

Agriculture's Connection to Health: A summary of the evidence relevant to British Columbia

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Executive Summary

The relationship between agriculture and human health in British Columbia (BC) is complex and multi-faceted. The availability of healthy food is an important determinant of health, but only one of many connections between agriculture and health. Agriculture influences food choices and healthy eating patterns, and impacts a variety of social, environmental and economic determinants of health. In other words, agriculture's relationship to the environment and its role as an economic driver have implications for human health.

The purpose of this document is to present the evidence on associations between agriculture and health. The Provincial Health Services Authority (PHSA) Population and Public Health program commissioned the review because BC health authorities expressed a need for consolidated evidence on current issues related to BC agriculture and its connection to health. This review aims to assist health authorities in supporting local governments in evidence-based planning and decision-making.

With guidance from an advisory group of health authority staff and local government planning staff, researchers searched for peer-reviewed journal articles using identified keywords in a variety of databases. A manual search of reference lists found further relevant documents. All articles were assessed for applicability to the BC context, scientific rigour and political neutrality before inclusion in this evidence review.

Of all the land in British Columbia, only half has any kind of agricultural capability, and nearly 40% is suitable only for grazing. A very small proportion of land (0.2%) is capable of supporting the widest range of crops. Within this landscape, BC supports diverse agricultural production. All regions of the province have some agricultural activity, although regional practices and products vary due to factors such as climate and terrain.

Certain small areas, including the Fraser Valley, Okanagan and Southern Vancouver Island, are extremely productive and produce many varieties of crops. In fact, BC leads Canadian provinces in the production of several types of fruits and vegetables.

Agriculture directly impacts health by influencing food choices and healthy eating patterns.

The current evidence on locally produced and organic foods is mixed.

- Both locally produced and organic foods are often perceived as healthier by consumers but scientific evidence does not support these perceptions
- Greater availability of locally produced fruits and vegetables may increase their consumption

Availability of culturally appropriate and Indigenous foods plays an important role in supporting cultural identity and healthy food choices for British Columbia's diverse population.

- The availability of culturally appropriate/traditional fresh fruits and vegetables can be an important part of healthy eating for immigrant populations
- Indigenous foods, foodlands and waters contribute to healthy eating and physical health and are core parts of culture and identity for Indigenous populations

Incorporating agriculture into schools and other institutions may influence food choices and health.

- Farm-to-school initiatives have the potential to contribute to healthy eating
- There is widespread interest in connecting farms with institutions, but regulations may hinder these efforts
- Farm-to-school and farm-to-institution programs may provide economic benefits to local farmers

Agricultural self-sufficiency can support healthy eating and food security for British Columbians.

- Food self-sufficiency can support healthy eating and food security in BC
- Factors including the presence of suitable farmland, population distribution, global markets and climate change can affect food self-sufficiency in BC
- Agricultural policy in BC contributes to food availability by preserving farmland and regulating the supply of some agricultural products

Agriculture influences a broad range of factors that affect people's mental and physical health.

There is limited evidence on whether agriculture influences the social environment.

- Rural communities tend to have stronger social networks compared to urban centres but more research is needed on social networks in farming communities

Agriculture influences people's health by supporting the economic environment and generating jobs.

- Primary agriculture (production) constitutes 0.6% of BC's GDP, including a total of \$2.9 billion in farm cash receipts in 2014
- BC agrifood exports (excluding seafood) were valued at \$2 billion in 2014
- In 2014, the agriculture sector employed 22,937 people in BC

Agriculture shapes the physical environment in ways that impact overall health.

- Spending time in green environments, which could include agricultural areas, may contribute to positive mental and physical health outcomes
- Agriculture can negatively affect surface and ground water quality through nutrient, sediment, bacteria and pesticide contamination
- Agriculture can negatively affect air quality through contributions to particulate matter, odours and volatile compounds
- Pesticides are associated with both negative health impacts (e.g. impaired neurobehavioural function) and positive health impacts (e.g. prevention of disease outbreaks)
- Buffer areas between farmland and residential areas can help to mitigate complaints of noise, dust and odours, but do not completely eliminate the impacts associated with farm activities

Climate change will likely impact agriculture and, in turn, food security.

- BC will experience increases in temperatures and frequency of weather events, which have the potential to negatively impact crop yields in some regions of the province; however, other regions may experience increased food production capacity
- Flooding and salination may impact land quality and negatively affect crop growth; in turn, decreasing food production
- BC's main fruit- and vegetable-producing regions are some of the most vulnerable to the effects of climate change

Conclusion

The most direct link between agriculture and health is that agriculture provides the major source of food that supports British Columbians in meeting the recommendations outlined in *Eating Well with Canada's Food Guide*. However, the connection between agriculture and health is more complex than simply providing healthy food.

Although the current evidence does not support the perception that local or organic foods are healthier, the literature does show that healthfulness is only one aspect of people's decision making. Individuals' knowledge and perception of the safety of local food, and the perceived better taste, also influence their decisions to buy local food and consume fresh fruits and vegetables. Public health programs such as farm-to-school that connect farm-fresh foods to schools may also contribute to healthy eating both at school and at home.

The availability of culturally appropriate foods also influences individual decisions to eat healthier foods. BC's agricultural lands and surrounding areas were, and continue to be, important sites for accessing Indigenous foods, which contribute to health and wellbeing of Indigenous communities. Land not typically considered as food-producing, such as surrounding or unused farmland, may provide Indigenous peoples with greater access to their traditional foods.

Numerous factors affect food security in BC. Changes in climate, the value of the Canadian dollar, agricultural policy and population distribution all affect food availability and cost at the provincial, regional and individual level. Creating a resilient food system in BC can help to mitigate the effects of these factors on food security and support access to, and availability of, healthy foods, particularly fruit and vegetables. For example, understanding BC's food self-sufficiency and the expected impact of climate change on food production, in BC and elsewhere, may help with agricultural planning.

In addition to influencing healthy eating and food security, BC agriculture affects various determinants of health such as the economy and the physical environment. For example, agriculture has a significant impact on BC's gross domestic product and provides thousands of employment opportunities. Farms can also provide greenspace, which may positively influence mental and physical health.

This evidence review highlights the need for continued research into the connections between agriculture and health. The strength of the evidence varies depending on the topic and while there is strong evidence for some topics, there is either a lack of, or inconclusive, evidence for others. Furthermore, topics such as the relationship between aquaculture, wild fishing and health, as well as Indigenous foodlands and food sovereignty, deserve greater investigation than what was possible within the scope of this review.

Glossary

Glossary

Throughout the document, definitions of key terms are presented in the same shape and colour box as this text.

Determinants of health

While there are multiple determinants of health frameworks,^{1,2} they all recognize that human health is determined by a complex interaction of factors. These factors generally fall under three broad categories provided by the World Health Organization: social and economic environments, physical environments, and individual characteristics and behaviors.³

Ethno-cultural vegetables

Vegetables consumed by a group that shares a similar cultural heritage.⁴

Foodlands

The concept of “foodlands” is used in BC to broaden the cultural scope beyond agriculture to include Indigenous harvesting and cultivation in the neighbouring forests, fields and waterways. This term recognizes the interconnected relationship between the health of food grown on agricultural lands and the health of the neighbouring Indigenous ecosystems.⁵

Food insecurity

Using the work of Davis and Tarasuk (1994), Health Canada defines household food insecurity as “the inability to acquire or consume an adequate diet quality or a sufficient quantity of food in socially acceptable ways or the uncertainty that one will be able to do so”⁶, which is most often the result of inadequate income.⁷

Food self-sufficiency

Food self-sufficiency in the context of this evidence review refers to a state in which BC’s food supply is stable and resilient to external pressures such as supply chains as well as economic and climatic changes.

Food security

There are multiple definitions of food security; a widely used definition is from the United Nations Food and Agriculture Organization (FAO):

“Food security exists when all people, at all times, have physical, social and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.”⁸

Hamm and Bellows’ definition for community food security is often referenced in BC documents: “Community food security (CFS) is defined as a situation in which all community residents obtain a safe, culturally acceptable, nutritionally adequate diet through a sustainable food system that maximizes community self-reliance and social justice”(37).⁹

Food system

An integrated view of the production, processing, distribution, consumption and waste management of food.

Local food

The Canadian Food Inspection Agency has adopted an interim definition of “local” while it reviews food labelling regulations, guidelines, and policies. In that definition, “local” foods are those produced within the province or territory where they are sold, or food sold across provincial borders within 50km of the originating province or territory.¹⁰

Supply management

Supply management, also known as supply quota systems, refers to a variety of policies that control the price of domestic food products, with the overarching goal of ensuring agriculture and agri-food producers have a predictable return on their investments.

Introduction

The most direct link between agriculture and health is that agriculture provides the major source of food that supports British Columbians to meet the recommendations of *Eating Well with Canada's Food Guide*. However, the connection between agriculture and health is more complex than simply providing healthy food.

As concerns rise about the impacts of climate change on the food supply, and interest grows in supporting a more resilient and sustainable food system, population and public health practitioners, especially those working in food security, healthy eating and environmental health are recognizing the need to better understand how the current agricultural system influences health. Within this topic, a major question is whether, or how, local agriculture affects health. This evidence review aims to address this question by presenting evidence on the associations between agriculture, healthy eating and the determinants of health.

Purpose

The British Columbia Provincial Health Services Authority (PHSA), Population and Public Health program, commissioned this evidence review based on a request from BC health authority staff working in food security for consolidated evidence on BC agriculture's connection to health. The intent of this review is to increase knowledge and understanding of how agriculture may influence human health, from both healthy eating and food security perspectives and more broadly through social, economic and physical environments.

The purpose of this document is to provide a high-level summary of the evidence in a format that is accessible to multiple audiences. A full reference list is provided for readers looking for more in-depth information on the topic areas presented.

This review aims to assist health authorities in supporting local governments in evidence-based planning and decision-making. The primary audience is the BC health authorities; however, the findings will also be useful to other stakeholders for informing and advancing food security activities and strategies in the province.

Scope

This evidence review was prompted by a request from the health authorities for accessible evidence-based information on land-based, non-urban food production and its associations to health. The scope was determined with input from an advisory committee dependent on: the availability and reliability of evidence; and the time and resources available. Based on these criteria, several topics of interest were deemed out of scope.ⁱ

Certain related topics, such as urban agriculture and farmer's markets, are not presented here but are included in other publicly available evidence reviews.^{12,13} This evidence review builds on the *Food for*

ⁱ Farmworker health was considered out of scope and Genetically Modified Organisms (GMOs) were not included as there is very little scientific literature on this topic. Due to limited time and resources, this review includes only a short discussion of aquaculture issues and the relationship between foodlands and health of Indigenous communities.

*thought: The issues and challenges of food security,*¹³ work previously done by PHSA, and aims to provide new information specific to local agriculture and health.

Methodology

The researchers used keyword searches in a university online database metasearch system, covering journal databases in the natural sciences, social sciences, medicine and public health. The search used synonyms and closely related terms and phrases, as well as both broader and more specific categories.ⁱⁱ After the initial search, a manual search of reference lists found further relevant articles. Reports by government agencies and non-governmental organizations (NGOs), cited in scholarly articles and books, were included when they were well researched, applicable to the British Columbia context, and provided a balanced perspective.

The search focused on sources that met the most rigorous standards in their respective disciplines, as represented by publication in peer-reviewed journals for original scholarly research projects, and approval by advisory boards and multiple highly qualified authors for government and NGO reports. In evaluating the quality and applicability of sources found in the course of the search, researchers considered several factors, including:ⁱⁱⁱ

- The size of the sample population(s) studied
- Use of established methods of scientific or social scientific inquiry
- Use of appropriate and established statistical methods of analysis
- Clear acknowledgements of study limitations and the implications of those limitations

As this document is geared primarily to an audience of public health stakeholders working in BC's health authorities, the reviewed evidence is limited to countries with strong economic and cultural parallels to Canada, such as the United States, Great Britain, Australia, New Zealand and some European countries.

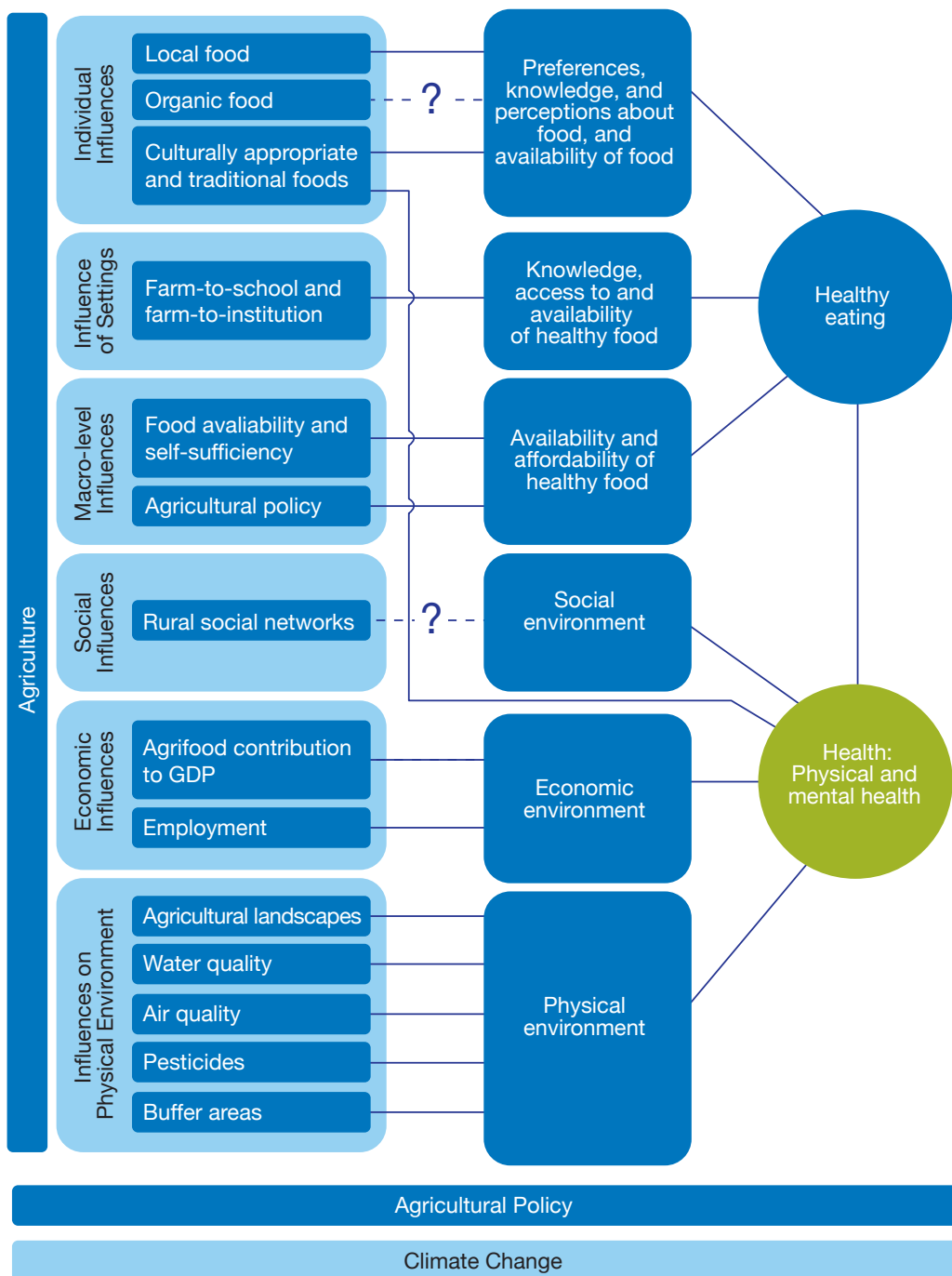
Evidence review: approach and structure

This evidence review has four sections. It starts with an overview of agriculture in British Columbia, followed by a section on the relationship between agriculture, food choices and healthy eating. The third section explores the relationship between agriculture and the broader determinants of health such as social, environmental and economic influences. The final section covers climate change, which has an overarching impact on sections two and three.

ii Search terms included not only "agriculture and health", but also "farming and health," and "food production and health". Other examples of search terms include "pesticides and health," "farm chemicals," "local food and health," "organic and health," "agriculture water quality," and "agriculture air quality".

iii The section on food availability, resilience, and self-sufficiency in BC and its Regional Health Authorities and Local Health Authorities includes data from original research conducted by the author, Aleck Ostry, which did not go through the same process.

The diagram below provides a visual overview of the connections made between health and agriculture throughout the evidence review. The figure is not comprehensive and only shows topics (with evidence and within the scope of this paper) most relevant to the public health sector in BC. This document does not provide in-depth analysis of the strength of the evidence. As such, the simplified diagrams used throughout the review indicate associations between the topics discussed and health, and do not provide information on the strength of the evidence. The diagrams do not replace the information included in the body of the document. The dashed lines with question marks indicate that there is not enough evidence to make an association.

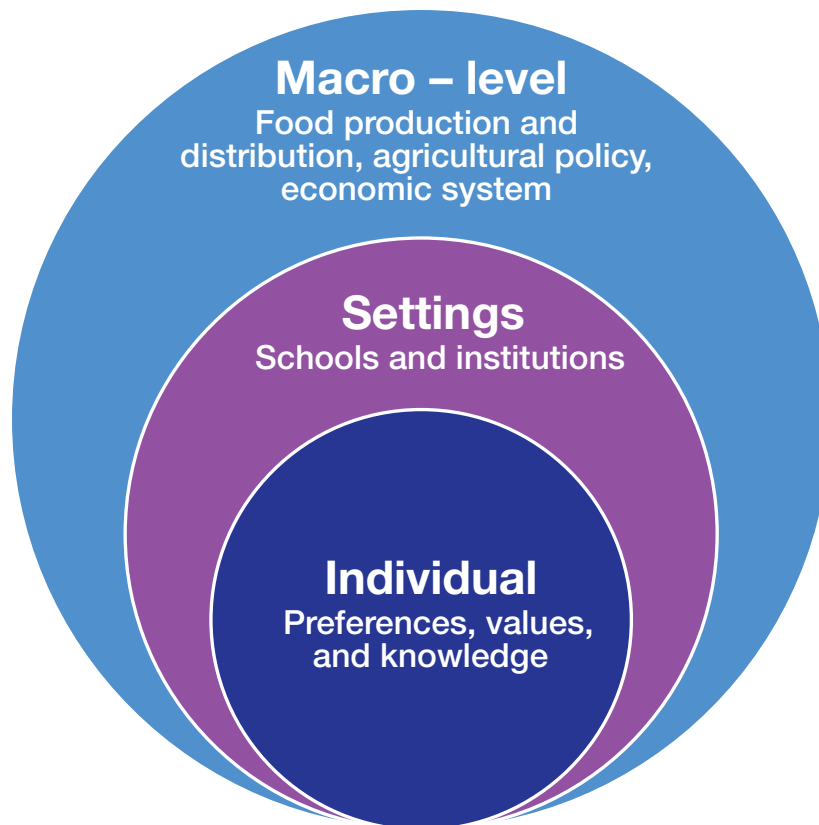


The second and third sections of the evidence review use frameworks to organize the different topic areas.

Section 2: Agriculture, food choices, and healthy eating

An ecological framework of healthy food and eating environments¹⁴ helps provide structure to this section (see Figure 1). Section 2 examines local agriculture's influence on individual food choices through: individual knowledge, preference, and perceptions; the availability of healthy food; and physical and economic access to healthy food.

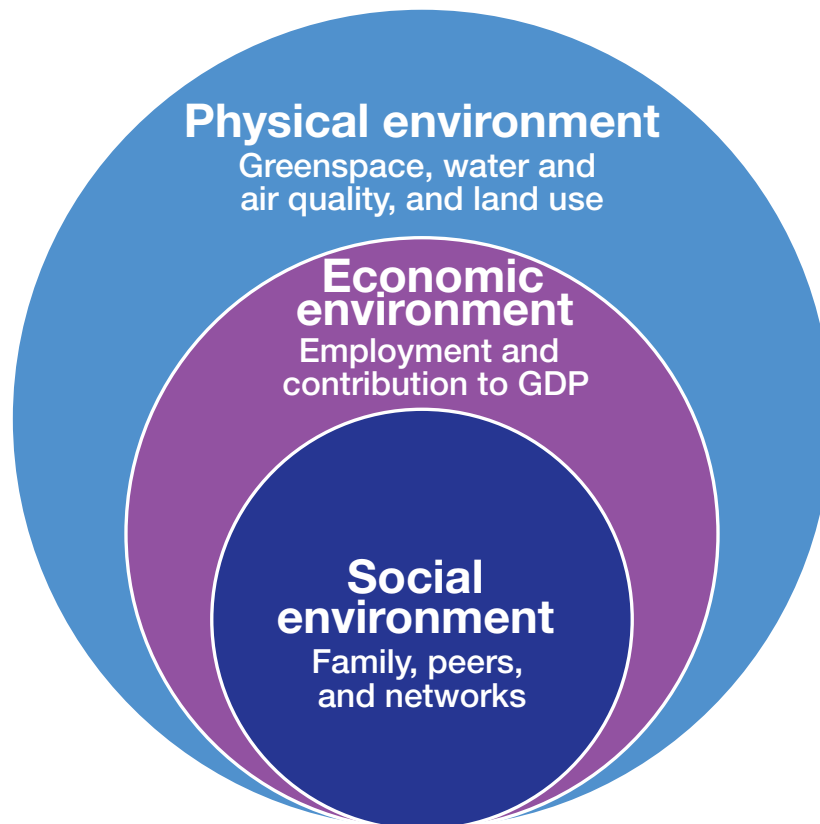
Figure 1: Modified ecological framework of healthy food and eating environments



Section 3: Agriculture and overall health

The third section of the evidence review explores agriculture's influence on broader social, environmental and economic determinants of health. Barton and Grant's health map model of determinants of health and well-being¹⁵ is modified to frame this section (see Figure 2).

Figure 2: Modified model of determinants of health and well-being



Section 1: Overview of agriculture in British Columbia

- Only half of BC's land area has any agricultural capability; only 0.2% can support the widest range of crops
- Regional agricultural practices and products vary across BC due to factors such as climate and terrain
- BC leads Canadian provinces in the production of many fruits and vegetables

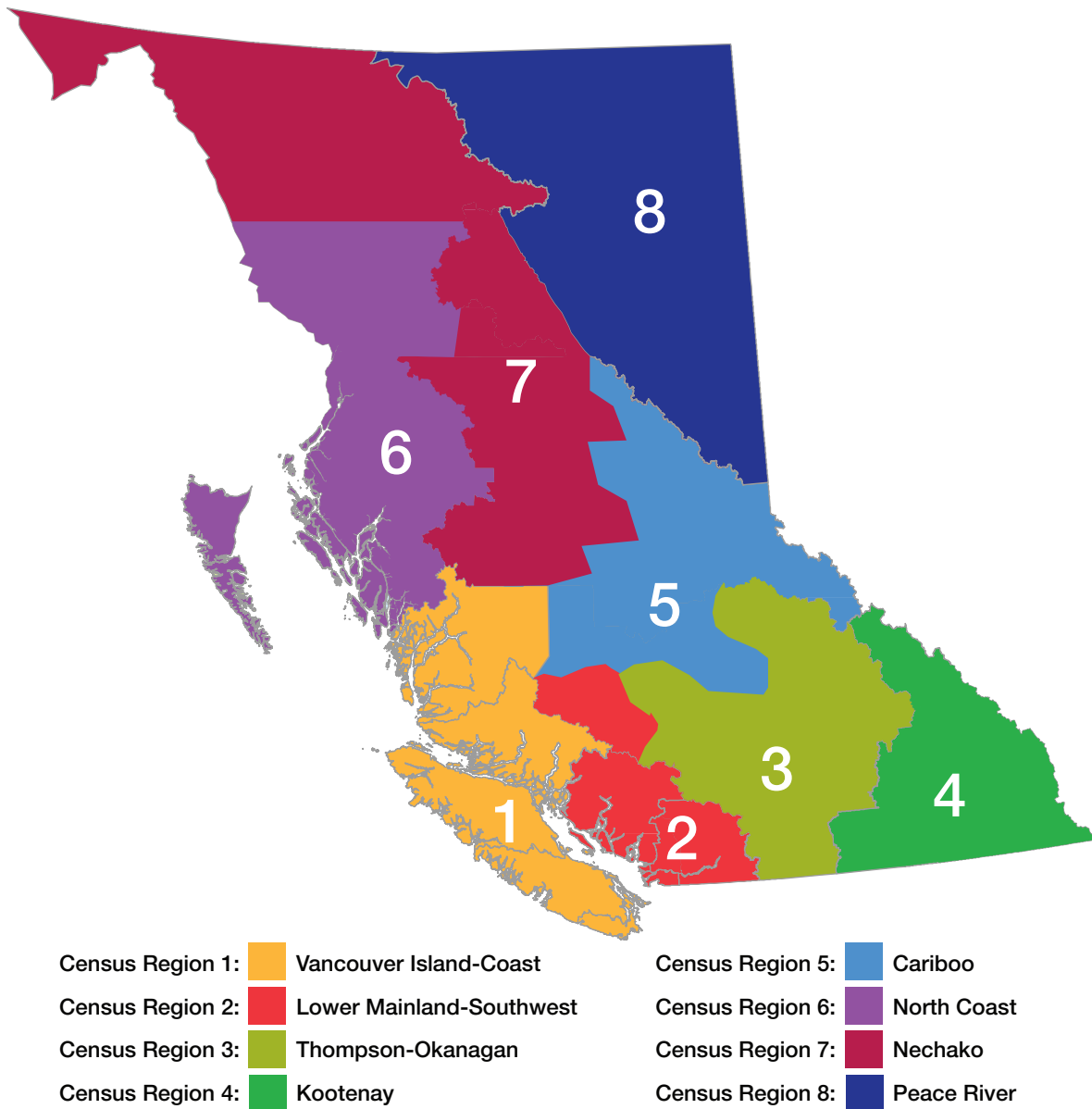
British Columbia is a large province with a strong agricultural sector, and yet only 11.9% of its land area is suitable for growing crops for human consumption. According to Canada Land Inventory characteristics, 49.7% of BC has no agricultural capability and 38.4% is suitable only for natural grazing, permanent pasture or forage crop production. Of the remaining land, 10.4% has severe or moderately severe limitations for crop production, 1.3% has moderate limits, and only 0.2% of land is capable of supporting the widest range of crops.¹⁶

Despite these limitations, there are certain areas of BC where both suitable farmland and favorable climatic conditions are present, allowing farmers to grow a wide variety of crops. These areas are the Fraser Valley area of the Lower Mainland, parts of Southern Vancouver Island, and the Okanagan. In 2013, BC's farmers led Canada in sales of blueberries, cranberries, sweet cherries, raspberries, garlic, apricots and leeks. Fifteen of the province's crops ranked second in sales in Canada: greenhouse peppers, greenhouse tomatoes, mushrooms, greenhouse cucumbers, grapes, lettuce, peaches, pumpkins, pears, Brussels sprouts, plums/prunes, nectarines, spinach, floriculture products and nursery products.

Regional variations in British Columbia agriculture

British Columbia is divided into eight census agricultural regions, as shown in Figure 3. In addition to providing a framework for the collection of statistics, the boundaries of these census regions also closely follow the divisions in agricultural practice due to such factors as terrain and climate.

Figure 3: Agricultural Census Regions of BC.¹⁷



Based on the 2011 Agricultural Census, Southwestern BC dominates the province's farm receipts, largely because of the acreage devoted to intensive production of high-value horticultural crops and poultry and dairy production in these regions:¹⁷

- The Lower Mainland-Southwest Region (Agricultural Census Region 2) includes only 5% of the province's total farmland, but takes in 65% of its total farm receipts.
- The Thompson-Okanagan Region (Census Region 3) takes in 16.4% of BC's total farm receipts on 20% of the province's farmland.

- The Vancouver Island-Coast Region (Census Region 1) takes in 5.7% of the province's farm receipts on 2% of the farmland.

The differences between the agricultural census regions can be identified and described in different ways: Table 1 provides an overview of farmland area and average receipts, and Table 2 provides an overview of their main characteristics. While averages and summaries cannot capture the complexities and variation within each region, they do provide a broad sense of differences among the regions.

Table 1: Farm Statistics by Agricultural Census Regions. Averages calculated from 2011 Census of Agriculture data.¹⁷

Census Region	Number of Farms (2011)	Total Farm Area (acres)	Average Farm Size (acres)	Total Farm Cash Receipts	Average Cash Receipt per Farm	Average Cash Receipt per acre	% of Total Farm Receipts in BC	% of Total Farmland in BC
1. Vancouver Island-Coast	3,000	128,806	42.9	\$167,549,987	\$55,850	\$1,300.8	5.7%	2%
2. Lower Mainland	5,793	310,765	53.6	\$1,920,747,557	\$331,563	\$6,180.8	65.0%	5%
3. Thompson-Okanagan	5,486	1,730,257	315.4	\$480,694,754	\$87,622	\$277.8	16.4%	20%
4. Kootenay	1,273	366,324	287.8	\$71,099,592	\$55,852	\$194.1	2.4%	6%
5. Cariboo	1,681	1,219,742	725.6	\$94,320,938	\$56,110	\$77.3	3.2%	19%
6. North Coast	126	20,853	165.5	\$2,366,235	\$18,779	\$113.5	0.1%	0.3%
7. Nechako	840	621,277	739.6	\$54,186,702	\$64,507	\$87.1	1.8%	10%
8. Peace	1,560	2,054,842	1,317.2	\$144,940,291	\$92,910	\$70.5	4.7%	32%

Table 2: Summary of agricultural census regions¹⁶⁻¹⁸

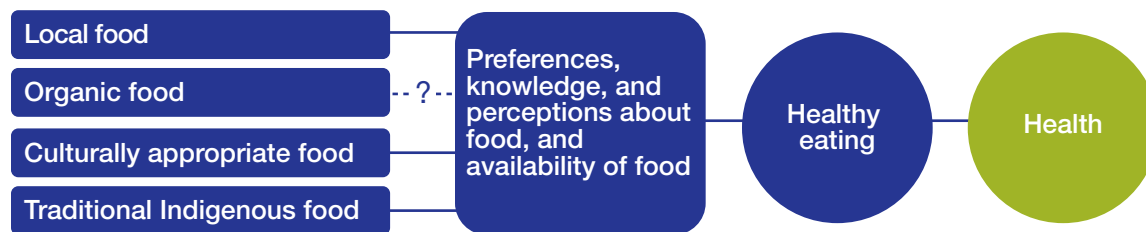
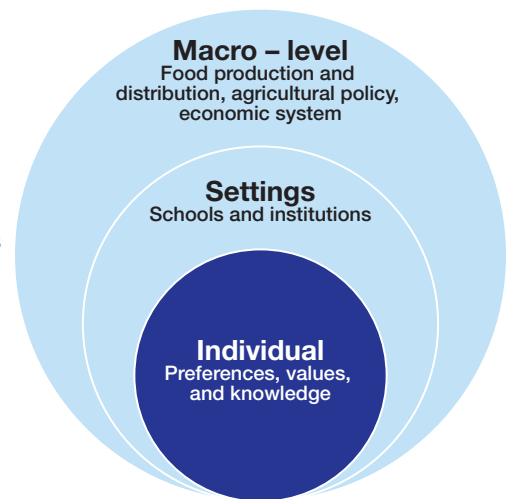
Census region	Example cities/ regional districts	Geographic features	Representative agricultural enterprises	Notable areas of production	Most common sizes of farm
1. Vancouver Island-Coast	Victoria, Nanaimo, Powell River	Mild climate, mixed precipitation levels; limited transportation options for ag products	Hay and field crops; tree fruit, berry, vegetables; greenhouse; beef; poultry	Lemons and olives becoming viable due to milder winters in recent decades	Under 10 acres; between 10 and 69 acres
2. Lower Mainland-Southwest	Metro Vancouver, Fraser Valley	Mild climate, ample precipitation; fertile soils; strong links to transportation	Berries; vegetables; nursery and floriculture; mushroom; greenhouse; hay and field crops; dairy; beef; poultry; honeybee	97% of province's total land in blueberries & cranberries; 92% of total in raspberries; 84% of total greenhouse area; 57% of BC's honeybee colonies	Under 10 acres; between 10 and 69 acres
3. Thompson-Okanagan	Okanagan Valley, Thompson River Valley	Hot summers, cold winters	Grapes; sweet cherries; tree fruits; hay and field crops; beef	87% of BC's and 75% of Canada's land in sweet cherries; 90% of BC's and 27% of Canada's land in grapes	Under 10 acres; between 10 and 69 acres
4. Kootenay	Cranbrook	Hot summers, cold winters; limited farming area in river lowlands; high transportation costs	Christmas trees; hay and field crops; beef	50% of BC's total land in Christmas trees	Under 10 acres; between 10 and 69 acres

Census region	Example cities/ regional districts	Geographic features	Representative agricultural enterprises	Notable areas of production	Most common sizes of farm
5. Cariboo	Fraser-Fort George	Cooler summers, cold winters; grassland and open forests	Hay and field crops; beef	25% of all beef cows in BC	Between 70 and 559 acres; above 560 acres
6. North Coast	Kitimat-Stikine	Isolated due to mountainous landscape; heavy rains and snow; some parts ferry-dependent	Beef; horse breeding; forage crops	Significant recent increases in turkeys and honeybees	Between 10 and 69 acres
7. Nechako	Vanderhoof, Atlin	Short growing season; not well-connected to transportation networks	Beef; forage crops	11% of all beef cows in BC	Between 70 and 559 acres; above 560 acres
8. Peace River	Ft. St. John; Dawson Creek	Prairie landscape	Grain and oilseed (wheat and canola); alfalfa; beef	94% of BC's land in canola; 87% of BC's land in wheat; 60% of BC's land in barley; 43% of BC's land in alfalfa	Above 560 acres

Section 2: Agriculture, food choices and healthy eating

Agriculture and individual food choices

- Both locally produced and organic foods are often perceived as healthier by consumers but scientific evidence does not support these perceptions
- Greater availability of locally produced fruits and vegetables may increase their consumption
- The availability of culturally appropriate/traditional fresh fruits and vegetables can be an important part of healthy eating for immigrant populations
- Indigenous foods, foodlands and waters contribute to healthy eating and physical health and are core parts of culture and identity for Indigenous populations



While there are many factors that influence individual food choices, this section focuses on food preferences, knowledge, and perceptions about food¹⁹, and covers topics such as local food production, organically produced food, and production and provisioning of culturally appropriate food.

Local food

Food sources, in particular whether or not they are “local,” are an important part of contemporary conversations surrounding agriculture. However, there is no universally accepted definition of “local”, and the distances and geographic areas used to

Glossary: Local food

The Canadian Food Inspection Agency has adopted an interim definition of “local” while it reviews food labelling regulations, guidelines, and policies. In that definition, “local” foods are those produced within the province or territory where they are sold, or food sold across provincial borders within 50km of the originating province or territory.¹⁰

define “locally produced” varies widely.^{20,21} In this evidence review, “local” refers to the geographic area where raw food ingredients are grown or raised.

To understand the relationships between local food, food choices and health in British Columbia, this section examines the evidence from two angles. The first looks at the relationship between a food's source and its actual and perceived safety and nutritional value. The second looks at the relationships between local food production and local food economies and health related behaviours and health outcomes.

Local food – food safety and nutrition

Some consumers perceive local food as safer than imported foods.^{20, 22-24} This may be because of different food safety, environmental, or labour regulations. This perception can result in avoidance of foods from places considered unsafe, such as occurred during the Chinese melamine milk scandal.²⁵ Less publicized issues, such as different regulations for the use of bovine growth hormone in dairy cattle between the US and Canada, can also create uncertainty that influences consumption.²⁶

Studies have also demonstrated that consumers perceive that local food is nutritious and can contribute to health benefits,^{20,24} and that local foods are of higher quality and “fresher” than imported foods.²⁷⁻³⁰ Research shows that individuals choose local food primarily because of its taste,²⁷ though other reasons include a desire to connect with rural life³¹ or a perceived environmental benefit.

Despite these perceptions, there is a lack of scholarly food science research quantifying the nutritional quality and food safety of local food. Studies that assess food quality need to address challenges such as the complexities of determining the chemical composition of foods (e.g. nutrients) from different supply chains and the difficulties in isolating the health effects of local food consumption within the context of overall diet.³²

Some studies used proxy indicators for local food and non-local food, such as time in storage and transport. Storage of vegetables over long transport can reduce their nutritional quality due to spoilage and loss of nutrients such as vitamin C, niacin and folic acid; however, for some vegetables, the majority of these losses are preventable using freezing technologies. In addition, due to contemporary rapid transportation methods, nutrient loss due to time spent stored in transit may no longer be a significant factor for some types of produce.³²

A study in the US found that counties with a higher percentage of farms with direct sales had lower obesity rates, and that as total per capita direct farm sales increased, rates of obesity and diabetes fell. The study also found that high farmers' market density was associated with lower rates of diabetes, yet acknowledged that the results showed a correlation and did not imply causation as, for example, people who value healthy lifestyles may seek out places with more farmers markets.³³ Studies that attempt to assess local food and health often only consider farmers' markets and other direct sales initiatives.³³ This excludes information about local food distribution through supermarkets, restaurants, and other food outlets — information that would be particularly relevant in light of British Columbia's large-scale local commercial market producers of fruits and vegetables.

Presence of local food production and a local food economy

Several studies note seasonal variation in fruit and vegetable consumption, a factor that the design of dietary guidelines and food guides do not always consider. Local seasonal availability can affect perceptions of fruit and vegetable tastiness,²⁷ the ways they are eaten (such as fresh, canned or frozen),³⁴ and the amount of the fruits and vegetables consumed.^{34,35} For example, in locations where access to fresh fruits and vegetables varies with the seasons people may consume fewer because the products that they desire are unavailable.³⁶

The local food economy (represented by the number of farmers' markets, community-supported agricultural initiatives and farm gate sales) is growing rapidly, but remains a small component of the Canadian food system.³⁷ Still, it can influence healthy eating: for example, shoppers at farmers' markets are more likely to consume five servings of fruit and vegetables every day than non-shoppers.³⁸ However, there are some barriers to consumer participation in farmers' markets. Not all areas have farmers' markets, although adding a market to an underserved area can improve food access.^{39,40} Prices at farmers' markets can also be higher than those at traditional food outlets,⁴¹ and the markets' limited hours and seasons may decrease their potential impact.⁴⁰

Organic food

Many British Columbians make food purchasing and consumption decisions based on the widespread perception that organic growing methods yield foods that are healthier and safer for consumers, and have less negative impact on the environment and agricultural workers, than foods grown using conventional methods. This section reviews scientific studies that compared health effects of consuming organic versus conventional products, and does not consider evidence related to their comparative potential environmental or occupational impacts.

Over the past two decades, numerous review articles have compared research on nutrition and food safety of organic and conventional foods.^{42,43} In 2012, the *Annals of Internal Medicine* published a review which criticized the methods and focus of prior reviews and sought to correct them through a comprehensive synthesis of 237 studies.⁴⁴ The following paragraphs are based on this review, and others as noted.

Evidence does not support the perception that organically produced foods are more nutritious than conventionally produced foods. There were no significant differences in vitamins C, A, or E in produce; vitamins A or E in milk or beef; or vitamin E in pork. Of 11 nutrients studied, only phosphorous and total phenols were significantly higher in organic produce; however, phosphorous levels are unlikely to have clinical significance since phosphorous deficiency only appears under near-total starvation.⁴⁴ There were significantly higher levels of omega-3 fatty acids in organic milk and chicken, though the number of studies investigating fatty acids was small. Other than a single study which found higher levels of trans-vaccenic acid in the breast milk of mothers on strictly organic diets, the studies comparing nutrient levels of those consuming organic to those consuming conventional diets did not indicate consistent differences.

While conventional produce is 32% more likely to have detectable pesticide residues than organic, study authors identified that this finding may not be clinically significant because there may only be small differences in risk for contamination with pesticide residues exceeding allowable limits.⁴⁴ There are no significant differences in the risk for presence of disease-causing microorganisms between organic and

conventional produce and animal products, although conventional chicken and pork have a higher risk for contamination with antibiotic-resistant bacteria.^{44, iv}

Overall, evidence suggests that the consumption of organic food does not yield substantial health benefits over the consumption of conventional foods. The authors of some reviews argue that there may still be positive outcomes for overall well-being based on the consumption of organic foods; however, the reasons are unclear.⁴⁶ There have not been any long-term, controlled studies comparing health of populations consuming primarily conventional food versus populations consuming primarily organic.⁴⁴

Immigrant populations and culturally appropriate foods

British Columbia is home to large and diverse multicultural populations, and these populations play key roles as farm owners, workers, and consumers. They also generate demand for culturally appropriate food such as vegetables perceived as having authentic taste and freshness. Not all countries of immigrant origin export to Canada and some products, particularly fruits, herbs, and tender greens, do not maintain the desired freshness across long-distance travel.⁴⁷ Local production and sale of these products may contribute to BC's diverse ethnic groups obtaining fruits and vegetables that contribute to a healthy diet.⁴⁸

Glossary: Ethno-cultural vegetables

Vegetables consumed by a group that shares a similar cultural heritage.⁴

Studies of immigrant populations have shown that respondents perceived that consuming ethno-cultural vegetables had positive health effects, such as: presence of vitamins, minerals and proteins; lesser medical expenses/good immune system; healthy diet; reduced constipation and good source of fibre; and prevention of chronic diseases.^{47,49} These perceived benefits can lead to greater fruit and vegetable consumption among immigrant populations, thereby support healthy eating.⁴⁸

The production and availability of traditional ingredients can have positive health implications for immigrants and minorities.⁵⁰ Incorporating culturally appropriate foods can be important in dietary plans designed to support disease treatment and improved health outcomes.^{51,52} Traditional foods can also assist in maintaining ethnic identity and reducing effects of acculturation.

Indigenous health, foodlands, and traditional foods

written with Dawn Morrison

BC's agricultural lands and surrounding areas were, and in many cases continue to be, crucial sites of Indigenous food provisioning. For BC's Indigenous population, traditional foods, foodlands and waters are not only important to physical health; they are also a core part of culture and identity. According to Indigenous author Jeff

Glossary: Foodlands

The concept of "foodlands" is used in BC to broaden the cultural scope beyond agriculture to include Indigenous harvesting and cultivation in the neighbouring forests, fields and waterways. This term recognizes the interconnected relationship between the health of food grown on agricultural lands and the health of the neighbouring Indigenous ecosystems.⁵

iv See section on pesticides

Corntassel, “Indigenous peoples are just that: Indigenous to the lands they inhabit, in contrast to and in contention with the colonial societies and states that have spread out from Europe and other centres of empire” (597).⁵³ Corntassel and Bryce further state that “Ongoing environmental destruction jeopardizes the sustainable relationships Indigenous Nations have practiced for thousands of years, including land-based and water-based cultural practices such as gathering medicines, hunting, fishing, and farming” (151).⁵⁴ Consuming traditional foods and being involved in traditional food harvesting and cultivation practices on Indigenous foodlands is an important part of ongoing decolonization efforts and overall physical and mental health.

Traditional Indigenous diets were highly seasonal and very diverse, and involved large quantities of seafood, game, berries and semi-wild plant matter.^{55,56} The processes of colonization and unresolved land claims have resulted in widespread loss of access to traditional lands and relationships that support the hunting, gathering, fishing, cultivation and trading of traditional Indigenous foods.⁵⁶⁻⁵⁸

Since at least the early nineteenth century, colonizers have been claiming lands that Indigenous people used for gardening and other food sourcing practices. These lands have been converted for agricultural uses, such as crop fields and animal pastures, as well as for the development of other industries such as mining and forestry. The loss of access to land has contributed to changes in the diets of Indigenous peoples, increasing their reliance on highly processed foods that contain relatively low nutritional value.⁵⁵ Contemporary agricultural processes continue to reinforce the colonization of Indigenous foodlands by affecting ecosystems, and creating environmental impacts that cross farm boundaries into dedicated Indigenous territories.

Indigenous foods

A majority of the approximately 100 species of plant foods that were traditionally cultivated by Indigenous peoples of coastal British Columbia are no longer in use, and many are unknown to the younger generations.⁵⁵ The First Nations Food, Nutrition and Environment Study (FNFES), which surveyed 1,103 individuals from 21 randomly selected Indigenous communities in BC, found that participants consumed an average of 98g of Indigenous foods per day. According to the FNFES findings, Indigenous foods complemented rather than replaced the consumption of market foods, and survey participants consuming Indigenous foods had higher quality diets as these foods significantly contributed to the intake of protein, vitamin D, vitamin A, iron, zinc and several other nutrients.⁵⁹

Survey participants reported harvesting over 200 different types of foods, most commonly fish (which 95% of the survey participants reported harvesting), berries (86%), land mammals (84%) and beach foods near the shore (60%). Other traditional foods consumed were root crops and greens (26%), mushrooms (24%), birds/fowl (17%) and foods from trees (9%). Twenty-six percent of respondents selected farming as a factor that affects or limits where they can hunt, fish, or gather berries (other factors selected include government restrictions, forestry, hydro installations and mining). Among respondents, 75% observed that climate change was affecting the availability of Indigenous foods for harvest, and almost 50% reported that climate change decreased the availability of Indigenous foods in their households.⁵⁹

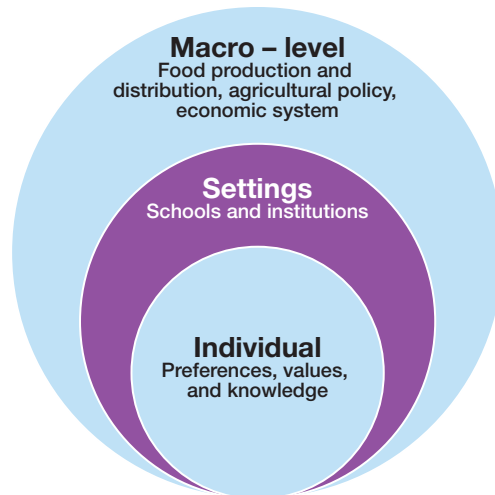
Research needs and Indigenous food sovereignty

Normative research methodologies provide, at best, very limited contributions to understanding Indigenous health. A transformative methodology of research around health and healing should recognize and build on the characteristics of strength and resiliency of Indigenous communities.^{58,60} Indigenous food sovereignty provides a framework for research and policy development that “explicitly recognizes the social, cultural and economic relationships that underlie inter-community food sharing and trading as a mechanism for Indigenous health and well-being” (1165).⁵⁸ Community consultations with Indigenous peoples have documented the ongoing significance of Indigenous foods and foodways to Indigenous health and cultural well-being in both rural/remote and urban areas.⁵⁸ These consultations have also drawn attention to the lack of access to traditional foods.⁶¹⁻⁶³ Dawn Morrison, a member of the Secwepemc Nation and Director of the BC Food Systems Network Working Group on Indigenous Food Sovereignty, describes the concept of Indigenous food sovereignty as follows:

Indigenous food sovereignty describes, rather than defines, the present day issues, concerns, situations and strategies that enable and support the ability of Indigenous communities to sustain traditional hunting, fishing, gathering, farming and distribution practices, the way we have done for thousands of years prior to contact with the first European settlers...We have rejected a formal universal definition of sovereignty in favour of one that respects the sovereign rights and power of each distinct nation to identify the characteristics of our cultures and what it means to be Indigenous.⁵⁷

Agriculture in public settings

- Farm-to-school initiatives have the potential to contribute to healthy eating
- There is widespread interest in connecting farms with institutions, but regulations may hinder these efforts
- Farm-to-school and farm-to-institution programs may provide economic benefits to local farmers



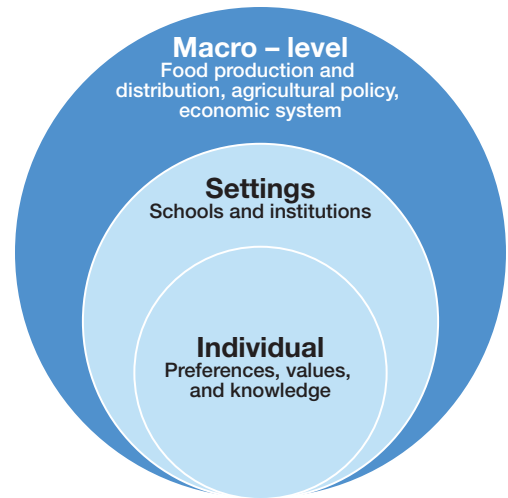
Agriculture can contribute to public health programming and healthy eating in a public setting. Farm-to-school programs are designed to increase the amount of locally produced foods, most frequently fruits and vegetables, served by schools.⁶⁴ Other objectives include improving student nutrition and providing health and nutrition education opportunities.⁶⁵ Evaluations of farm-to-school initiatives in the United States indicate their potential for positive economic benefits for farmers and positive health benefits for individuals; in particular, as a means to combat obesity by promoting healthy eating among children.^{66,67}

Most of the research on the implementation and effectiveness of farm-to-school programs comes from the US, where farm-to-school initiatives have been active since the 1990s.⁶⁸ As of 2012, there were over 40,000 U.S. schools involved.⁶⁹ In a review of 11 studies that looked at dietary changes, 10 showed that “positive dietary behaviors result when students are served more fruits and vegetables, especially when the product is fresh, locally grown, picked at the peak of their flavor, and supplemented by educational activities” (236).⁶⁵ Of four studies that reviewed the impacts of education activities, all showed increases in student knowledge of topics such as nutrition and health, local and seasonal foods, and sustainable agriculture.⁶⁵ Five of the 11 studies also examined out-of-school behavior, and four of those found increases in fruit and vegetable consumption outside of school. There was limited data on farm-to-school programs and parent behavior, although three studies of programs that included a parent education component “have reported positive changes in parental behaviors, knowledge, and attitudes” (240).⁶⁵ Other studies since this review support the findings,^{70,71} though there have been calls for additional and more rigorous studies.⁷²

While farm-to-school is the most widely implemented farm-to-institution program in Canada and the United States, colleges, hospitals, senior centres and correctional facilities also participate in such programs. As broader farm-to-institution programs are newer than farm-to-school programs, much of the research on non-school initiatives has focused on evaluating interest in the program and analyzing their structures. The impacts of non-school farm-to-institution programs on health, knowledge, or local farms has not yet been studied.⁷³⁻⁷⁵ More work is also needed to evaluate the economic impact of farm-to-institution for individual farmers and for the farming sector. Despite interest in participating in farm to institution programs, regulatory frameworks surrounding procurement, food safety certification, liability and insurance may hinder implementation efforts.^{65,76}

Agriculture and food choices within macro-level environments

- Food self-sufficiency can support healthy eating and food security in BC
- Factors including the presence of suitable farmland, population distribution, global markets and climate change can affect food self-sufficiency in BC
- Agricultural policy in BC contributes to food availability by preserving farmland and regulating the supply of some agricultural products



The availability of food and resiliency of the food supply in British Columbia are key components of food security and healthy eating. This section considers food availability in BC through two lenses: first, by analyzing BC's food self-sufficiency based on available production, consumption and export data; and, second, by examining the policy frameworks for agricultural production in BC.

Glossary: Food self-sufficiency

Food self-sufficiency in the context of this evidence review refers to a state in which BC's food supply is stable and resilient to external pressures such as supply chains as well as economic and climatic changes.

Food availability and self-sufficiency in BC: a factor in healthy eating

by Aleck Ostry

BC has a strong agriculture sector that supports food availability for residents of the province, as well as other parts of Canada and the global market. BC also depends on imports of fruits, vegetables, and other products for its food supply. Changes to the current global economy and climate^v affect the global food system and impact food availability and costs in BC. Therefore, BC needs a resilient food system that ensures access to, and consistent availability of, healthy food for the population.

Examining within-province food production in relation to consumption needs provides basic data on food self-sufficiency and resilience for essential foods such as meat, vegetables and fruit, and can indicate the overall resilience of BC's agricultural system. The information in this section uses data from 2006, as data from the 2011 census was not available at the Local Health Authority (LHA) level. Six foods—eggs, dairy products, meat, grain for human consumption, fruit and vegetables—are examined. Fish is not included as there is no data available linking it to individual LHAs in this context.

Reasons for considering food self-sufficiency in British Columbia

1. Food production within British Columbia is highly concentrated, with four areas producing most of the province's food: the lower Fraser Valley, the Okanagan, South-central Vancouver Island and Peace River^{vi}. Except for the Peace River area, which focuses mainly on the production of grains for animal feed and cattle, these food-producing areas are located in and around the province's major population centers.⁷⁷ And, as the Lower Mainland is the main destination point for foods imported into BC, the result is that people in many rural and remote parts of the province are located far from the main sources of both foreign and BC-produced foods.
2. Supplying small populations located far from food production and processing regions is expensive, making food prices and therefore access to food more precarious in these areas. Many of these rural and remote areas of BC also experience economic instability, compounding the problems of access caused by long and expensive food supply chains.^{78,79} Changes to provincial slaughtering rules also likely had a disproportionate impact in these areas, by closing local meat processing facilities.^{80,81}
3. Importing foreign foods could become more difficult in the 21st century due to accelerating demand for these same foods from rapidly developing nations. In countries such as China and India, the food consumption patterns of the middle classes are moving towards high consumption of enriched grains, meat, dairy, and fruit and vegetables in all seasons.^{82, 83} This may increase both competition for, and the price of, foreign foods purchased from traditional suppliers.
4. Instability in currency exchange rates has become more "normal" since the global economic recession of 2008.⁸⁴ When Canadian currency drops in value relative to the currency of major foreign food suppliers, formerly affordable sources of imported food can rapidly become very expensive. In this

v See section 4 on climate change

vi See section 1 on agriculture in BC

currency environment, over-reliance on food imports from nations with relatively high value currencies, such as the United States, could disrupt food access.^{85,86}

5. The impact of climate change on the production and availability of foods both in the province and in other regions need to be determined, particularly for food insecure British Columbians.^{87, 88} Of particular concern is California, which produces 40-50% of BC's supply of fruits and vegetables. The impacts of these anticipated climatic changes in California include diminished yields from increased temperatures,⁸⁹⁻⁹¹ shorter periods of crop development,⁹²⁻⁹⁴ reduced quality from unseasonal precipitation or adverse temperatures during fruit development⁹⁵ and shifts in growing regions suitable for specialty crops.⁹⁶ Increased temperatures may also diminish yields of tomatoes,⁹⁰ rice,^{93,97} stone fruits,⁹² grapes⁹⁸ and milk.⁹⁹ It is expected that orchards in California will experience fewer than 500 chill hours per winter by the end of the 21st century, to the detriment of fruit and nut production.^{100, vii}

Determining food self-sufficiency in British Columbia

Food self-sufficiency at the provincial level can be estimated from the production quantity of each of the basic foods (meat, dairy, eggs, vegetables, fruit and grains) consumed by British Columbia's population, on average, in a given year. If the quantity of food consumed by this same population is known, it can then be divided by the production data to obtain measures of self-sufficiency for these six types of foods.^{101,102}

Several studies have estimated food self-sufficiency in BC,^{77, 103-107} including the BC Ministry of Agriculture's *BC's Self-Reliance Report* (2006). This report used 2001 Agricultural Census data to estimate production of basic foods in the province, and National Food Disappearance (NFD) data to estimate the quantities of these same foods consumed by BC's population, determining that BC was 56% food self-sufficient.⁷⁷ A later study by Ostry *et al* modifies the methods for estimating food self-sufficiency by basing consumption estimates on the 1998 BC Nutrition Survey.^{101,102} This survey was representative of BC's population and therefore provides more precise estimates of food consumption patterns in the province compared to NFD data.¹⁰¹ As well, this study estimated self-sufficiency at the sub-provincial Regional Health Authority (RHA) and LHA levels.

British Columbia's overall food self-sufficiency

In 2006, British Columbians consumed and produced approximately 1.9 million and 1 million tons of food, respectively (Table 3).^{viii} Based on Ostry *et al*'s methods, the calculations in Table 3 show that BC was 52.2% food self-sufficient. Food self-sufficiency was greatest for meat (115.4%) and eggs (99.9%), followed by dairy (57.2%) and vegetables (45%) and fruit (47.7%). Grains for human consumption had the lowest rate of self-sufficiency (10.8%).^{101,102}

vii See section 4 on climate change

viii Estimates of self-sufficiency were calculated at the provincial, RHA, and LHA levels by dividing consumption data (obtained as outlined in Morrison *et al*⁸⁹) for the six basic foods by production data for these same geographic boundaries (*ibid.*)

Table 3: Production, Consumption (tons) and Food Self-Sufficiency (%) for Major Food Categories in BC, 2006¹⁰⁸⁻¹²¹

Food Category	BC Production (tons)	BC Consumption (tons)	Food Self-Sufficiency
Vegetables	157,521	349,902	45.0%
Fruit	164,472	344,709	47.7%
Grains (human consumption)	28,819	267,405	10.8%
Meat, poultry	177,050	153,429	115.4%
Dairy products	436,240	762,205	57.2%
Eggs	33,144	33,107	99.9%
Total	997,246	1,910,819	52.5%

Regional food self-sufficiency in British Columbia

A region may produce food destined for consumption by the local population and for export markets. Some regions may import considerable quantities of food to feed their populations. The balance between food produced for local consumption versus for export, and the extent to which a region imports food varies across regions, food category, and time, depending on many factors. Some of these factors include: the agricultural potential of the region; the extent to which it is linked with regional, national and international markets for agricultural products; consumer trends; agricultural policy; the changing price of different foods; and the character and shape of the food chains accessed by large retailers operating in the region.⁸⁷

Table 4 shows the range of basic food self-sufficiency rates by RHA, ranging from a high of 89.1% in Fraser Health (FH) to a low of 4.8% in Vancouver Coastal Health (VCH).^{101,102} The five regions have diverse characteristics (such as terrain, soil, and climate) that affect their production capabilities and potential; not all regions can be food self sufficient in all food categories. However, describing the RHAs in terms of their ability to provide a balanced diet helps to identify regional deficits in balanced food production, showing which RHAs are most vulnerable to food supply disruption.

Table 4: Food Self-Sufficiency (%) for Major Food Categories by RHA, 2006¹⁰⁸⁻¹²¹

Food Category	Fraser Health	Interior Health	Northern Health	Vancouver Coastal Health	Island Health	BC
Vegetables	100.8	23.8	8.1	10.6	17.6	45.0
Fruit	28.9	202.7	0.8	10.5	9.1	47.7
Grain	0.6	7.2	140.9	0.0	0.5	10.8
Meat	185.6	185.2	253.5	3.0	21.0	115.4
Dairy	116.1	50.5	21.2	1.5	37.3	57.2
Eggs	228.5	44.4	39.8	6.5	54.8	99.9
Total	89.1	78.1	50.9	4.8	22.3	52.2

Outside of FH, no region is self-sufficient in vegetable production, and no region other than Interior Health (IH) is self-sufficient in fruit production. The pattern is similar, but with a much greater disparity, in the case of grains for human consumption—outside of Northern Health (NH), grain self-sufficiency in BC is very low.

The average animal food self-sufficiency for BC was 90.8% (calculated by averaging self-sufficiency for eggs, dairy, and meat). The average for plant foods (taken by averaging for fruit, vegetables, and grains for human consumption) was 46.4%. IH was the only region with balanced self-sufficiency for plant (113.3%) and animal foods (93.4%). While VCH had greater self-sufficiency in plant compared to animal foods, overall self-sufficiency for both was low. In both FH and Island Health (VIHA) animal food self-sufficiency was about three times that of plant foods. The differences are even greater in NH, where vegetable and fruit self-sufficiency averaged 4.5%, compared to 104.8% for animal food products.

Fruit and vegetables: a key component of healthy eating

The question of regionally balanced production is especially important when it comes to fruit and vegetables because people consume less—and, in some cases, much less—than recommended for maintaining health.¹²² In particular, NH has both major concentrations of at-risk populations with high rates of diet-related illness and inadequate fruit and vegetable intake,^{101,102} and the lowest rate of self-sufficiency in the production of these foods. This increases the region's vulnerability to possible price increases and disruptions in the food supply because of long supply chains originating both within and outside of the province.

British Columbia's vegetable growing sector has also undergone major change in the past two decades, characterized by rapid growth in greenhouse vegetable production and steady declines in non-potato field vegetable production.¹²³ In 2006, BC produced approximately 40% of the 157,000 tons of vegetables grown using greenhouses, with the majority located in FH. FH also produces the majority of field vegetables (Table 5).

Table 5: Total Vegetable (Greenhouse & Field) Production (tons) in BC by RHA, 2006¹⁰⁹⁻¹¹¹

RHA	Non-Potato Field Veg.	Potatoes	Field Veg. & Potatoes	Green House Veg.	Total Veg.
FH	23,746	35,818	59,564	62,485	122,049
IH	5,003	7,574	12,577	1,067	13,644
NH	478	1,360	1,838	13	1,851
VCH	1,257	7,129	8,386	1,030	9,416
VIHA	3,329	4,995	8,324	2,237	10,561
BC	33,814	56,875	90,689	66,832	157,521

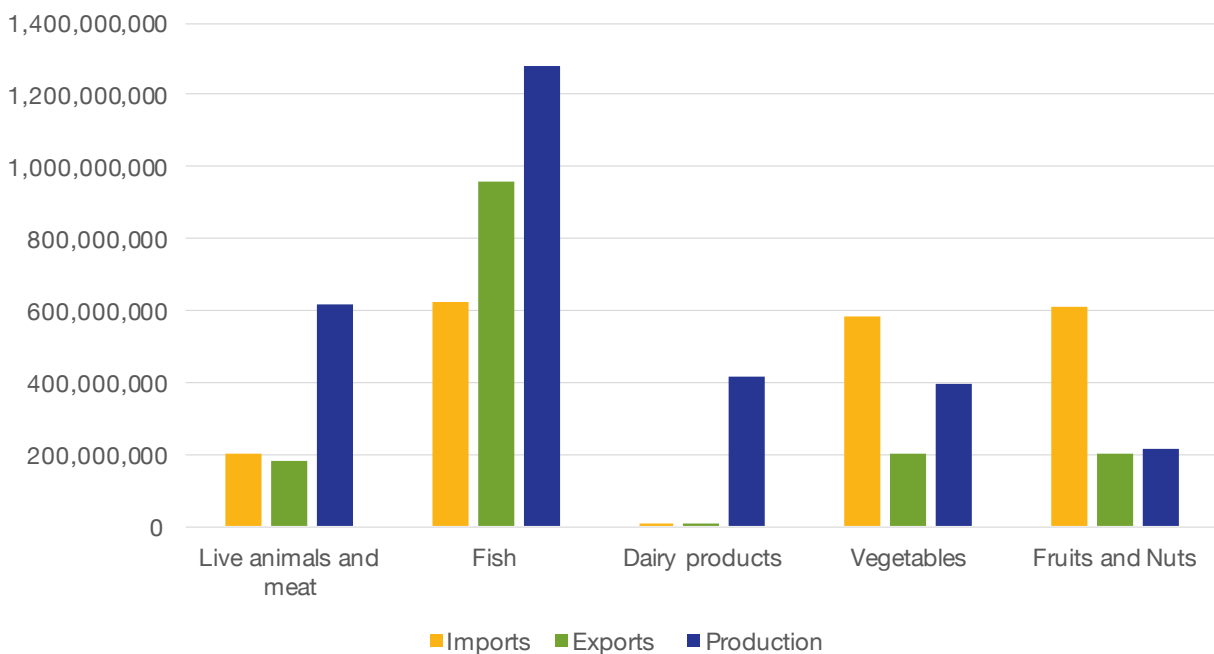
Greenhouse vegetable production in BC focuses on cucumbers, peppers, and tomatoes and most of these crops are exported to the United States.⁷⁷ Since greenhouse vegetables represent the major share of overall vegetable production in BC, and most of these are exported, the province's self-sufficiency in vegetables is less than the calculated 45%. The result is that the momentum in the vegetable producing sector in BC is shifting towards increased dependence on importing foods.⁸⁷

Import/export dynamics of food

Figure 4 shows the approximate Canadian dollar value of foods imported, exported and produced in British Columbia. Most dairy production in BC is for consumption within the province, with limited imports and exports. There is a somewhat similar pattern for live animals and meat, although it is much less pronounced. Fruit and nuts (a category that is overwhelmingly fruit) and vegetables constitute the greatest dollar value of imports of foods—approximately \$600 million each—into BC, after fish products.

Approximately 70% of the province's vegetables are imported from the United States with a further 17% coming from Mexico. The US also accounts for approximately 60% of the province's fruit imports. Since California produces much of the vegetables and fruit in the US, BC is highly reliant on the state's agricultural productivity for future imports of these foods.¹²⁴

Figure 4: Approximate Value in Canadian Dollars of Foods Imported into, Exported from, and Produced in British Columbia (2007).^{124,ix}



For more information on food self-sufficiency in BC's Local Health Areas, see the Appendix.

ix Industry Canada has data on the Canadian dollar value of BC's food imports and exports, and Statistics Canada has data on the value of BC's food production. While these two agencies classify foods in different ways, preventing a direct and accurate comparison, aggregating Statistics Canada's food categories makes it possible to roughly compare the value of foods produced within the province with Industry Canada's values for imports and exports.

British Columbia's policy framework for agriculture

Agricultural production has remained viable in British Columbia for the past four decades because of farmland preservation and other policy interventions. These help to maintain a level of food production that contributes to the province's levels of food self-sufficiency.¹²⁵

Farmland preservation

In the early 1970s, BC was still experiencing the robust population growth in urban and suburban areas that began after World War II. New housing developments were often situated on farms, as many of the characteristics that make land well suited for crops also make it well suited for building.¹²⁶ Total farmland in the Lower Mainland region had peaked in 1941 at 330,259 acres.¹²⁷ By 1961, total land in farms fell to 274,588 acres, and then to 256,236 acres by 1966,¹²⁸ a loss of over 74,000 acres in 25 years.

In 1973, the provincial government passed the *Land Commission Act*, which included a mandate to zone agriculturally productive lands as protected farmland (known as the Agricultural Land Reserve, or ALR), and created a Land Commission to oversee the designation and management of these lands.¹²⁹ Despite high numbers of petitions to exclude land from the reserve, some successful, the ALR has been able to protect farmland in BC. Geographic information systems analyses of original ALR boundary maps, additions and approved exclusions show a net loss of 7% of ALR land in the Lower Mainland since its formation (this does not include non-farm use on ALR land, or right-of-ways cutting through agricultural parcels).¹³⁰ Support for the ALR in BC is very high: a 2008 survey indicated 95% support for farmland preservation through the ALR, including 52% who say they “strongly support” it.¹³¹ In 2014, the provincial government implemented changes to the governance structure of the ALR and established two separate zones of ALR land. Zone 1 consists of Vancouver Island, the South Coast, and the Okanagan. Zone 2 consists of all other areas of the province, and has the potential for expanded uses beyond those previously permitted in the ALR.^{132,133}

In 1996, the province passed the *Farm Practices Protection Act* (FPPA), otherwise known as the Right to Farm Act, which remains in effect today. This act states that farmers are not liable for disturbances and cannot be prevented from conducting defined normal farm activities on designated farmland or land permitted for agricultural use.^{134,135} Municipalities around the province have since adopted policies to further protect farmland, support their local agricultural economies, and mediate conflicts between farmers and neighboring residents.

Food supply management

Another policy framework that affects farmers, the food supply, food access and health is supply management. By regulating the production of specific commodities, as well as limiting imports, supply management is one method of safeguarding farmers and ensuring the viability of local agricultural and agrifood industries. Agricultural marketing boards set common minimum prices for any controlled commodity, guaranteeing producers a minimum earning. Consumers can be expected to pay higher price for these compared to other countries without supply management. In Canada, the dairy, egg and poultry industries are the primary

Glossary: Supply management

Supply management, also known as supply quota systems, refers to a variety of policies that control the price of domestic food products, with the overarching goal of ensuring agriculture and agri-food producers have a predictable return on their investments.

beneficiaries of supply management.¹³⁶ Milk, cheese, butter, ice cream, eggs, chicken and turkey production are all regulated and controlled through a quota system, administered by producer associations.¹³⁷⁻¹³⁹ A separate issue is the control of wild fisheries harvests for managing the viability of the wild population, which is beyond the scope of this document.

Supply managed products are associated with decreased availability and increased costs, which could result in lower consumption compared to unregulated products.¹⁴⁰ Contrary to these expectations, however, the per capita availability of food products in supply-managed sectors is higher than the availability of comparable, unregulated commodities. For example, chicken and turkey are more widely available than beef, pork and other meat products, despite the fact that quota systems do not limit production in these industries.¹³⁶ Current supply management policies are among the factors that have contributed to increased prices for poultry products.¹⁴¹ Arguing that poultry is lower in saturated fats than other meats, particularly beef, Cash *et al.* suggest that supply management policies may actually encourage consumers to make less healthy food choices.¹⁴⁰ However, poultry consumption is significantly higher than that of beef or pork, and is the only meat product for which consumption levels continue to rise steadily.¹³⁶

Supply management may also contribute to a perception that food produced under its policies is safer because it is highly regulated and its source is known^x. Moreover, average consumption of supply-managed commodities generally exceeds the recommended maximums in *Eating Well with Canada's Food Guide*.¹⁴² One other aspect of the quota system needing further study is the possibility of regional concentration, which makes it more difficult to produce managed food categories in remote areas.

Supply management, food prices and low-income populations

Low-income households suffer disproportionately from the effects of high food prices. Policies that increase the prices of staple products have highly uneven impacts, and can contribute to food insecurity for low-income households and individuals with relatively low purchasing power.¹⁴³ For example, per capita milk consumption in Canada is significantly higher than the global average,¹⁴⁴ and consumption of all dairy products, measured in their milk equivalencies, is well over double the global average.¹⁴⁵ However, income inequality contributes to lower consumption of milk and dairy products, and general food insecurity, in low-income households and in families headed by lone mothers.^{143,146} The high levels of average dairy consumption in Canada, and the cultural role played by milk, cheese, and other dairy products, can also compound feelings of social exclusion in households where caregivers have difficulty providing milk for their families.^{143,147}

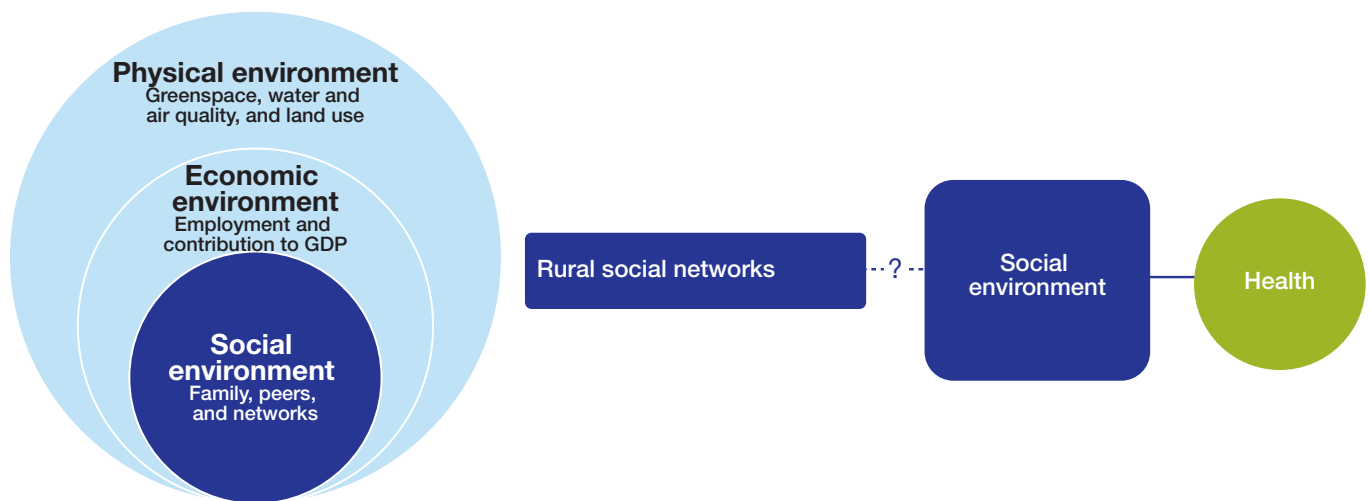
While prices affect grocery purchasing, increased resources and flexibility in household budgets have a much greater influence on the consumption of healthy food.^{148,149} Changes in household income, rent increases and fluctuations in expenditures not only impact purchasing of meat and dairy products, but also fruits, vegetables and other foods not subject to supply management.¹⁵⁰ In contrast to the case of milk and other supply managed food products, average consumption of fruits and vegetables are insufficient to meet *Eating Well with Canada's Food Guide* recommendations,¹⁵¹ and low-income individuals and households consume fewer servings still.^{150,152} Income disparities have a greater influence on the different levels of fruits and vegetables consumption among socio-economic groups than on the consumption of other food products, including supply-managed commodities.¹⁴² While decreasing the costs of dairy, egg, and poultry would be beneficial for low-income purchasers, this would not necessarily address existing imbalances in dietary composition.

Section 3: Agriculture and overall health

This section describes the positive and negative links between agriculture and mental and physical health in the context of social networks, the environmental factors of green space, air quality, water quality and pesticide use. It also describes the economic link between agriculture and health, in terms of agriculture's financial impact and role as a significant employer in the province. Buffer areas that separate farmland and residential spaces are included as a strategy to manage potential adverse effects of agriculture.

Agriculture and the social environment

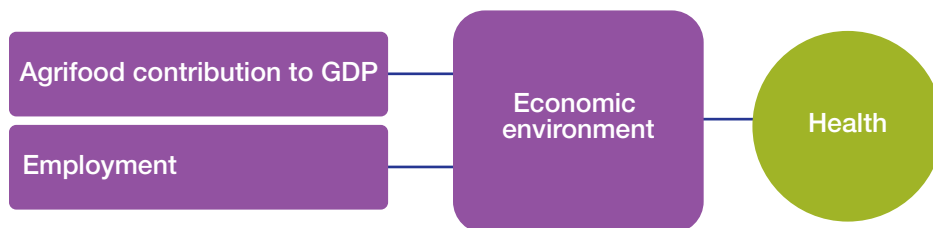
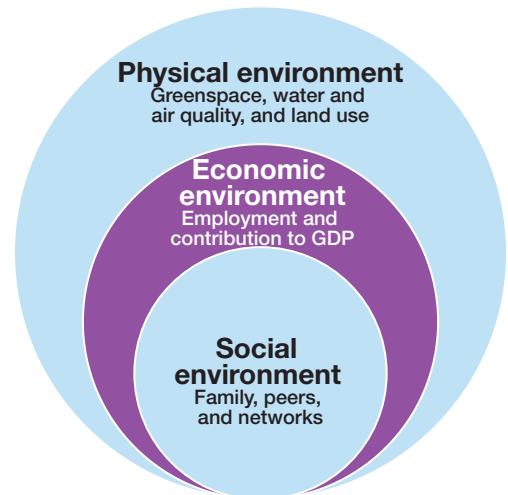
- Rural communities tend to have stronger social networks compared to urban centres but more research is needed on social networks in farming communities



Social support networks are a key part of the social environment that influences individual health and making healthy choices. There is a widely held belief that members of farming communities have strong social ties and support one another through difficult times. While there is some evidence showing that there tend to be stronger social bonds within rural communities compared to urban settings¹⁵³, and a few recent studies have looked at rural social bonds in Canada,¹⁵⁴⁻¹⁵⁶ more research is needed specifically on social networks in farming communities.

Agriculture and the economic environment

- Primary agriculture (production) constitutes 0.6% of BC's GDP, including a total of \$2.9 billion in farm cash receipts in 2014
- BC agrifood exports (excluding seafood) were valued at \$2 billion in 2014
- In 2014, the agriculture sector employed 22,937 people in BC



Agriculture is an economic driver in British Columbia

The total contribution of primary agriculture (production) to British Columbia's GDP has been roughly 0.6% each year for the past 5 years.¹⁵⁷ Total farm cash receipts were \$2.9 billion in 2014 and have been near this level for the past few years.¹⁵⁷ This total is split nearly evenly between crop products and livestock/poultry products with approximate values of \$1.4 billion and \$1.5 billion, respectively.¹⁵⁷

Agricultural exports have significant economic impact

In 2014, British Columbia's agrifood exports (excluding seafood) totaled \$2 billion.¹⁵⁸ Even with decreases in some years, export values have, overall, increased over the past decade from \$1.36 billion in 2004.¹⁵⁸ The U.S. has long been BC's biggest export market, receiving roughly two-thirds of the total.

In addition to generating revenue, exports also support other economic multipliers. In 2008, the Canadian agriculture, forestry, fishing and hunting sectors had a combined export employment multiplier of 1.9. In other words, each job directly associated with exports is also associated with an additional 0.9 indirect jobs.¹⁵⁹

Agriculture provides employment

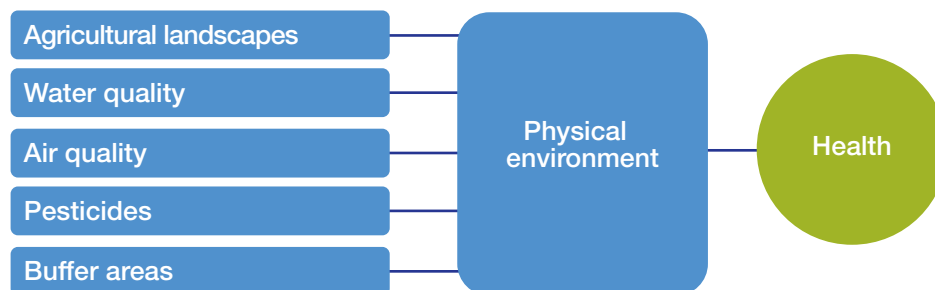
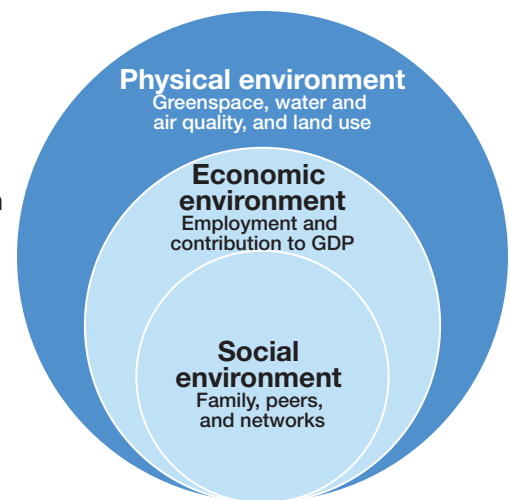
Having an income-earning job provides not only the economic resources to support a healthier lifestyle, but also a sense of identity and purpose and a stronger social framework, resulting in greater physical, mental and social health.¹

According to the BC Ministry of Agriculture, employment in agriculture peaked in 2005 at 36,300 and experienced a near steady decline until 2012, when agriculture employed 22,439 people.^{157, 161} In 2014, there were 22,937 people in British Columbia directly employed by agriculture.¹⁵⁷

In the Fraser Valley and Okanagan areas, recent immigrant populations compose a significant number of farm operators and employees. Nearly 40% of Metro Vancouver's farmers and farm managers reported belonging to a visible minority group, most commonly South Asian followed by Chinese. This is three times higher than the provincial rate and eighteen times higher than the rate across Canada.⁴⁸

Agriculture, the physical environment and health

- Spending time in green environments, which could include agricultural areas, may contribute to positive mental and physical health outcomes
- Agriculture can negatively affect surface and ground water quality through nutrient, sediment, bacteria and pesticide contamination
- Agriculture can negatively affect air quality through contributions to particulate matter, odours and volatile compounds
- Pesticides are associated with both negative health impacts (e.g. impaired neurobehavioural function) and positive health impacts (e.g. prevention of disease outbreaks)
- Buffer areas between farmland and residential areas can help to mitigate complaints of noise, dust and odours, but do not completely eliminate the impacts associated with farm activities



Agricultural landscapes and mental and physical health

There is a body of research examining the mental and physical health effects of viewing and being in and around landscapes, including landscapes with characteristics often found in farming and ranching areas.

A review of 31 studies on the effects of viewing landscapes on health found that natural landscapes generally created “a stronger positive health effect than urban landscapes” (209).¹⁶² The main health effects were “related to reduced stress, improved attention capacity, facilitating recovery from illness, ameliorating physical well-being in elderly people, and behavioural changes that improve mood and general well-being”(210).¹⁶² However, most of the studies in this review made few distinctions within the category of “natural” and only two specifically pointed to agricultural landscapes.^{163,164} Many neither explicitly included nor excluded agricultural landscapes in the undifferentiated green or open spaces they studied.

One study from the Netherlands, which did examine agriculture areas, found a positive correlation between the amount of greenspace in one's living environment and self-perceived health. Of the three types of greenspace included (urban green areas, agricultural areas, and forests and nature areas), only agricultural green was related to perceived health. They did not interpret this as agricultural greenspace having a stronger effect on health than the other two types; rather, they attributed this to agricultural areas being the largest component of total greenspace.¹⁶⁵

There is also evidence indicating an important relationship between green and natural spaces and physical activity, health and quality of life. In particular, visits to green and natural environments are associated with higher levels of physical activity, especially walking, regardless of the purpose of the visit.¹⁶⁶ A 2013 study from the United Kingdom investigated differences between mental health effects of group walks in urban environments and in farmland environments, and found that group walks in farmland environments were significantly associated with less perceived stress and negative emotions, and greater mental well-being.¹⁶⁷

While there is a considerable body of evidence supporting the idea that viewing and being in green space can have positive health outcomes, especially for mental health, there is a need for more research on the effects of specific characteristics of greenspace, and agricultural land in particular.

Agriculture, environmental quality and health

Water quality

Agricultural practices depend on a reliable supply of high quality water. For the 274,630 irrigated acres on 7,304 of British Columbia's farms,¹⁷ water quality is especially important because contaminants such as pathogens, organic compounds and chemicals may damage crops and persist after harvest. Water quality is also a concern when raising livestock. For example, cattle can generally tolerate lower quality water than poultry or hogs, but cattle are highly susceptible to nitrate poisoning.^{168,169} In addition to requiring more resources for their care, sick animals may produce meat that is of reduced quality or unfit for human consumption.

Agricultural practices can adversely affect water quality. The Canadian Water Quality Guidelines provide the safe levels of substances for water uses such as drinking, protecting freshwater aquatic life, irrigation and

watering livestock. These guidelines include several substances “commonly derived from agriculture” (29), including bacteria, nitrate, nitrite and various pesticides.¹⁶⁸ Determining agriculture’s effects on water quality is complicated by the challenges of tracing the source of pollutants in waterways, delays in the appearance of their effects and diverse farming practices on different types of land and soil.¹⁶⁸

BC receives three-quarters of its potable water supply from surface sources, including rivers, streams, creeks, lakes and rainfall. These sources are vulnerable to contamination from agricultural practices, as well as from other human and animal activities, and natural occurrences such as heavy rainfall runoff or landslides.¹⁷⁰ The presence of pollutants in surface water can affect the size and quality of fish populations, and pollutants in groundwater can potentially contribute to gastrointestinal illnesses and other negative health effects in humans who drink it.

In recent decades, several studies have examined agriculture and water quality around BC. Many of these studies focused on the Fraser Valley as it is the site of both intensive animal and horticultural production. In addition, it sits over the Abbotsford-Sumas aquifer, which provides water to over 100,000 people in the U.S. and Canada. Nitrate concentrations in the groundwater there exceeded the Canadian drinking water guidelines in about half of the aquifer.¹⁶⁹ In the digestive systems of human infants and in ruminant animals, such as cattle and sheep, nitrate can be converted into the nitrite and other compounds, which may contribute to negative health outcomes such as blue baby syndrome and impaired thyroid gland function.¹⁷¹ Researchers have attributed nitrate concentrations in Fraser Valley groundwater to agriculture largely because of the dominance of poultry, dairy and raspberry production.^{172, 173}

Air quality

There is a large body of research on the impacts of air quality on human health. Assessing agriculture’s relationship to air quality presents challenges similar to that of water quality, due to vast differences across agricultural practices and land types, as well as the difficulties of tracing substances in the atmosphere back to specific sources. There are several ways in which agriculture may reduce air quality such as contribution to particulate matter, odours and volatile compounds such as ammonia in the air, all of which could lead to negative effects on human health.

Different crop production methods affect air quality in a variety of ways. Plowing the soil before planting and after harvest can generate dust, which generates particulate matter. Exposure can contribute to asthma, bronchitis and other negative health effects. Conservation tillage methods can significantly decrease agriculture’s dust production by reducing the extent to which a field is plowed and leaving plant residue in the field, and can be used on many of British Columbia’s crops.^{29,174-178}

There is evidence that as farms grow in size and intensity, there are increasing atmospheric emissions of compounds such as organic acids and trace gases, including carbon dioxide, methane, nitrogen oxides, ammonia and hydrogen sulfide.¹⁷⁹ These compounds have the potential to contribute to respiratory diseases and other negative health outcomes, including headaches and nausea.¹⁸⁰⁻¹⁸³ Livestock production, fertilizer application, land use change and burning of biomass are a major source of gases and volatile organic compounds, which lead to increased levels of ozone and sulfur dioxide.¹⁷⁹ Exposure to these pollutants contribute to respiratory illnesses (for example asthma and bronchitis), especially in vulnerable populations such as children and the elderly.¹⁸³

Several studies of livestock operations have demonstrated that animal production, especially hogs, can result in emissions of a diverse array of volatile organic compounds, including acids, hydrocarbons, aldehydes, ketones and steroids.^{184,185} Some of these generate odours and have the potential to negatively impact human health, with effects such as irritation and inflammation of tissues in the human body. These effects depend on factors such as individual health conditions, weather and proximity to the animal operation.¹⁸⁶ Similar emissions and potential effects have been associated with dairy operations.¹⁸⁷

Pesticides

Pesticides include herbicides, insecticides, fungicides, fumigants and rodenticides. There is no single answer to the question of how hazardous pesticides are to humans; it depends on factors such as the particular chemicals used, the amounts and methods of application, soil properties and other environmental conditions, and existing individual health circumstances. While acute poisoning from high levels of pesticide exposure is well-established as having negative effects on nervous system function, there is not clear scientific consensus on the effects of long-term, low-level pesticide exposure. Numerous studies show associations between pesticide exposure and negative health outcomes, such as impaired neurobehavioural function, in certain populations (see below); however, challenges and specificities of study design make it difficult to draw widely applicable conclusions.¹⁸⁸⁻¹⁹³

One of the most heavily studied populations in regards to direct pesticide exposure is farmworkers and others who have direct occupational contact with the chemicals; however, farmworkers are not representative of the general population and the occupational health concerns are outside of the scope of this review.^{188,189,193} Several studies have identified food consumption as a source of pesticide exposure for the general population, in particular children (in comparison to organic food consumption).^{45,194,195} While some associations between dietary pesticide exposure and negative health outcomes have been found, there is insufficient evidence to establish conclusive links between low-level dietary exposures to pesticides and negative health outcomes, and more work is needed in this area.^{45,196-198}

In order to be effective, pesticides must persist in and beyond environments well after they are applied. This same characteristic, however, also amplifies concerns about their potential health effects because the longer they persist, the greater the potential for transport of some fraction of the applied amount to areas beyond the target area.¹⁹⁹ A number of studies have looked at pesticide exposure risk in populations living near agricultural fields where pesticides are applied. Though most studies have found that decreased distance to fields where pesticides are applied is associated with increased exposure, other studies have not found a significant difference.^{200,201}

Research has also looked at the presence and effects of agricultural pollutants in areas of British Columbia and Western Canada that are not centres of agricultural production. Sampling of air, soil and lichen in Yoho and Mount Revelstoke national parks in BC and Banff National Park in Alberta found the presence of organochlorine pesticides in these areas.²⁰² A study of the Chilliwack River and its mountain stream tributaries found that semi-volatile organic compounds (including organochlorine pesticides) were being concentrated and magnified in those ecosystems. The cause appears to be the transportation and deposition of substances by the atmosphere from population and agricultural centres to the west.²⁰³ Pesticides reaching surface waters can directly kill fish and other organisms and inhibit their growth and reproduction. Bioaccumulation and biomagnification of pesticides can occur in aquatic organisms, and wildlife, which may be then consumed by humans.²⁰⁴ Surface water samples taken in the BC agricultural

areas of the Lower Fraser Valley and the Okanagan in 2003-2005 had levels of some pesticides which exceeded water quality benchmarks developed in conjunction with Environment Canada.²⁰⁴

The United States Environmental Protection Agency states that the use of agricultural pesticides can also have positive impacts on health. For example, pesticides are used to control disease organisms, insect pests and weeds in many agricultural settings and thus contribute to food production and crop yield. By controlling some vector rodent and insect populations, pesticides are able to prevent some outbreaks of some diseases in humans, such as Hantavirus and West Nile Virus.²⁰⁵

Managing health concerns at the rural-urban interface

Persistent conflicts between farmers and residents of housing developments at the rural-urban interface contributed to the passing of provincial right to farm legislation in British Columbia, which provides safeguards for reasonable farm activities and encourages municipal-level planning to address the needs of farmers and non-farmers.^{xi} Among the most common complaints by non-farming populations living adjacent to farming areas are exposure to pesticides, machinery noise, dust and livestock odours, all of which have implications for reduced physical and mental health.²⁰⁶ A common strategy for mitigating these concerns at the provincial and municipal level is the use of buffer areas—spaces, grasses, trees, shrubs or wetlands placed between productive farm fields and residential areas. Research in BC shows that buffers can benefit residents close to farmland by reducing noise, dust and odours, and can help farmers by reducing trespassing and crop damage.^{207,208} However, it is noted that buffers alone cannot eliminate the impacts associated with farm activities.²⁰⁸

The evidence shows direct environmental benefits of buffer spaces.²⁰⁶ Buffers can help improve water quality by capturing residues from pesticides and fertilizers in rainfall run-off from fields.^{209,210} In particular, nitrogen runoff could be reduced by 40 to 94% in a buffer or wet land before entering a stream.²¹¹⁻²¹⁵ Buffers also have the potential to contribute to climate change mitigation by sequestering carbon in the soil.²¹⁶

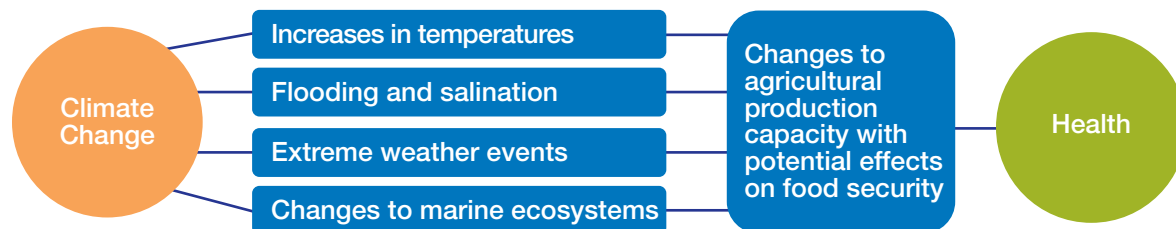
xi See section 2 on BC's policy framework

Section 4: Climate change, agriculture, and health

This section focuses on climate change in British Columbia and its effects on agricultural production. Climate change will likely impact BC agriculture and, with it, the food security and health of BC's population.

Climate change in British Columbia

- BC will experience increases in temperatures and frequency of weather events, which have the potential to negatively impact crop yields in some regions of the province; however, other regions may experience increased food production capacity
- Flooding and salination may impact land quality and negatively affect crop growth; in turn, decreasing food production
- BC's main fruit- and vegetable-producing regions are some of the most vulnerable to the effects of climate change



As a mid-to-upper latitude region, British Columbia is experiencing climatic changes that are greater than the changes at lower latitudes, and will likely continue to see accelerated change in excess of the average change in temperature across all latitudes. The province will experience increases in both baseline temperatures (with particularly steep increases in overnight minimums and winter lows) and the frequency of extreme climate events. Though the precise impact of climate change on agriculture and health is difficult to estimate, weather-related disruptions are expected to increase in both severity and frequency. These weather disruptions may negatively impact crop yields and, therefore, food security. BC could experience improved growing conditions in the Northeastern and central regions of the province, increasing the capacity for crop production in those areas.²¹⁷

Changes in precipitation and temperature due to climate change may result in more frequent, severe, and widespread plant disease outbreaks.²¹⁸⁻²²⁰ Invasive plant species (weeds) that compete with field crops may grow more vigorously and be less responsive to herbicide controls with increases in atmospheric carbon dioxide.^{220,221} Studies show that crops grown in an atmosphere with higher carbon dioxide levels may have reduced nutritional value, including, for example, reduced levels of protein and vitamin C.^{222,223} Crop production, and in turn food security, may also be impacted if plant diseases previously not a concern are able to persist in higher temperatures. Climate change may also affect livestock production, through

increased viability and range of both insects carrying disease and diseases themselves, and through heat stress.^{220,224} All of these effects have the potential to negatively impact food production.

In addition to the information presented in this section, two recent reports, both available online, discuss the relationship of climate change to food security in the BC and Canadian contexts.^{13,217}

Potential impacts of climate change on fruit and vegetable production in British Columbia

by Aleck Ostry

Over-dependence on small and climate-change sensitive regions for fruit and vegetable production (specifically the central Okanagan and Lower Fraser Valley) leaves BC's production of these basic foods particularly vulnerable to the effects of climate change, such as rising sea levels, flooding and drought.

Rising sea levels can degrade groundwater and land quality through salination along the coast and coastal valleys.²²⁵ High winter stream flow and increased groundwater levels, coupled with increased runoff due to greater frequency of extreme events, may lead to greater erosion and contamination of agricultural land and water along the coasts.^{226,227} Given that flood plains tend to be agriculturally productive (such as in the Peace River and Fraser River valleys), increased flooding caused by climate change may negatively affect crop growth and, therefore, food production, particularly if contaminant and salt levels increase.^{228,229}

While the coasts may experience increased water inundation, the earlier spring melt, coupled with shifts to more precipitation in winter and less in summer, will reduce groundwater recharge rates in summer time. This will lead to more frequent and prolonged droughts especially during peak summer demand periods, particularly in the Okanagan and other dry regions of the province.²³⁰

There is limited evidence on potential impacts of climate change on BC's food production. The existing data indicates that climate change may further stress regions that are already water stressed, such as the Okanagan, and that regions such as the Lower Fraser Valley may be more susceptible to flooding in the future. To the extent that these type of changes occur in the future in these regions, both fruit and vegetable production could be at risk, requiring the expansion of fruit and vegetable production to more climate change resilient regions in the province where possible.²³¹

Impact on British Columbia salmon and other seafood

While the focus of this evidence review is on land-based food production, a short discussion on aquaculture is included since Pacific salmon is both a cultural keystone species for West Coast Indigenous communities as well as the most popular fish within BC's non-Indigenous populations.²³² A case study of the St'át'imc people who live in the areas surrounding the towns of Lillooet and Pemberton examined the threats climate change poses to the continued existence of Pacific salmon runs, and the disruption such changes pose to traditional food preparation methods such as drying. Disruptions to these ecosystems can reach far beyond the local region due to the presence of informal trading networks between communities.²³³ The continued health of the Pacific Salmon fishery thus has health impacts in communities throughout BC.

Climate change could significantly disrupt marine ecosystems through increases in ocean acidification caused by the dissolution of carbon dioxide into carbonic acid (which impedes the survival of shell-building marine life) as well as increased ocean temperatures.^{234,217} Because the salmon life cycle includes both the ocean and rivers, they are particularly sensitive to the changing climate's effects: decreased water levels; increased water levels both on land and at sea; and the increase in extreme flood events.²¹⁷

Conclusion

The most direct link between agriculture and health is that agriculture provides the major source of food that supports British Columbians to meet the recommendations outlined in *Eating Well with Canada's Food Guide*. However, the connection between agriculture and health is more complex than simply providing healthy food.

Although evidence does not support the perception that local or organic foods are healthier, the literature does show that healthfulness is only one aspect of people's decision making. Individuals' knowledge and perception of the safety of local food, and the perceived better taste, also influence their decisions to buy local food and consume fresh fruits and vegetables. Public health programs such as farm-to-school that connect farm-fresh foods to schools may also contribute to healthy eating both at school and at home.

The availability of culturally appropriate foods also influences consumption of healthier foods. BC's agricultural lands and surrounding areas were, and continue to be, important sites for accessing Indigenous foods which contribute to health and wellbeing of Indigenous communities. Land not typically considered as food-producing, such as surrounding or unused farmland, may provide Indigenous peoples with greater access to their traditional foods.

Numerous factors affect food security in BC. Changes in climate, the value of the Canadian dollar, agricultural policy and population distribution all impact food availability and cost at the provincial, regional and individual level. A resilient food system in BC could help mitigate the effects of these factors on food security, and support access to, and availability of, healthy foods, particularly fruit and vegetables. For example, knowledge of BC's food self-sufficiency and the expected impact of climate change on food production could be used to improve agricultural planning.

In addition to influencing healthy eating and food security, BC agriculture affects various determinants of health such as the economy and the physical environment. Agriculture has a significant impact on BC's GDP and provides thousands of employment opportunities. Farms can also provide greenspace, which may positively influence mental and physical health.

This evidence review highlights the need for further research into the connections between agriculture and health. The strength of the evidence varies depending on the topic and while there is strong evidence for some topics, there is either a lack of, or inconclusive, evidence for others. For example, more research is required to determine the impact of farm-to-institution programs on health, behaviours, and farm income. Another example is the lack of evidence on how, or whether, organic versus conventional diets affect health.

In sections 3 and 4, evidence is lacking on the influence of agriculture on social bonds in agricultural communities and on mental health in relation to agricultural landscapes. Only limited evidence on the potential impacts of climate change on BC's food production capacity exists, and much of it is based on extrapolation; there needs to be much more work on climate change and agriculture in the BC context.

Finally, topics such as the relationship between aquaculture, wild fishing and health, as well as Indigenous foodlands and food sovereignty, deserve greater investigation than what was possible within the scope of this review.

In summary, this review provides high-level consolidated evidence on the associations between agriculture and health. Health authorities can use this information to support local governments in evidence-based planning and decision making and to inform and advance food security activities and strategies in the province.

Appendix

Food self-sufficiency in British Columbia's Local Health Areas (LHAs)

LHAs with “balanced” food self-sufficiency

by Aleck Ostry

Economic and climate changes have the potential to reduce the availability of healthy foods in BC, particularly in rural and remote areas. An LHA-level analysis of the capacity to provide a balance of foods can help identify the least resilient local food systems. This health-focused approach estimates the extent to which a given LHA could meet the dietary health needs of its population, which require a balance between meat and animal products, grains and plant foods (fruit and vegetables). For example, if an LHA produces enough meat for its own population, but grows few vegetables and fruit, it is unable to provide for the dietary needs of the local population or is dependent on importing foods from outside the area.

In many LHAs, climate, soil and other conditions do not lend themselves to fruit and vegetable production, meaning little can be done to improve their ability to grow a balance of foods. Nonetheless, describing LHAs in terms of their ability to provide a balanced diet helps to identify regional deficits in balanced food production and which LHAs are most vulnerable to food supply disruption.

To characterize LHAs in terms of their ability to provide a balanced diet, a plant food average was calculated using average food self-sufficiency for vegetables and fruit, as well as an animal food average based on average self-sufficiency for eggs, milk, dairy products and meat.^{xii} These were combined and grouped into seven food self-sufficiency categories as shown in Table A.

Table A: Food Self-sufficiency Cut-offs for Grouping LHAs with “Balanced” Food Self-Sufficiency

Food self –sufficiency category	Level of average self-sufficiency	
	Plant based products	Animal products
Zero	<5%	<5%
Low	<50%	<50%
High plant	50-100%	<50%
High animal	<50%	50-100%
Very high plant	>100%	<50%
Very high animal	<50%	>100%
Balanced	>50%	>50%

^{xii} Grains for human consumption are not included in the average for plant foods because these are produced in such low amounts in BC.

Figure A maps LHAs in terms of these seven food self-sufficiency categories.

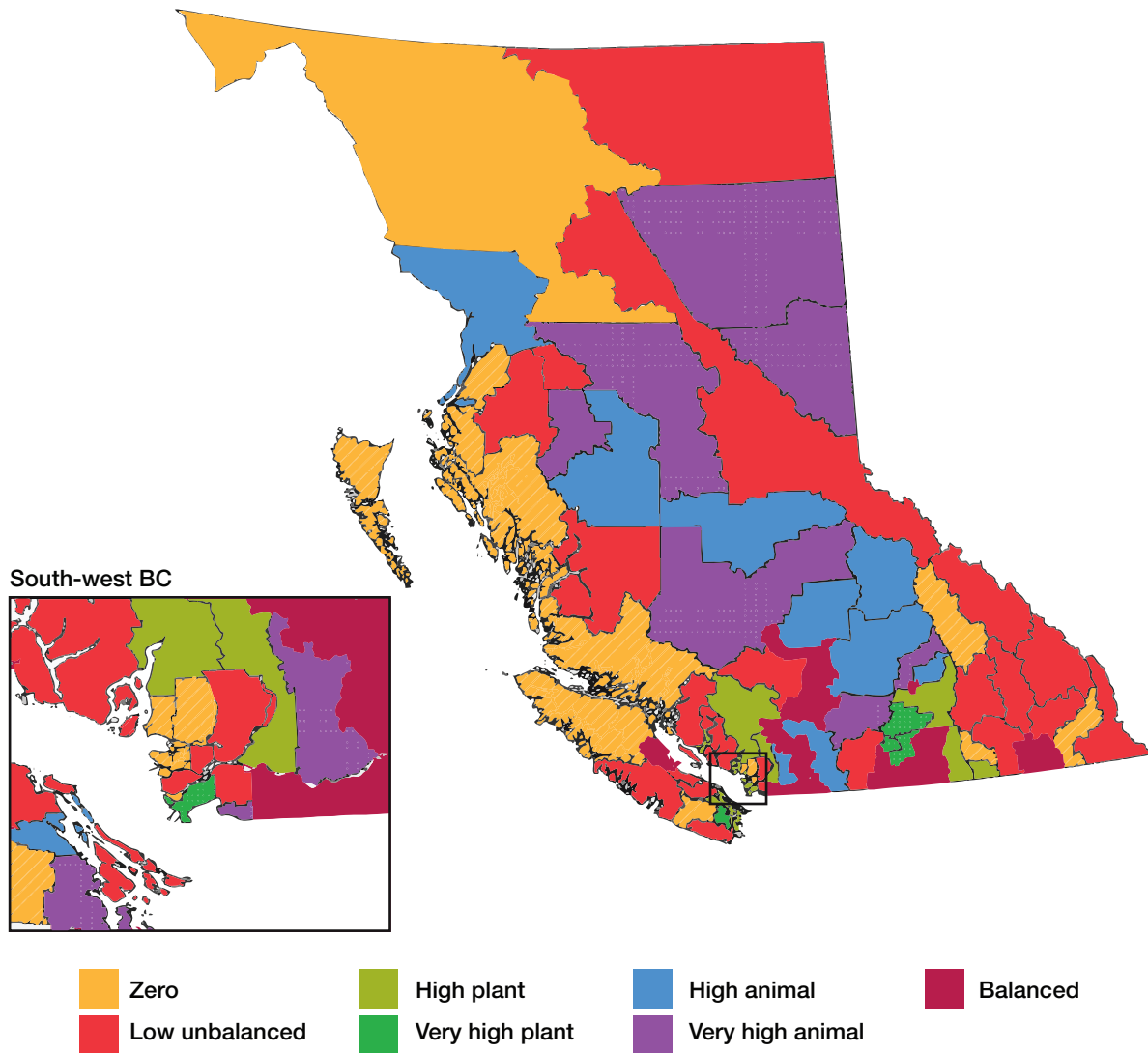


Figure A: “Balanced” Plant and Animal Food Self-Sufficiency by LHAs in BC

Forty-nine (55%) of BC’s LHAs have zero or low balanced self-sufficiency and four regions have the highest number of LHAs with zero or low balanced food self-sufficiency (Figure A):

- The first is located along BC’s Western mainland coast extending from Metro Vancouver, interrupted only by Snow Country LHA, to the Yukon border. This region includes LHAs in VIHA (Vancouver Island North), VCH (Bella Coola and Central Coast) and NH. Within NH, almost all the LHAs in the Northwest Health Services Delivery Area (HSDAs) have zero or low balanced food self-sufficiency.

- The second region contains all of Vancouver Island's West coast and all of Vancouver Island north of Courtney and Comox (in other words, North Vancouver Island and Central Vancouver Island HSDAs). Ten of 14 LHAs in VIHA have zero or low balanced food self-sufficiency.
- The third region of zero or low food self-sufficiency consists of most of the LHAs located in the South and South-East of IH within the East Kootenay and Kootenay Boundary HSDAs.
- The fourth region consists of the urban and some peri-urban LHAs located in and around Metro Vancouver and includes most of the LHAs within Metro Vancouver and some in Fraser. While it is unrealistic to expect highly urban regions to be food self-sufficient, with their relatively high populations in relation to productive farmland, some peri-urban regions such as Delta and Surrey have the most productive agricultural lands in the province within their boundaries, with a large proportion of them in the ALR. As such, these regions have the potential to be much more self-sufficient than at present.

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