery, dairy products and bakeries each had sales of over \$1B.



In 2017, \$6.5 billion in agriculture and food & beverage products were exported to 149 and 157 markets respectively across the globe.<sup>2, 3</sup> In 2017, the United

States remained the most important export market, receiving three quarters of BC’s agrifood exports, with Asia second in position led by China, Japan, South Korea and Hong Kong among this growing segment.<sup>4</sup> The top 5 exports included Atlantic salmon, food preparations/natural health products, baked goods and cereal products, blueberries and mushrooms.

This strategy highlights areas of focus for genomics and expands on the priorities identified in consultation with sector stakeholders in agrifood. It is by its nature designed to complement and align with co-existing industry, government, and sector strategies for the benefit of all British Columbians.

## 2. Current state of the sector

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### *Demographic Shift*

There is a major demographic shift occurring in food production and processing. Success of BC's agrifood sector in the future will depend on equipping next generation workforce with the knowledge and skills essential in the new technology driven, value-added agri-economy. Labour is expensive and availability sometimes unpredictable so the move toward mechanization and robotics has the potential to fill gaps and reduce costs. Future success in the agrifood sector requires planning for succession while simultaneously removing affordability barriers to access land or food manufacturing infrastructure for new entrants, younger British Columbians as well as First Nations groups.<sup>5</sup>

### *Agricultural Land Reserve (ALR)*

In the province of British Columbia, the ALR "is a land use zone where agriculture is the priority use."<sup>6</sup> Five percent of BC's total land base is protected for agricultural production. Increasing food production sustainably requires strong support for the ALR to ensure continued farming into the future in BC. Further, stewardship of BC's agricultural land base for future food security and economic development will also require a strong consideration of environmental sustainability and climate change adaptation.



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### *Buy local, sell global*

'Buy local' movement combined with the BC Government's 'Grow BC, Feed BC, Buy BC' initiative will provide new opportunities for producers and processors to grow their businesses.<sup>5</sup> Locally, a strong agrifood sector requires public trust and consumer confidence that the food they buy is safe, that plants are grown sustainably, and animal health and welfare are adequately protected. Internationally, BC's proximity to some of the largest export markets is important for agrifood, but the sector still relies heavily on the US. Working in partnership, expansion into new international markets will help reduce BC's dependency on a single trading partner and support an economically stable sector.<sup>5</sup>

### *Diversified and nimble agrifood sector*

There is a need to maximize commercial opportunities in agriculture and food & beverage processor sectors. In BC, no single commodity dominates the agrifood sector with over 200 agricultural products produced in 8 unique geographical regions.<sup>1</sup> A recent BC Food Processors Association industry study found that close to 90% of the food and beverage establishments in BC were micro and small operations employing fewer than 5 people.<sup>7</sup> BC's smaller, more diverse agrifood sector can sometimes lack economies of scale, run into temporary labour shortages and face sudden changes in input costs that can challenge producers and processors. Small farming and food processing operations also face challenges related to capital costs and implementation of innovative technologies that may help grow their businesses. The agrifood sector needs to do more to differentiate itself by offering higher margin, value added agriculture and food products tailored to specialized niche and fast growing markets.<sup>5</sup> To remain competitive individual sub-sectors may need to become more vertically integrated from farm to retail.



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## 3. Sector challenges and opportunities

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Climate change, land use, environmental sustainability, plant and animal health, food safety and adoption of innovation are serious challenges facing BC's agrifood sector. Further, the sector faces increasing market competition through globalization. However, these challenges also offer opportunities to advance innovation and competitiveness to those who can address them.<sup>8</sup> BC's agriculture sector reflects the diverse climate and growing conditions allowing agriculture and food & beverage processor sectors to exploit new opportunities that will allow it to be more resilient in the face of these future changes.

### *A changing climate*

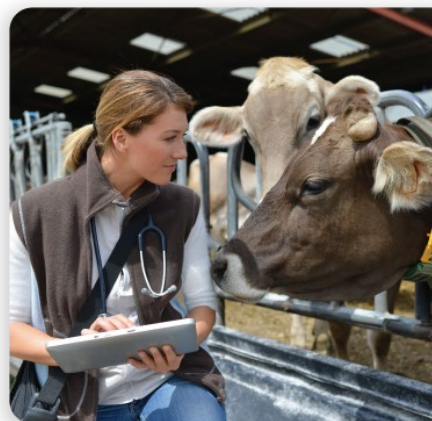
Climate change is already impacting BC. The average air temperature in the province is rising,<sup>9</sup> and the occurrence of extreme weather events and their negative impact on the environment is becoming more common. Further, as BC's climate changes, new pathogens and pests and other invasive species will move into the province. One approach to adapt to a changing climate is to enhance resiliency of domestic crops and animals through new breeding approaches: genomic selection coupled with climate and geographic modelling will enable the development of hardier, resistant plants and livestock.

### *Environmental sustainability*

Soil, water and ecological biodiversity are critical to an environmentally sustainable agrifood sector. Human activity from food production and processing, such as animal nutrient and food by-product waste, fertilizer, and pesticides/herbicides, can negatively impact these vital resources. Genomics provides an opportunity to develop new tools for better assessment and management decisions for land and water quality. In addition, genomic technologies allow for monitoring of plant, animal and microbial biodiversity that provide ecosystem services critical to agriculture and the surrounding environment.

### *Plant and animal health*

Plant and animal health are on the minds of today's producers and consumers alike. In animal health there is growing international concern focused on antimicrobial resistance due to overuse or misuse of antibiotics in livestock production systems.



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This has led to governments around the world restricting or in many cases eliminating access to this first line of defense. Attention has turned to the potential of genomics to breed enhanced disease resistance traits in animals against many pathogens using biomarker and genomic selection technologies. Another approach focuses on the generation of novel treatments against animal diseases. For plants, genomics can facilitate breeding new disease resistant cultivars, the generation of new biological treatments to replace synthetic chemicals and the development of growth bio-stimulants to support plant health.

### *Food safety and human health*

Food safety is important to consumers as they look to government regulators to develop the necessary policies, regulation and food standards to assure that quality and safety of food products throughout the agrifood value chain. Genomics can improve food safety through detection and identification of food

borne pathogens. Implementing better genomic methods for surveillance and outbreak investigations can lead to faster, more accurate responses linking food contamination sources to human illness. Industry benefits from the reduction in overall incidence of foodborne illness and more targeted responses during an outbreak. Also, genomic testing technologies are being deployed in food identification to ensure that it is free from allergens and contaminants, which can cause serious and even deadly health complications in people. Genomic testing of products such as honey and seafood to protect consumers from counterfeit products will need more attention.

### *Microbiome*

An emerging area of study is the microbiome – the community of microorganisms that populate agricultural plants and animals. Researchers are now beginning to understand through genomics the importance of the diversity and health of the microbiome and the role it plays through its ecological relationship with agricultural plants and animals. Using genomic approaches, it will be possible to devise strategies to influence plant and animal microbiomes to increase production and improve plant and animal health.

### *Pest and pathogen surveillance*

Early detection of pests and pathogens before they enter BC's food production system is critical to the economic success of producers and food & beverage manufacturers that rely on locally grown food. Current biosecurity and surveillance tools used to manage ongoing and emerging pest and pathogen outbreaks are outdated, inadequate, and reactive. Adoption of newer tools developed from genomics can assist in the detection and surveillance of ongoing pest and pathogen threats to plant and livestock health before they impact the agrifood sector. Biosecurity will become a greater issue with climate change and new genomic diagnostic tests will need to be developed quickly and economically to detect and manage these foreign incursions. These new approaches will require the development of new policies, regulations and standards by government.

### *New Product Innovations*

BC's agrifood sector is comprised of small to medium size producers and processors. Increased domestic demand through the 'Grow BC, Feed BC, Buy BC' initiative along with continuing expansion into export markets with growing populations and rising incomes offers new business opportunities for BC's agrifood sector. To flourish, the sector needs to focus its efforts and mobilize resources to develop higher value products that are unique in the marketplace and provide



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higher profit margins. Consumer genomics is an area of research focused on product attributes that appeal to evolving consumer tastes specific to local or international markets. These new products can provide unique branding opportunities, quality certification programs, plant and animal health assurances and grower exclusivity through 'club varieties' to exploit unique commercial opportunities. Other opportunities might include specialty or niche value added products like health products, cosmetics, functional foods, nutraceuticals, and alternative proteins. Genomics and microbiome research have the potential to impact the food bio-economy of the future.

On the production side there are emerging opportunities using genomics for the development of novel biocontrol methods against plant pests and pathogens or novel treatments to support plant and animal health. In addition, the microbiome is also providing innovative ways to address the management and utilization of agricultural nutrient waste and food processing by-products with the potential to develop biofuels and bioproducts from these inputs.

### *Stakeholder Engagement*

What are the potential impacts of the latest genomic innovations and how can they be employed in such a way to enhance rather than reduce the environmental, social and economic sustainability for BC's agrifood sector? Today these are key questions and early work considering these

aspects can inform the development and application of such innovations and to help recognize and reduce barriers to translation. This research could advance evidence driven agricultural and food processing policy and regulation, and articulate and quantify the benefits of genomics based innovations. Consumers are important voices in this debate, raising concerns ranging from animal welfare, to climate change and environment sustainability. Lack of engagement with consumers about what they value and perceptions of the health, environmental, social and economic impacts of the latest technologies can sometimes limit the uptake of new technologies and products. Two-way dialogue involving all parties and addressing questions raised by the community are essential.



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## 4. The role of genomics in addressing sector challenges

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### *Success stories*

Genome BC's agrifood project portfolio (34 projects and \$57M in co-investments) spans discovery and applied research. Much of the primary motivation early on for Genome BC's investment in genomics based research in agrifood focused on the generation of basic knowledge and necessary genomic resources. BC researchers, in collaboration with national and international partners have played a key role in developing genomic resources and knowledge in sunflowers, bees, grapevine, and livestock. Today, Genome BC's foundational investment in agrifood, combined with ongoing research internationally in genomics, is driving the next stage of translational research in all areas of food production and processing.



In an emerging issue pilot study, genomic tools were used to detect a highly pathogenic form of avian influenza in wetland sediments at a rate greater than the current gold standards. The result of this project revealed the potential for genomics analysis of wetland sediment samples to serve as an early warning system for incursion of avian influenza and has led to further investment to refine the genomic detection tool.



The domesticated honeybee pollination support services are essential for key agricultural crops including many fruits, nuts, vegetables and cereals accounting for over \$200M per year in agricultural production. The mite, *Varroa destructor*, has been implicated in colony collapse disorder. In partnership with the Ministry of Agriculture, a proteomic biomarker test was developed that BC breeders could use to select for *Varroa* resistant bees.



In Canada, the Plant Breeders' Rights (PBR) Act (under UPOV '91) and Regulations provides protection for new plant varieties from illegal propagation, distribution, and commercialization by unlicensed producers. Rather than rely on subjective evidence like a plant's physical appearance, cherry and apple varieties developed in BC and managed by Summerland Varieties Corp will use next generation genomic tools for variety identification by assigning a unique genomic identifier, called a DNA fingerprint, to distinguish between two closely related varieties and potentially identify licensing infringements.

## *Current initiatives*

Genome BC has made investments in several research projects that are helping the agrifood sector learn about and realize the benefits of genomics and the potential impacts on the social and economic well being of the province. Several short and long-term projects are underway that focus on market access and trade, improving management decisions, addressing animal and plant health, adaptation to climate change, and responding to environmental impacts in the agrifood sector. Specific examples are noted below.

Genomics can support competitive domestic and international markets for BC's agrifood products. Routine molecular testing for plant viruses is time consuming, laborious and requires individual analysis for each species. For horticultural commodity exporters to the US and internationally, this drives up costs. By using next generation sequencing, plant breeders and nurseries can detect all viruses present in a single plant sample, including those not routinely tested. This will ensure plants shipped abroad are virus-free and will keep markets open for plant material from BC and Canada.

Climate change is already impacting BC. The use of new breeding approaches involving genomic selection will enable the development of hardier plants better adapted to future climate challenges in our province without loss of plant yield. Sunflower is a great model system for studying plant adaptation to climate change. By investigating the molecular and physiological basis of wild sunflower's adaptations to stress, breeders will be able to transfer these stress resistance traits to elite sunflower cultivars and use similar approaches in other agriculturally important crops.

Infectious diseases are a leading cause of illness in livestock and result in direct economic losses to producers and potentially to disastrous international trade restrictions. There is also the potential for direct transfer of disease from animals to people. Vaccination is one of the most effective ways to preventing infectious disease in animals. Using a genomic based approach called reverse vaccinology, researchers are now able to identify unique proteins that have the potential to be used in development of a vaccine in cattle against bovine tuberculosis and Johne's Disease.

## **5. Approach**

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Building capacity in the agrifood sector and expanding the availability of BC food products requires innovation. In BC, "innovation means the development of promising agriculture and agrifood products, practices, processes or technologies that might be adopted or commercialized by the sector."<sup>8</sup> For the sector to remain internationally competitive and environmentally sustainable in the long term, it is imperative to diversify and adopt innovative technologies that will allow the sector to create unique BC products for a local and global market. Genome BC supports innovation through genomics research catalyzing partnerships and knowledge transfer, increasing sector sustainability and competitiveness to exploit new business opportunities.

Genome BC has consulted with stakeholders not only in BC's agrifood sector but across Canada to understand how genomics might continue to be applied to maximize economic and social benefits arising from agriculture and food & beverage sector activities. The overarching goal of developing this genomics strategy for BC's agrifood sector is to understand the challenges and opportunities facing the sector; to continue to build on previous investments, results, and strengths; and establish priorities with input from sector stakeholders into an actionable set of next steps. Genome BC will invest in research and development innovation to advance genomic applications critical to user partners including sector associations, governments and industry. Potential target areas include: Plant and animal health, climate change, environmental sustainability, new practice, product, process and technology development, implementation and commercialization, product safety and quality, new market opportunities, and social license.



## 6. Conclusions

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Genome BC is continuing in its efforts to realize the benefits of genomics across the entire value chain of the agrifood sector. After strategically focusing on foundational research early in its mandate, Genome BC, as part of its strategy, will continue to transition its investments to applied work within the agrifood sector and in its partnerships with industry and other end users; to pilot or take to scale genomics applications; implementing innovations that will deliver tangible benefits to government, companies, regulators, communities and British Columbians. As genomics becomes mainstream in the agrifood sector it is becoming clear that navigating the way from laboratory research to end user application is not without challenges. To help advance genomics along the research and innovation continuum to end user application and delivery of concrete economic and social benefits, a strategy for research and investment is required. As part of its commitment to BC and its vision for the benefits of using genomics, Genome BC is developing this genomics strategy to provide a framework for future investment and research to support sustainable development of BC's vibrant agrifood sector.

## 7. References

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1. Fast Facts 2017 – British Columbia's Agrifood and Seafood Sector - October 2018 ([https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/statistics/industry-and-sector-profiles/fast-stats/faststatsbc\\_2017.pdf](https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/statistics/industry-and-sector-profiles/fast-stats/faststatsbc_2017.pdf)). Accessed May 10, 2019.

2. Sector Snapshot 2017: BC Agriculture - November 2018, Ministry of Agriculture – Corporate Statistics & Research Unit [https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/statistics/industry-and-sector-profiles/sector-snapshots/bc\\_agriculture\\_sector\\_snapshot\\_2017.pdf](https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/statistics/industry-and-sector-profiles/sector-snapshots/bc_agriculture_sector_snapshot_2017.pdf). Accessed May 10, 2019.
  3. Sector Snapshot 2017: BC Food and Beverage Processing - October 2018, Ministry of Agriculture – Corporate Statistics & Research Unit [https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/statistics/industry-and-sector-profiles/sector-snapshots/bc\\_food\\_and\\_beverage\\_processing\\_sector\\_snapshot\\_2017.pdf](https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/statistics/industry-and-sector-profiles/sector-snapshots/bc_food_and_beverage_processing_sector_snapshot_2017.pdf). Accessed May 10, 2019.
  4. Sector Snapshot 2017: BC Agrifood and Seafood - July 2018, Ministry of Agriculture – Corporate Statistics & Research Unit [https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/statistics/industry-and-sector-profiles/sector-snapshots/bc\\_agriculture\\_seafood\\_and\\_agrifood\\_sector\\_snapshot\\_2017.pdf](https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/statistics/industry-and-sector-profiles/sector-snapshots/bc_agriculture_seafood_and_agrifood_sector_snapshot_2017.pdf). Accessed May 10, 2019.
  5. Ministry of Agriculture 2019/20 to 2021/22 Service Plan – February 2019 <https://www.bcbudget.gov.bc.ca/2019/sp/pdf/ministry/agri.pdf>. Accessed May 10, 2019.
  6. Provincial Agriculture Land Commission - <https://www.alc.gov.bc.ca/alc/content/home>. Accessed June 10, 2019.
  7. BC Food Processors Association Industry and Economic Impact Study of the BC Food and Beverage Processing Industry [https://www.bcfpa.ca/sites/default/files/bcfpa\\_factsheet\\_-\\_nov\\_7\\_2016\\_final.pdf](https://www.bcfpa.ca/sites/default/files/bcfpa_factsheet_-_nov_7_2016_final.pdf). Accessed May 14, 2019.
  8. Climate Change <http://www.env.gov.bc.ca/soe/indicators/climate-change/temp.html>. Accessed May 15, 2019.
- Canada-BC Agri-Innovation – <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/programs/canada-bc-agri-innovation>. Accessed May 16, 2019





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