Institute for Sustainable Food Systems

The Township of Langley Food System Study

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Findings from the Township of Langley Food Self-reliance Study

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Abstract

In 2016 the Institute for Sustainable Food Systems (ISFS) at Kwantlen Polytechnic University, completed the Southwest British Columbia (Southwest BC) Bioregion Food Systems Design Project. Once this project was complete the Township of Langley (the Township) expressed interest in applying the same methods to an assessment of the Township's food system.

For this study we modelled a 2016 Baseline scenario and three future scenarios for the year 2041. Outcomes included food self-reliance potential, total food production, farm gate revenue, and environmental impacts. It was concluded that the Township has significant potential to increase food self-reliance, and provide exports to neighbouring communities, by expanding production to under-utilized farmable land, and growing crops that can be consumed by the local population.

Institute for Sustainable Food Systems

The Institute for Sustainable Food Systems (ISFS) is an applied research and extension unit at Kwantlen Polytechinc University that investigates and supports regional food systems as key elements of sustainable communities. We focus predominantly on British Columbia, but also extend our programming to other regions.

Our applied research focuses on the potential of regional food systems in terms of agriculture and food, economics, community health, policy, and environmental stewardship. Our extension programming provides information and support for farmers, communities, businesses, policy makers and other. Community collaboration in central to our approach.

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1. Introduction

In 2016 the Institute for Sustainable Food Systems (ISFS) at Kwantlen Polytechnic University, completed the Southwest British Columbia (Southwest BC) Bioregion Food System Design Project[1]. This multi-disciplinary research project was the first of its kind to provide data driven information on outcomes of theoretical food system regionalization through the comparison of different future scenarios. In order to complete this work, ISFS developed a computational model that elucidates the relationship between land based food production, population food need, agricultural land use, environmental protection efforts and economic outcomes (Mullinix et. al., 2016).

The model demonstrated how regional food self-reliance changes as other attributes of the food system were altered. The study not only addressed food system challenges, such as a growing population and climate uncertainty, but it also provided information about the implications and opportunities of the bioregional food system. The outcomes of this research emphasized how sustainable bioregional food systems could play an important role in the vision for sustainable communities in BC.

The key results from the Southwest BC Project suggested that: (1) other things held constant, Southwest BC's food self-reliance could be substantially increased if agricultural land was allocated differently to produce food that is consumed by people living in the bioregion; (2) agricultural land availability and utilization is an important factor in increasing food self-reliance; (3) economic impacts were driven by the food processing sector; and (4) as the bioregion produced more food locally to achieve a higher level of food self-reliance, environmental impacts from agriculture increased. However, some of these impacts could be mitigated through diet change, reallocation of the types of crop and livestock produced and imposition of hedgerow and riparian buffers.

Upon completion of the Southwest BC project, the Township of Langley (the Township) expressed interest in applying the model to the Township to assess food self-reliance capacity, and to inform decision making about the development of the agriculture/food system sector. As a result, the Township of Langley Food System Design project was approved by the Township Council on March 6, 2017. The study commenced in November 2017 and was completed in the fall of 2018.

Why Study Food Self-reliance?

Studying food self-reliance can provide information about the capacity of an area (bioregion, municipality, province etc.) to feed the population with food grown, processed and distributed locally. The study of food self-reliance can support efforts to develop strong local-regional food systems by:

1. Exploring the current capacity of food systems
2. Demonstrating the food production, economic and environmental outcomes of the food system through scenario based comparison
3. Providing information about the potential capacity of the food system and the relationship between local supply and demand in the future
4. Providing information about the implications and opportunities of food system localization

2. Study Objectives

Using the computational model developed by the Institute for Sustainable Food Systems, current and future food system scenarios for the Township can be generated to provide information for decision makers such as population food need, food production capacity, potential of under-utilized farmable land, and food self-reliance. Through discussions with the Township's stakeholders, four scenarios are selected as examples to offer comparison between different food system conditions, and to answer the following questions:

1. What is the current level of the Township's food self-reliance?
2. How will the Township's food self-reliance change if the status quo in the land use and food production regime remains the same?
3. When all agricultural land is put into production, can the Township increase its food self-reliance as well as support populations in other regions?
4. Under what condition could the Township achieve the highest level of food self-reliance?

3. Methods

3.1. Calculating Food Self-reliance

Put simply, food self-reliance measures the proportion of the population's diet that could be satisfied by locally produced food (see Equation 1). These calculations are dependent on the geographical scale, population and the biophysical characteristics of the area being studied. Areas with a higher food production to population ratio are likely to have a higher food self-reliance potential than areas with a lower ratio. Food self-reliance for the Southwest BC bioregion in 2011 was calculated to be 40% using the best available data. When the population increased to an estimated 4.6 million people in 2050 and the agriculture production regime remained the same (no change to land availability, yield, production practices etc.) food self-reliance for the bioregion drops to 28% (Mullinix et al., 2016). This suggest a direct relationship between the amount of land available for food production, population size, and food self-reliance. Similar to the Southwest BC project measures food self-reliance for the land-based components of the diet only, using the best available data for the Township.

Equation 1:

$$\text{Township of Langley Food Self-reliance } (\%) = \frac{\text{Total Food Production (tonnes of food produced locally)}}{\text{Food Need } (\textit{tonnes of food required for population})}$$

3.2. Data Inputs

For this study, data from British Columbia and Canada census year 2016 are used, including the 2016 Census of Agriculture. Additionally, this study used data from the 2016 BC Ministry of Agriculture-Agricultural Land Use Inventory (ALUI) database to determine currently farmed land and farmland availability for the Township. Each group of data required is further explained below, data input categories include:

- Food Need
- Population
- Farmland Availability
- Crop and Livestock Yield

Table 1: Modelled food types in this study, by food group

Fruit and Vegetable

Apple, dried	Grape, juice	Pineapple, juice	Broccoli, fresh	Pea, fresh
Apple, juice	Grapefruit, juice	Plum, fresh	Brussels sprout fresh	Pea, frozen
Apple, pie filling	Grapefruit, fresh	Raspberry, frozen	Brussels sprout, frozen	Pepper, fresh
Apple, sauce	Grape, fresh	Strawberry, canned	Cabbage, fresh	Potato, frozen
Apple, fresh	Guava and Mango, fresh	Strawberry, fresh	Carrot, canned	Potato, sweet, fresh
Apple, frozen	Lemon, juice	Strawberry, frozen	Carrot, fresh	Potato, white, fresh
Apple, canned	Lemon, fresh	Asparagus, canned	Carrot, frozen	Pumpkin and squash, fresh
Apricot, canned	Lime, fresh	Asparagus, fresh	Cauliflower, fresh	Radish, fresh
Apricot, fresh	Orange, juice	Beans green and wax, canned	Celery, fresh	Rutabaga and turnip, fresh
Avocado, fresh	Orange, fresh	Beans green and wax, fresh	Corn, canned	Spinach, fresh
Banana, fresh	Papaya, fresh	Beans green and wax, frozen	Corn, fresh	Spinach, frozen
Blueberry, fresh	Peach, canned	Beet, canned	Corn, frozen	Tomato, juice
Blueberry, frozen	Peach, fresh	Beet, fresh	Cucumber, fresh	Tomato, canned
Blueberry, canned	Pear, canned	Broccoli & Cauliflower, frozen	Lettuce, fresh	Tomato, fresh
Cherry, fresh	Pear, fresh	Broccoli, fresh	Manioc, fresh	Tomato, pulp, paste and puree
Cherry, frozen	Pear, canned	Brussels sprout fresh	Mushroom, canned	
Coconut, fresh	Pear, fresh		Mushroom, fresh	
Cranberry, fresh	Pineapple, canned		Onions and shallot, fresh	
Date, fresh	Pineapple, fresh		Pea, canned	
Fig, fresh				

Meat and Alternatives

Baked and canned bean	Egg	Peanut
Beef and veal	Lima bean	Pork
Chicken and stewing hen	Mutton and lamb	Turkey

Milk and Alternatives

Buttermilk	Concentrated skim milk	Partly skimmed milk 1%	Standard milk 3.25%
Cheddar cheese	Concentrated whole milk	Partly skimmed milk 2%	Variety cheese
Chocolate drink	Cottage cheese	Powder skim milk	

Fats and Oils

Butter	Shortening and shortening oil
Margarine	
Salad oils	

Grain

Corn flour and meal	Rice
Oatmeal and rolled oats	Rye flour
Pot and pearl barley	Wheat flour

3.2.1. Food Need

Food need is the quantity of food required to meet dietary recommendations that is also aligned with the preferred diet for a population (Dorward, 2015)[2]. There are no direct data sources available, so this project utilizes the same methods as the Southwest BC Project to estimate food need by combining two datasets. The first is the Food Available in Canada database which tracks the stocks and flows of food commodities across the country. The second is the Canada's Food Guide which provides nutrition recommendations for Canadians by age and gender [3].

The Food Available in Canada database[4] estimates a total amount of food that the Canadian population consumes in a year. This amount of food consumed per person is assumed to be the preferred diet of an average Canadian. With no provincial or regional food consumption data available, this study must assume that the Township's population consumes an average Canadian diet. Additionally, we assume that individuals in the Township consume at least the recommended amount of food in each food group based on Canada Food Guide's recommendations of food for for their age and gender category. Table 1 shows the food groups and types of food used in the modelling work.

3.2.2. Population

This study uses current population data for the Township available from the 2016 Census of Population [5]. Baseline calculations were made using exact 2016 census numbers for each age and gender category [6]. In order to estimate the future population, this study uses population growth projections for the Township available from Metro Vancouver (Metro Vancouver, 2017). These projections were used to determine the overall growth rate for three different time periods: 2016-2021, 2021-2031, and 2031-2041. These growth rates were then applied to each age and gender category in the Township. Table 2 shows the breakdown across age and gender categories for 2016 and 2041. Future scenarios are projected for 2041 to align with population projections available for the region and with long range planning thresholds for the Township.

Table 2: Population projections for the Township of Langley, by age and gender categories

Age Range	Population 2016	Population 2041
Under 2	2,525	2,037
2 to 3	2,695	4,733
4 to 8	7,290	12,802
9 to 13	7,640	13,417
Female (14-18)	3,690	6,480
Male (14-18)	3,880	6,814
Females (19-50)	24,440	42,920
Males (19-50)	22,930	40,769
Females (51+)	22,005	38,644
Males (51+)	19,875	34,903
Total	**117,255**	**203,518**

3.2.3. Farmland Availability

Farmland availability is determined using the 2016 BC Agricultural Land Use Inventory (ALUI)[7] for the Township. This survey collects information about on each parcel in two ways: land cover (the biophysical materials on the surface of the earth or main object type) and land use (the economic function or type of establishment using the land). Only land cover is considered when determining if land is available for farming.

Land inside and outside the Agricultural Land Reserve (ALR)[8] was surveyed for the ALUI report. All land not surveyed is considered not available for farming because it is currently used for urban development, transportation infrastructure, or is not physically suitable for farming (e.g., wetland, protected forest). For the purpose of this study land is placed into three categories. The categories used to classify land surveyed in the ALUI are:

Currently Farmed: Land that is directly contributing to agricultural production of both food and non-food production operations (including forage and pasture land).

Under-utilized Farmable Land: Land not currently being farmed, but can be used for agricultural purposes without displacing a current use and without significant topographical, physical or operational constraints to farming.

Land in Parks: Land that is designated for parks and therefore not considered farmable, regardless of soil class.

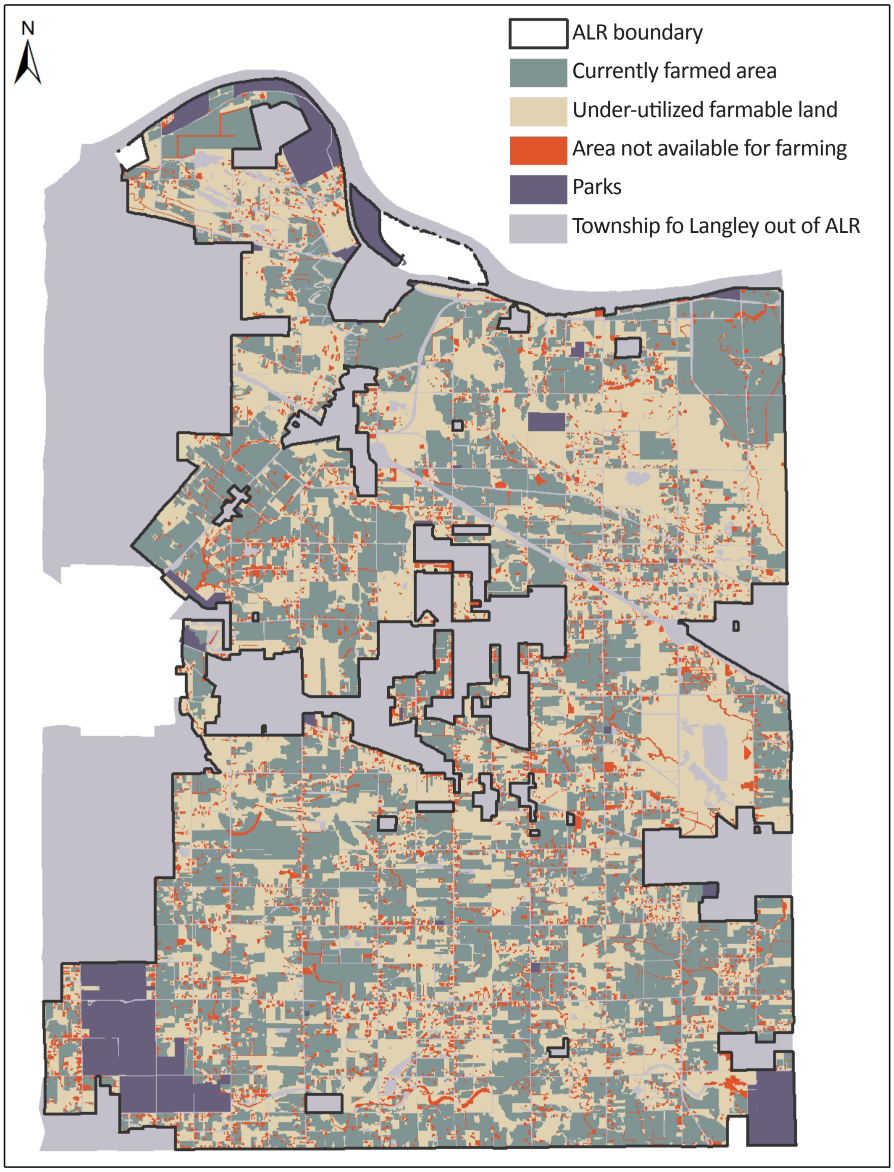
Table 3: Land cover categories and number of hectares for area modelled in the ALUI

Land Cover Classification			Ha in ALR	Ha not in ALR	Total Area (Ha)	Total area modelled (Ha)
Currently Farmed Land	Actively Farmed	Cultivated Field Crops (incl. forgae and pasture)	8,100.48	129.38	8,229.87	9.507.56
		Farm Infrastructure	1,059.11	26.93	1,086.04	
		Greenhouses	166.63	0.49	167.12	
		Crop Barns	24.62	0.00	24.62	
Under-utilized Farmable Land	Inactively Farmed	Unmaintained Forage/ Pasture	409.27	13.49	422.77	9,714.97
		Unmaintained Field Crops	21.90	2.10	24.00	
		Unmaintained Greenhouse	1.81	0.56	2.37	
		Unmaintained Crop Barn	0.37	0.00	0.37	
	Anthropogenic	Managed Vegetation	1,552.25	77.59	1,629.84	
		Non-built/Bare	261.36	9.33	270.69	
	Natural/ Semi-natural	Vegetated	6,990.46	374.48	7,364.94	
Land in Parks			1,273.83	548.17	1,822	1,822

The ALUI surveyed 22,857 hectares (56,482 acres) in the Township, 94% of land surveyed was located within the ALR and remaining 6% is located outside the ALR. Table 3 shows the amount of land available for farming by land cover classification in the ALUI database. The total currently farmed land used in the model was 9,507 hectares (23,494 acres). Under-utilized farmable land was 9,715 hectares (24,066 acres) (46% of total surveyed area). Parks account for 1,822 hectares (4,502 acres) in the ALUI survey and are not considered available for farming for the purposes of this study and were therefore not used in the model.

According to the ALUI for the Township, 30% of the total Township land area (or 45% of total ALUI surveyed area) is currently farmed. Two thirds of the currently farmed area (about 6,300 hectares or 15,567 acres) is used in forage and pasture for livestock and equine (horse) operations. Although horse farming is a permitted use in the ALR, these farming operations do not produce food crops and therefore do not contribute to food self-reliance. Figure 1 shows the amount of land available, and compares the currently farmed area with under-utilized farmable land.

Figure 1: Land Use Types in the Township of Langley



3.2.4. Crop and Livestock Yield

Crop (fruit, vegetable, grain, legume, etc.) yields per unit area is based on BC 10 year average data available from the Census of Agriculture. Livestock yield (beef, pork, poultry, dairy, and egg) per animal is based on BC or Canadian average data also from the Census of Agriculture. We recognize that yields possible in the Township may be different than those possible on average for BC or Canada, however no Township-specific crop yield data is currently available.

3.2.5. Crop and Livestock Farmgate Price

The prices per tonne of all crop and livestock commodities are calculated from the marketed production (tonnes) and total gross farm receipts ($) for each crop and livestock commodity. The marketed production and gross farm receipts are based on BC 2016 average data as well as Canadian average data where BC data are not available.

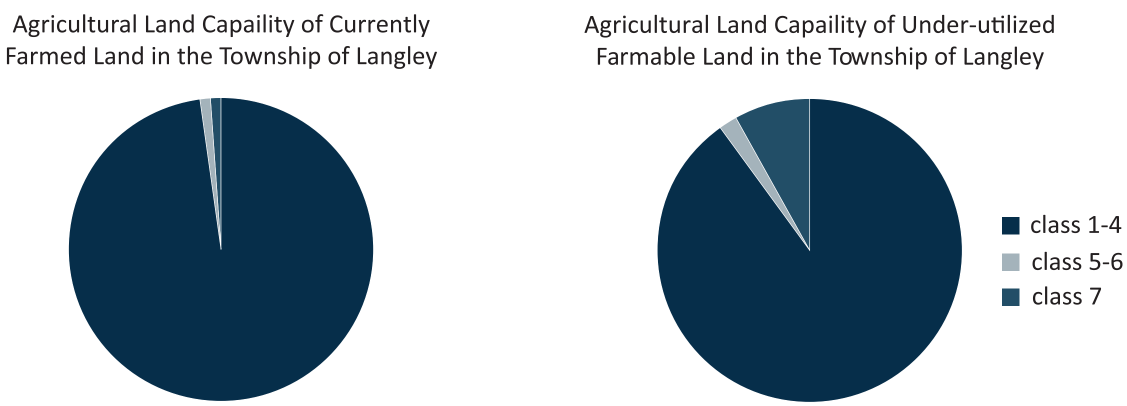
Agricultural Land Capability for the Township of Langley

In British Columbia, land is categorized based on its capability for agriculture. There are seven capability classes ranging from land with no, or only slight limitation for crop production (Class 1) to land with no capability for crop production or sustained grazing (Class 7) (Kenk & Cotic, 1983). Classes 1-4 are considered the most ideal lands for agriculture, with limitations that can be managed using moderate to intensive management practices (e.g. irrigation, timing of tillage, specialized planting and harvesting etc.). Within BC only 2.7% of lands are classified as Class 1-4 (Kenk & Cotic, 1983).

The Township is located in one of the best agricultural regions in the province which is reflected in the classification of soils within the Township. Figure 2 shows the amount of land in three soil classification categories in the Township. Of land that is currently farmed, 98% is Classes 1-4 which supports the production of a wide variety of crops. Only 1% of land is classified as Classes 5-6 and 1% is Class 7. Under-utilized farmable land is 90% Classes 1-4, 2% Classes 5-6 and 8% Class 7. This suggests that there is significant potential in the Township to grow a diversity of crops and to expand production onto currently unproductive lands and engage in diverse crop production, and livestock grazing.

Unfortunately, the only available data on agricultural soil capability in BC is from 1983. Although this information is old it demonstrates potential for agricultural production in the Township. Even if soil has been degraded over time, there is potential for the quality and capability to improve through the use of good soil management practices (i.e. crop rotations, limited tillage, cover cropping etc.).

Figure 2: Agricultural land capability for currently farmed and under-utilized farmable land in the Township



4. Food System Scenarios

Scenarios are data-driven stories created to explore the relationships between factors in the food system and to illustrate the outcomes and trade-offs of different decisions. Scenarios do not predict what will happen, nor do they prescribe a particular approach. The food self-reliance model can generate infinite numbers of scenarios depending on the parameters that are set for the food system. For the purposes of this study, only four scenarios have been selected, and are explained in this section. These four scenarios provide information that can tell a story about the food self-reliance, economic outcomes and environmental impacts of the Township's food system.

4.1. Terms and Definitions

Baseline Food Mix: The baseline food mix reflects current crop and livestock production and land use regimes in the Township. It is found by determining the amount of land devoted to each food crop in 2016 and the number of livestock raised in the Township, and multiplying these values by their yield per unit area or per unit livestock.

Localized Food Mix: The localized food mix reflects an alternative land use regime. The types of crop and livestock production are determined by the populations food need. An optimization model is employed to maximize the Township's food self-reliance that optimizes land area allocation for different crop and livestock commodities produced on that land.

Local Market: The local market consists of the current or projected population of the Township. For the purposes of this study local consumption is considered to be food consumed only by these residents.

Export Market: The export market is considered to be all food produced in the Township that is consumed outside of the Township. This could be regional, provincial, national or international. The location is not specified in these scenarios.

Land Available for Food Production: For this study land available for food production is determined based on current land uses. However, some land is removed, including all land classified as Class 7 based on the agricultural land capability index. Land and greenhouse infrastructure dedicated to non-food crop production of nursery plants, trees, turf and flowers is also excluded.

Land Modelled: Land modelled represents the amount of land that is considered for food production in each scenario.

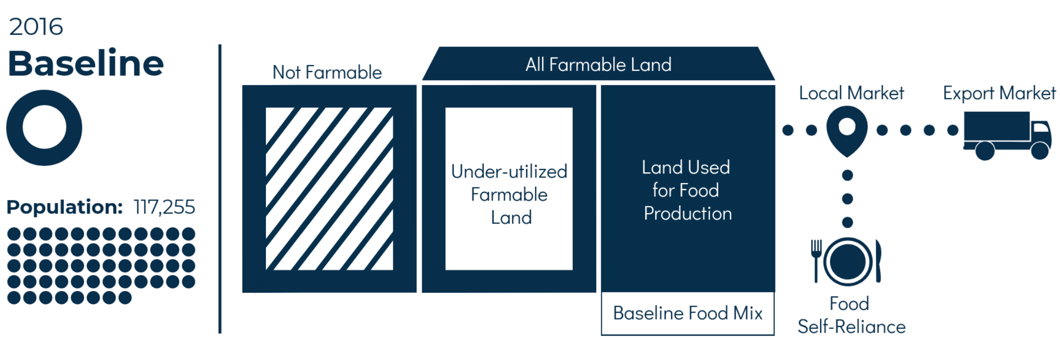
4.2. Food System Scenarios for the Township of Langley

In this study, a baseline and three unique future food system scenarios are modelled. The baseline explores the current conditions using the most up to date information available, while the three future scenarios provide information about food systems conditions in 2041.

2016 Baseline

The 2016 Baseline reports on the current outcomes of food production in the Township, and provides a reference point against which future scenarios can be compared. In this scenario, the crops being produced are based on the crop and livestock products reported in the 2016 Census of Agriculture. This crop and livestock mix is referred to as the baseline food mix. We assume that food produced in the Township is first sold in the local market, directly contributing to food self-reliance, and that any food remaining after the Township's food need is satisfied can go to the export market.

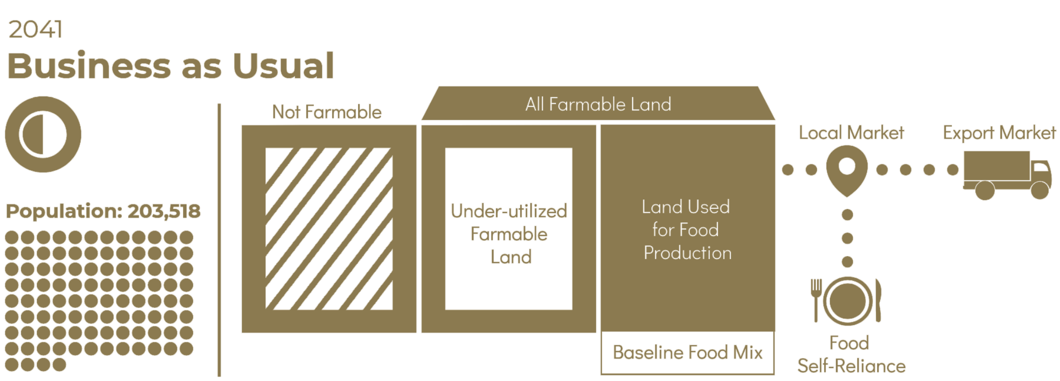
Figure 3: Conceptual diagram for the 2016 Baseline food system scenario



2041 Business as Usual (2041 BAU)

The first future scenario explores the outcomes of maintaining current farming activities and land use as the population grows. The only change from the 2016 Baseline is a population increase to a level estimated by for 2041. Land that was farmed in 2016 continues to grow the same crops grown in the previous scenario (baseline food mix). Food produced in Township is first sold in the local market, directly contributing to food self-reliance, and any food remaining can go to the export market.

Figure 4: Conceptual diagram for the 2041 Business as Usual food system scenario



2041 Expand into Local Markets (2041 Expand Local)

The second future scenario explores the outcomes of increasing the amount of actively farmed land in the Township. In this scenario, all under-utilized farmable land is brought into production effectively doubling the amount of land available for farming. The production regime from the previous two scenarios is maintained (baseline food mix), and with additional capacity crops are grown specifically to meet local food need (localized food mix). Both local and export markets are served in this scenario.

Figure 5: Conceptual diagram for the 2041 Expand Local food system scenario

2041 Focus on Local Markets (2041 Focus Local)

The third future scenario explores the outcomes of prioritizing production for the local market on all farmable land in the Township. In this future scenario farming activities on all farmable land in the Township shift to produce food that will satisfy local food need, and contribute to food self-reliance (localized food mix).

Figure 6: Conceptual diagram for the 2041 Focus Local food system scenario

5. Study Results

The Southwest BC Project demonstrated that population growth, climate change, and global trade uncertainty could have a significant impact on food self-reliance and viability of the agri-food sector in the bioregion. The four different future scenarios modelled in that pioneering study demonstrated how different decisions could not only improve food self-reliance, but also improve economic and environmental outcomes of the food system (Mullinix et al., 2016).

For discussion of the outcomes of this study, food self-reliance is presented as the percentage (%) of the diet that could be satisfied by locally produced food. The model allows us to separately analyze the food self-reliance for different food groups (i.e. fruit, vegetable, dairy, red meat etc.), and for the total diet (approximated average Canadian diet).

In addition to the food self-reliance potential, other food system outcomes include: total food production, estimated total farm gate revenue, and environmental impacts such as; ecological footprint, greenhouse gas emissions and nutrient (nitrogen and phosphorous) surplus from animal manure are also described.

5.1. Model Assumptions

In order to use the computational model to estimate food self-reliance for a given study area a number of data inputs are required, as described previously in this report. It is also necessary to make assumptions in order to approximate the complex conditions of the food system. As a result, the food self-reliance outcomes discussed in this report should be read as conservative estimates, and readers should understand that if these assumptions do not hold true, the level of the Township's food self-reliance may be lower than projected.

5.1.1. Local Food Availability and Access

There are two important assumptions made in the estimation of food self-reliance that have to do with the access and availability of local food. First, we assume that locally produced food is a preferred choice for consumers whenever it is available. This means that people have access to, and will choose local products over imports. Imports are therefore only required for products in the diet that are not grown in the Township, or consumed out of season. Second, we assume that the Township has the capacity to process primary crop and livestock products into food products that satisfy its population's food need (e.g. all dairy and meat products require post production processing prior to human consumption). There can also be a higher cost associated with local food that can make it difficult to access for some consumer, however in this model we assume that local food is available and accessible to the local population.

5.1.2. Livestock Production and Implications for Food Self-reliance

This study also makes assumptions related to livestock production, that could have a significant impact of food self-reliance outcomes. First, we assume that the study area (i.e. the Township) is not required to produce feed for livestock which can use significant amounts of land. Instead, we assume that livestock feed can be imported from other regions which means that an area can achieve higher levels of food self-reliance for animal products (i.e. red meat, poultry, dairy etc.) than if feed was produced locally.

Similar assumptions were made for the Southwest BC project. In that study for the baseline scenario the bioregion was able to reach 40% food self-reliance by relying on imported animal feed. When imported feed is not available, grain, silage and hay must be produced in the bioregion and food self-reliance drops significantly to 12% (Mullinix et. al. 2016). It can be assumed that no access to imported livestock feed would have a similar impact on food self-reliance in the Township.

Environmental Impacts: Ecological Footprint, GhG Emissions and Nutrient Balance

An ecological footprint refers to the quantity of natural resources, measured in global hectares (gHa), that are required to produce goods that the population consumes, as well as to absorb associated carbon emissions. In this study only the ecological footprint of food consumption is considered. This is broken down into food produced locally, and food imports. Food produced in the Township for export is not included in the ecological footprint calculation in this case.

The three main greenhouse gases (GhG) produced from agricultural production are carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4). These emissions come from fossil fuel use, fertilizer applied to crops, manure management, and enteric fermentation (digestion) in ruminant livestock such as cows. In this report, the estimated GhG emissions includes only emissions from crop and livestock production in the Township and does not include emissions from food that is imported. This is therefore an estimation of the GhG emissions of food producing agricultural activities in the Township.

Manure is a valuable source of nutrients, primarily Nitrogen (N) and Phosphorus (P), which are essential plant nutrients and necessary for crop production. In traditional, diversified farming models manure from livestock is composted and applied to fields to support the growth of crops for human and livestock consumption. This nutrient cycling which is a common practice on diversified farms creates balance and can eliminated contamination from excess nutrients flowing into the environment.

In this study nutrient supply is based on the number of livestock in the Township multiplied by the quantity of manure produced and estimated concentrations of N and P found in the manure of each livestock type. Nutrient demand is estimated from the amount of N and P per hectare recommended to meet requirements for different crops multiplied by the number of hectares of each type of crop grown in the Township.

5.2. Model Results

The following section outlines the results of the baseline and three future food systems scenarios. This includes the food self-reliance, economic and environmental impacts. These results will be compared and further discussed in section 6.

2016 Baseline

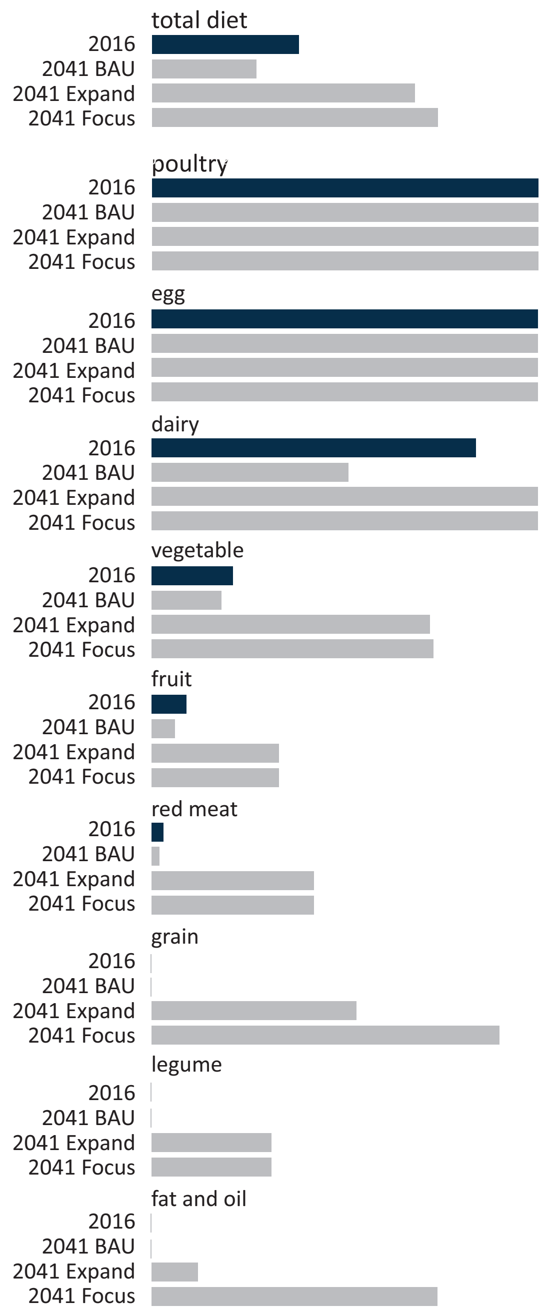
Population: 117,255 people
Food need: 98,330 tonnes
Land available for farming: 17,759 ha
Land modelled: 8,895 ha

This first scenario was chosen to reflect the current conditions in the Township's food system based on available information about food production and land use in 2016. This will act as a point of reference for comparison with the other future scenarios modelled for 2041.

Food Self-reliance: 38%

Based on current farming activities and food production in the Township, potential for food self-reliance for the total diet is 38%. In this scenario food self-reliance for poultry (broiler hens and turkeys) and egg food groups is 100%. This means that the amount of production of those food groups is equal to, or greater than the populations food need in the Township. Dairy is also high at 84%, and vegetables is higher than other food groups at 21%. Food self-reliance for grain, legume and fat and oil is 0% which suggests that there is no significant production of these crops in the 2016 baseline year.

Figure 7: Food self-reliance for 2016 Baseline for total diet and food groups



Food production: 91,911 tonnes

The Township has significant capacity for the production of food. In this scenario, 70% (63,839 tonnes) of the food produced in the Township is exported. In order to meet the food need for the Township year round, significant imports in all food groups are required. The largest food imports by weight are for fruits and vegetables followed by dairy and grains. The largest exported food groups by weight are poultry, vegetable and fruit.

Total Farm Gate Revenue: $206 million

Total farm gate revenue from the local production of food crops and livestock is estimated at $206 million. Note that this number is used for scenario comparison only and should not be compared with the Census of Agriculture data. This measures economic outcomes from crop and livestock production for human consumption, and revenue generated from non-food crops and livestock such as horses, Christmas trees and cut flowers are not included in this calculation.

Environmental Impacts

Ecological Footprint

The ecological footprint (or the total biologically productive land require to produce the food and absorb carbon emissions) for food consumed by the population of the Township is estimated at 97,423 gha total or 0.83 gha per capita. This total can be broken down as 23,821 gha for locally produced crops and 73,603 gha for imported crops.

Greenhouse Gas (GhG) Emissions

The estimated GhG emissions from crop and livestock production is 60,451 tonnes of CO2e[9] which is about 2.6% of the provincial total GhG emissions from agriculture sector in 2015[10].

Nutrient Balance

The total nutrient surplus from livestock production (not including equine industry) is expected at 249 tonnes for N and 180 tonnes for P. That is, on average, the Township has a 28 kg/ha of N surplus and 20 kg/ha of P surplus.

Figure 8: Tonnes of food production in the Township of Langley, in thousands

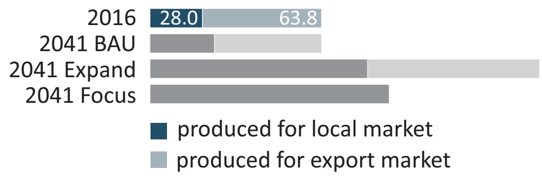


Figure 9: Farmgate revenue for the Township of Langley, in thousands of dollars

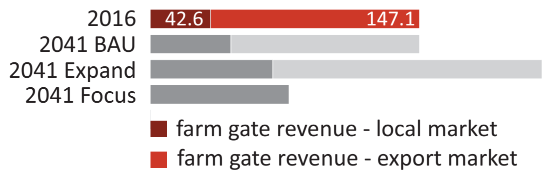


Figure 10: Global hectares (gha) required to meet food need for the Township of Langley's population, in thousands

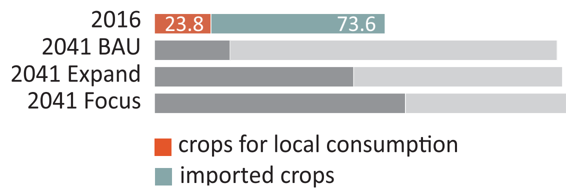
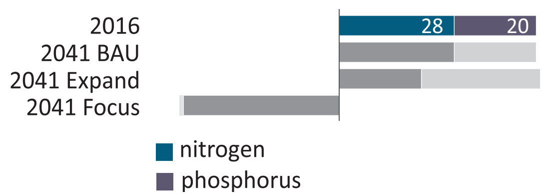


Figure 11: Tonnes of CO_2e emitted from food production in the Township of Langley

Figure 12: Nutrient balance (suplus or deficit) from animal manure, in kilograms per hectare



2041 Business as Usual

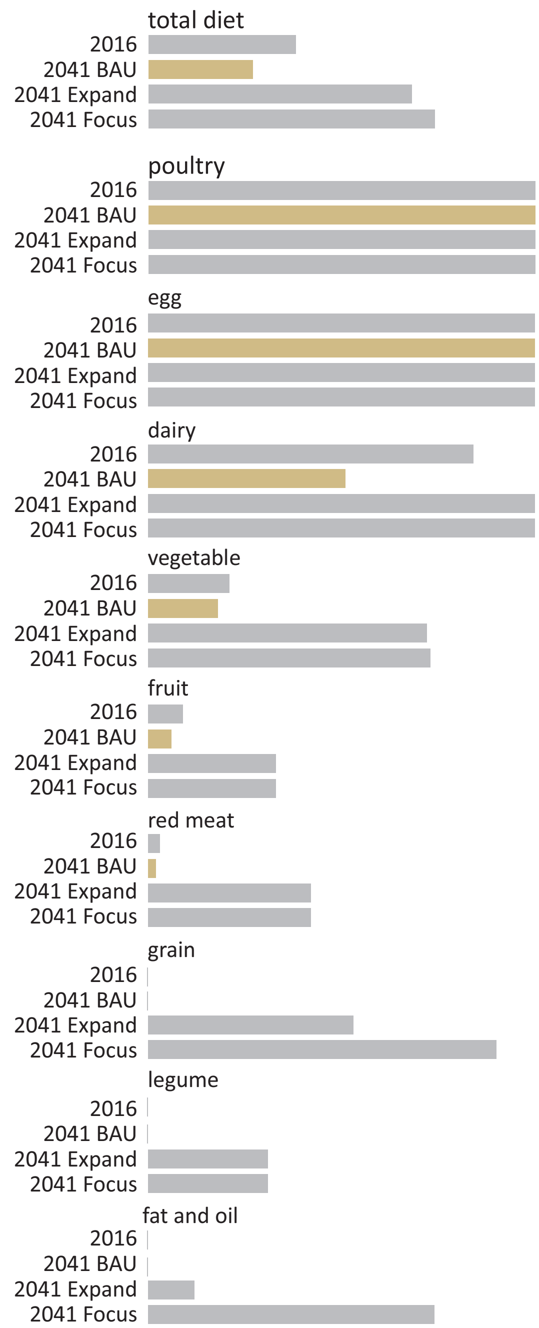
Population: 203,518 people
Food need: 171,088 tonnes
Land available for farming: 17,759 ha
Land modelled: 8,895 ha

The 2041 Business as Usual (2041 BAU) scenario represents a future where there is no change to food production regime (type of crops grown, technology, production practices etc.) and land use in the Township. The most significant change in this scenario from Baseline 2016 is that the population of the Township increases to the estimated level for 2041. The Township is a rapidly growing municipality, the estimated population for 2041 is 203,518, which adds over 86,000 people to the area.

Food Self-reliance: 27%

With a larger population in the Township the food need will grow significantly. Without an equivalent increase in production capacity, food self-reliance in the BAU 2041 scenario decreases to 27%. The food self-reliance potential for poultry and egg remains at 100%. This indicates that there is significant potential in these sectors to support the food need of the population in the Township while also supporting some export to other areas.

Figure 13: Food self-reliance for 2041 Business as Usual for total diet and food groups



Food production: 91,911 tonnes

As we assume that the yield, production practice, and farmed area remain constant, the estimated amount of food produced in the 2041 BAU scenario does not change compared to the 2016 Baseline. However, the amount of imports is almost double that of the 2016 Baseline scenario because there is no increased capacity for local food production. As the Township's population increases by 74% so does the overall food need which means a greater reliance on imports to fill need not satisfied by local production.

Total Farm Gate Revenue: $206 million

The farm gate revenue in this scenario remains the same as the 2016 Baseline.

Environmental Impacts

Ecological Footprint

The ecological footprint associated with food consumed in the Township increases in this scenario to 170,138 gha (75% increase from the Baseline) due to the increase in food need from a larger population. The per capita footprint increases from 0.83 gha to 0.84 gha. This total can be broken down as 31,916 gha for crops produced for local consumption and 138,222 gha for imported crops.

Greenhouse Gas (GhG) Emissions

Same as 2016 Baseline scenario.

Nutrient Balance

Same as 2016 Baseline scenario.

Figure 14: Tonnes of food production in the Township of Langley, in thousands

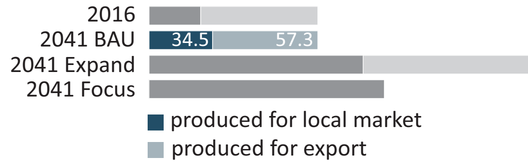


Figure 15: Farmgate revenue for the Township of Langley, in thousands of dollars

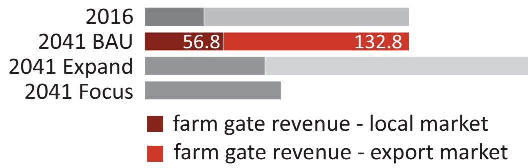


Figure 16: Global hectares (gha) required to meet food need for the Township of Langley's population, in thousands

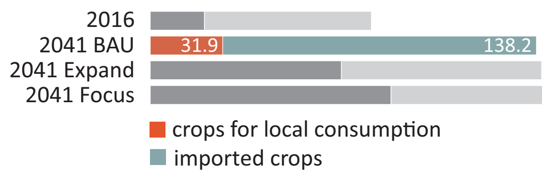
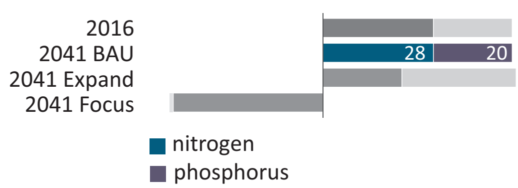


Figure 17: Tonnes of CO_2e emitted from food production in the Township of Langley

Figure 18: Surplus nutrients from animal manure, in kilograms per hectare



2041 Expand into Local Markets

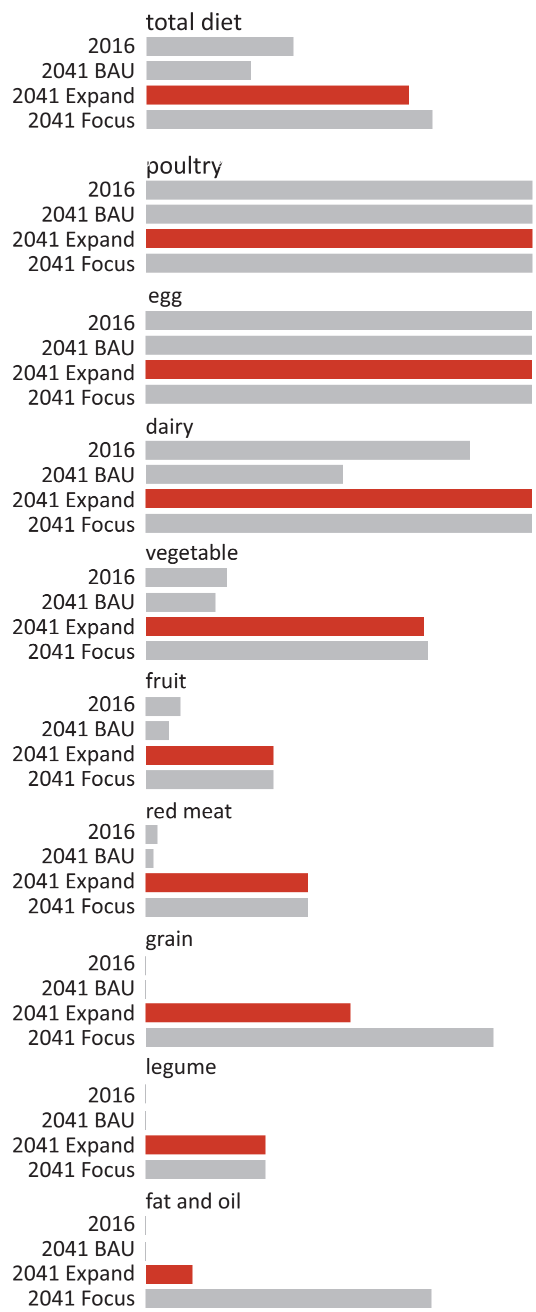
Population: 203,518 people
Food need: 171,088 tonnes
Land available for farming: 17,759 ha
Land modelled: 17,759 ha

The 2041 Expand into Local Markets (2041 Expand Local) represents a scenario where the most significant change is bringing all under-utilized land into production, which effectively doubles the land available for food production in the Township.

Food Self-reliance: 68%

In this scenario, based on food need for the estimated 2041 population, food self-reliance potential is 68%. This is a significant increase from the 2016 Baseline scenario and is reflective of the additional land being brought into production. Food self-reliance increases in each food group, however they all increase at different rates. Fruit and vegetable increase to 33% and 72% respectively. Grain, legume and fat and oil also increase significantly from no production in the 2016 Baseline scenario to 53%, 31% and 12%. Red meat also increases significantly to 42%.

Figure 19: Food self-reliance for 2041 Expand Local for total diet and food groups



Food production: 208,482 tonnes

When more land was available for food production, the total amount of food that can be produced increases to 208,482 tonnes. In this scenario there is significant food production for both export and local markets. The estimated amount of food produced for export is over 90,000 tonnes and food groups with the notable export potential by weight, from highest to lowest are: poultry, dairy, vegetable, fruit and egg.

Total Farm Gate Revenue: $358 million

In this scenario, the land available for farming is doubled and food production increases significantly. The total farm gate revenue increases 73% from the 2041 BAU Scenario.

Environmental Impacts

Ecological Footprint

The ecological footprint of food consumption increases to 172,396 gha. The per capita footprint increases slightly to 0.85 gha. This total can be broken down as 84,153 gha for crops produced for local consumption and 88,243 gha for imported crops.

Greenhouse Gas (GhG) Emissions

The estimated GhG emissions from crop and livestock production is 140,574 tonnes of CO_2e which is more than double the amount of GhGs emissions in the 2016 Baseline and 2041 BAU scenarios respectively. This significant increase is due to the increase in crop and livestock production as underutilized farmable land is brought into production.

Nutrient Balance

The total nutrient surplus from livestock production is expected to be 349 tonnes for N and 514 tonnes for P. That is on average the Township has 20 kg/ha of N surplus and 29 kg/ha of P surplus.

Figure 20: Tonnes of food production in the Township of Langley, in thousands

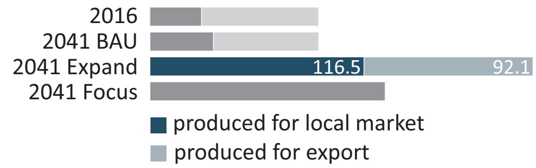


Figure 21: Farmgate revenue for the Township of Langley, in thousands of dollars

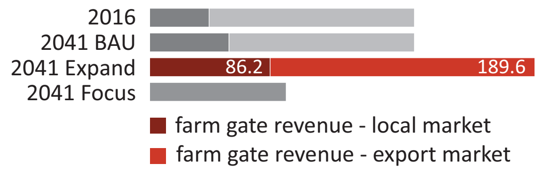


Figure 22: Global hectares (gha) required to meet food need for the Township of Langley's population, in thousands

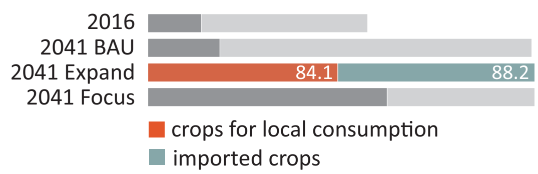
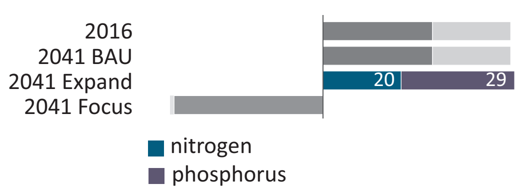


Figure 23: Tonnes of CO_2e emitted from food production in the Township of Langley

Figure 24: Surplus nutrients from animal manure, in kilograms per hectare



2040 Focus on Local Markets

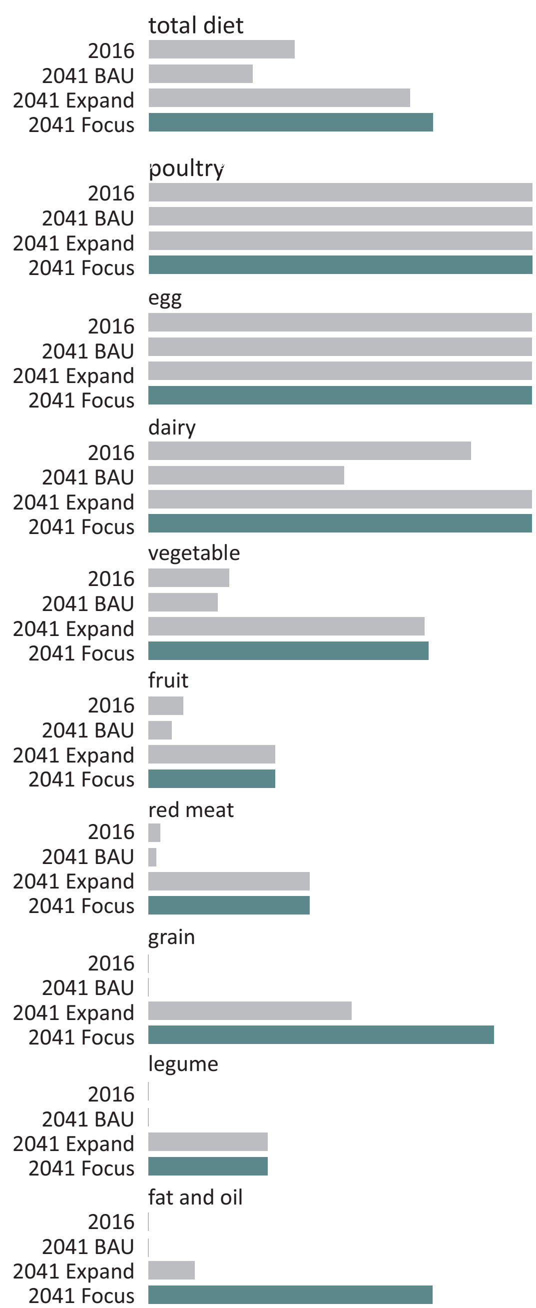
Population: 203,518 people
Food need: 171,088tonnes
Land available for farming: 17,759 ha
Land modelled: 17,759 ha

The final future food system scenario is called 2041 Focus on Local Markets (2041 Focus Local). This represents a future where significant shifts are made in land use, and food production activities. Like the previous scenario (2041 Expand Local) food production is expanded onto all under-utilized farmable land. Additional changes are applied in production activities. A shift is made from producing for both export and local markets to producing only food that is consumed by the local market, contributing directly to food self-reliance.

Food Self-reliance: 74%

This scenario suggests a future where there are significant shifts in both production regime, and agricultural land use in the Township. Due to the amount of land available for farming, and a focus on producing food for the local market food self-reliance in this scenario is the highest at 74%, which is a significant increase from the 2016 Baseline of only 38% .

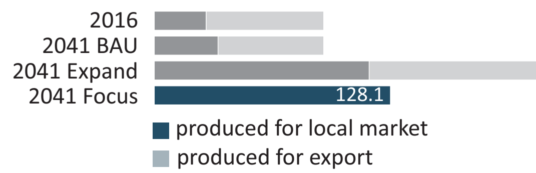
Figure 25: Food self-reliance for 2041 Focus Local for total diet and food groups



Food production: 128,137 tonnes

When compared to the 2041 Expand Local scenario, total food production decreases by 39% due to the absence of exports. In this scenario, we assume that all resources are devoted to producing food for the local market. Therefore, all food produced in the Township goes to the local markets; there is no production for the export market.

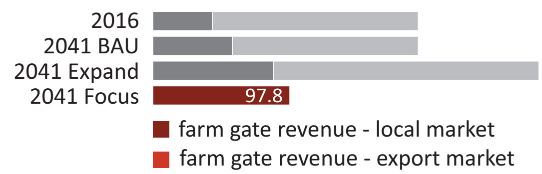
Figure 26: Tonnes of food production in the Township of Langley, in thousands



Total Farm Gate Revenue: $163 million

Comparing to the 2041 Expand Local scenario the farm gate revenue decreases significantly by 54%. This is due to the loss in export revenue in high value commodities such as poultry, dairy and fruit (i.e. berries). Land once used to grow these crops is reallocated to produce other commodities that satisfy the local population's diet.

Figure 27: Farmgate revenue for the Township of Langley, in thousands of dollars

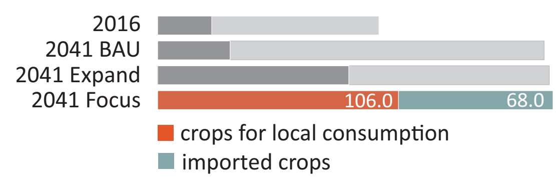


Environmental Impacts

Ecological Footprint

The ecological footprint of food consumption for the Township does not decrease because the diet does not change. The total footprint increases slightly to 174,048 gHa compared to the 2041 Expand Local scenario. This total can be broken down as 106,008 gha for crops produced for local consumption and 68,040 gha for imported crops.

Figure 28: Global hectares (gha) required to meet food need for the Township of Langley's population, in thousands



Greenhouse Gas (GhG) Emissions

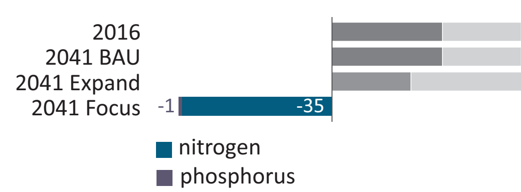
The estimated GhG emissions from crop and livestock production in this scenario is 85,302 tonnes of CO_2e which is about 40% less than the amount of GhG emissions in the 2041 Expand Local scenario. The main reason is because of the reduction in livestock production.

Figure 29: Tonnes of CO_2e emitted from food production in the Township of Langley

Nutrient Balance

As a result of reduced livestock production there is a nutrient deficit of 677 tonnes of N and 20 tonnes of P. This translates to a deficit of 35 kg/ha of Nitrogen and 1 kg/ha of Phosphorus.

Figure 30: Surplus nutrients from animal manure, in kilograms per hectare

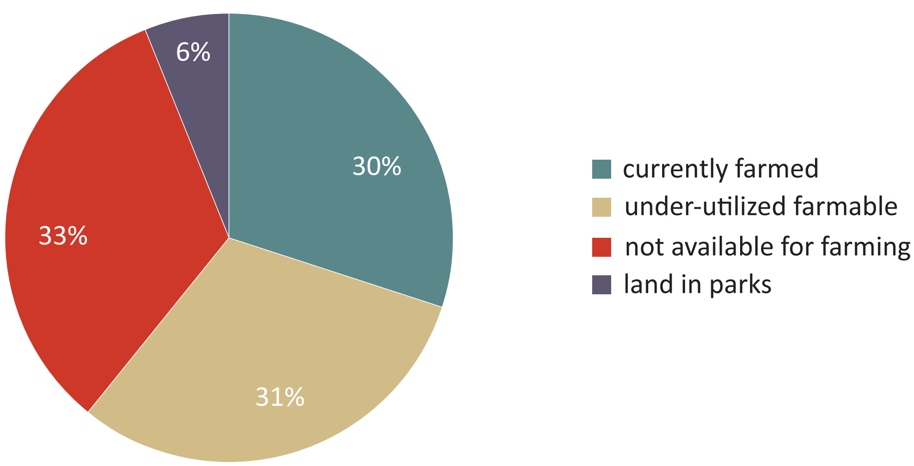


6. Discussion

6.1. Agricultural Land Use and Food Self-reliance

According to ALUI data, a significant amount of currently farmed land in the Township is dedicated to pasture and forage. These lands may support agricultural activities, but they are currently having a marginal impact on increased food self-reliance, due to the fact that they support non-food farming (i.e. horses), or land intensive food production (i.e. grazing). There is also significant under-utilized farmable land in the Township where no agricultural uses are currently recorded. This study found that with the amount of land available for farming in the Township it is possible to support food need for the local population and provide exports to other communities in the bioregion, if production was expanded to these lands.

Figure 31: Land Cover Types in the Township of Langley, based on ALUI data from 2016



Source: BC Ministry of Agriuclture, ALUI database

In the Township, and across the region, speculation of agricultural land has causes an increase in price, which can also negatively impact food self-reliance because farming no longer becomes a viable use of land (Condon, P., et al., 2010; Mullinix, K., et al., 2013). When land prices are high, due to speculation, purchasing land and establishing systems that produce food, especially for local markets is often not an attractive pursuit for farmers. For example, in 2016 there were 263 land parcels sold in the Township of Langley at an average cost of $160,000 per acre[11]. This value inflation is due to the fact that land is either owned in speculation (often for residential development), or purchased as a rural residence by non-farming owners (Tatebe, K., et al., 2018). If this trend continues it could decrease projected food self-reliance levels while also impacting the Township's economy and the viability of local farms. Policies that support the use of under-utilized land to produce food are needed so that the Township food system can achieve its full potential. This can include: supporting farmer training and education, creating opportunities for farmers to lease land from non-farming land owners, and adjustments to the taxation on land that is used for meaningful food production.

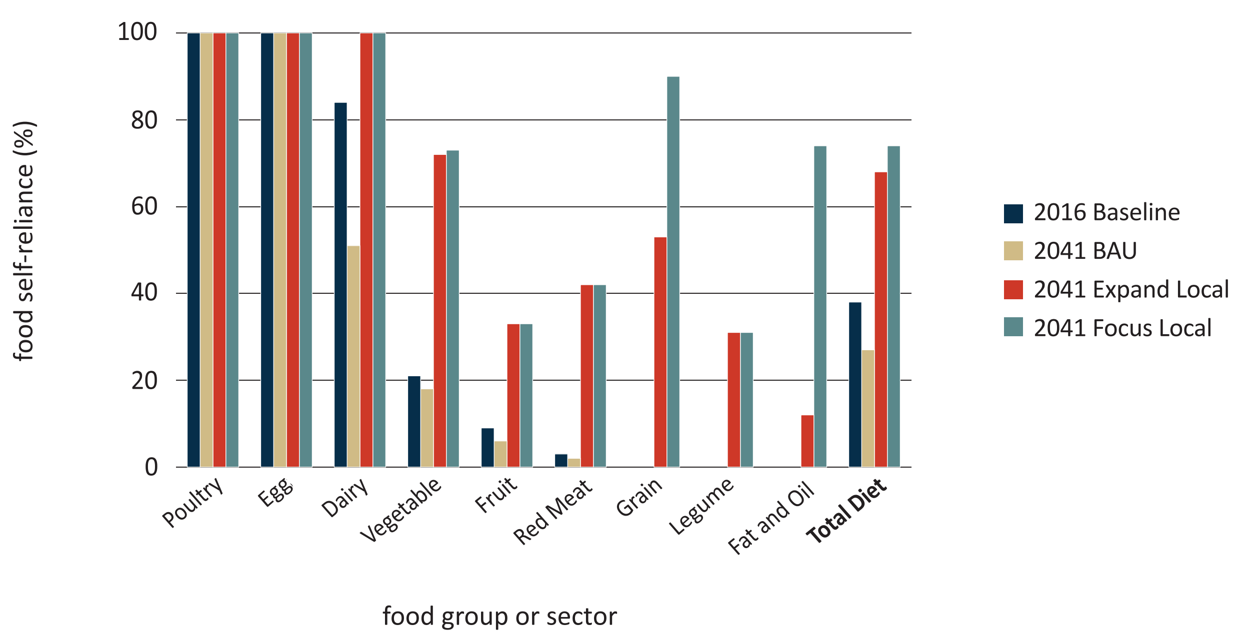
The use of agricultural land for non-food farming is another challenge that is not significantly addressed in this study. However, it could be an important issue for the Township to consider given the significant amount of land dedicated to horse farming, and the impending legalization of marijuana in Canada.

6.2. Food Self-reliance for the Growing Township

Food self-reliance is a valuable measure for local and regional governments because it provides assessment of the capacity of the food system, based on known factors such as land use, population, and types of crop production. The Metro Vancouver region is expected to grow rapidly, and significantly over the next few decades (Metro Vancouver, 2017). The 2041 BAU scenario demonstrates the impact that population growth would have on the Township's food system. In this case, when no additional land is made available for farming, and the population grows food self-reliance decreases by about 10% from the 2016 Baseline scenario. This means that the Township will be required to rely more on imported food, despite the high agricultural capability of the area. This also means a loss of revenue from food production, and other food system activities with the majority of money spent on food by the local population leaving the Township.

In the 2041 Focus Local scenario, the theoretical maximum food self-reliance for the Township of 74% is reached. This maximum is reflective of a doubling in the capacity of the Township to produce food (bringing all under-utilized farmable land into production), but also of the food choices made by the local population. Measuring food self-reliance requires estimating the food need for a local population. In this case we used estimated food need for an average Canadian diet. This assumes that people are eating a diet that contains food that cannot be grown or produced in the local

Figure 32: Food self-reliance in the Township for total diet and all food groups, by scenario comparison



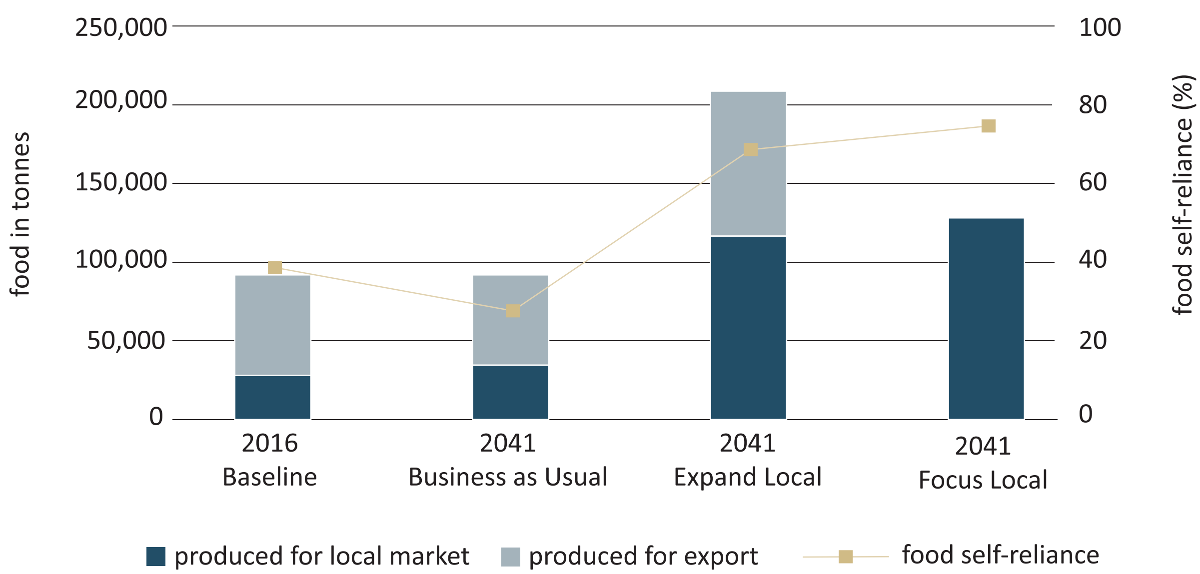
area, such as tropical fruit, or products eaten out of season. Therefore, it is impossible to reach 100% without a change in diet that excludes these foods. Theoretical maximum of 74% food self-reliance for the Township is reached in the 2041 Focus Local scenario because all land is brought into production, and is growing food that meets local food need. Figure 32 compares the percentage of food self-reliance for major food groups or sectors for each of the four scenarios in this study.

6.3. Food Production and Trade-offs

The food production potential for the Township increased significantly in the 2041 Expand Local and 2041 Focus Local scenarios because of the increase in amount of land available for food production. This suggests an obvious correlation between the amount of farmland available and the amount of food that can be produced. However, the relationship between the amount of food production and food self-reliance is not as straight forward.

In the 2041 Expand Local and 2041 Focus Local scenarios, although the same amount of land is available for farming, the 2041 Focus Local scenario produces over 80,000 tonnes less of food. In the 2041 Focus Local scenario the same amount of land, and resources are being used to produce a wider variety of foods to satisfy the local market, resulting in a high (theoretical maximum) food self-reliance. A trade-off of reaching this theoretical maximum could be a decrease in overall production and subsequent loss of revenue associated with the export market. Figure 33 shows the total food production as compared to the potential for food self-reliance in each scenario. The left hand axis shows total food production, in tonnes, broken down by production for local consumption and for export. The right hand axis shows the relative change in food self-reliance potential.

Figure 33: Total food production and food self-reliance, by scenario



6.4. Food Export Potential and Economic Outcomes

For this study, the model focuses on measuring the total farm gate revenue as the only economic indicator. This is primarily a measure of the quantity, and price of agricultural food products produced in the Township. The 2041 Expand Local scenario showed the highest farm gate revenue when compared to other scenarios. This is due to expanded production, and the ongoing production of high value crops for export markets (i.e. poultry, certain types of fruit and vegetable). The lower farmgate revenue in the 2041 Focus Local scenario is due to the fact that land is being dedicated to produce a wider variety of products to satisfy food need. Although farmgate revenue is low, in this scenario food self-reliance is highest. Figure 34 provides a comparison of the farmgate revenue generated in each of the scenarios.

Figure 34: Farmgate revenue compared to food self-reliance, by scenario

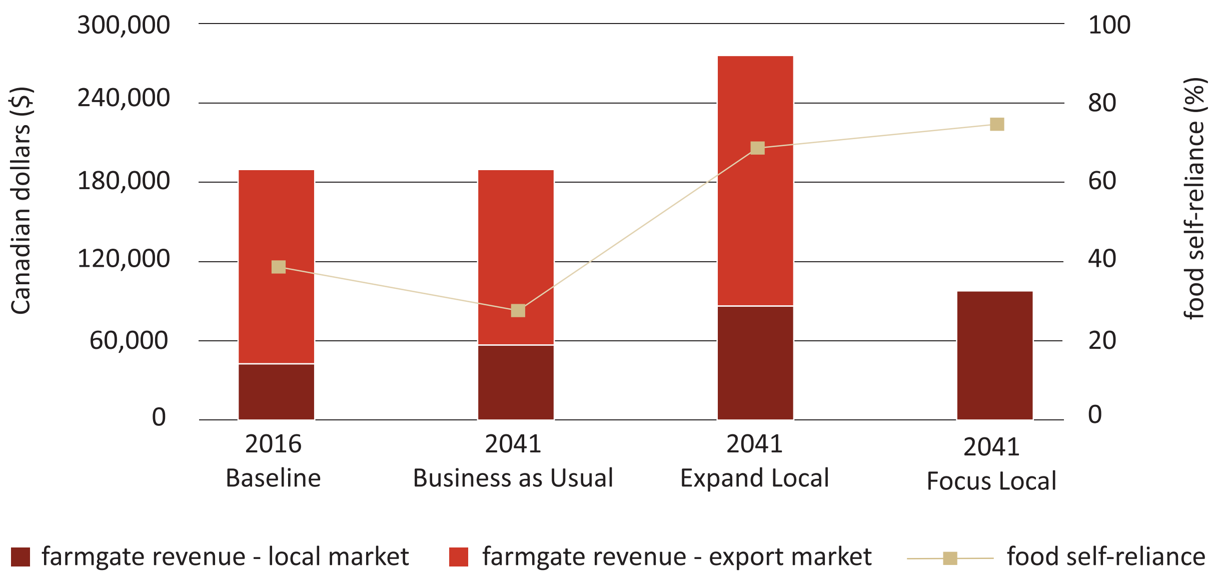
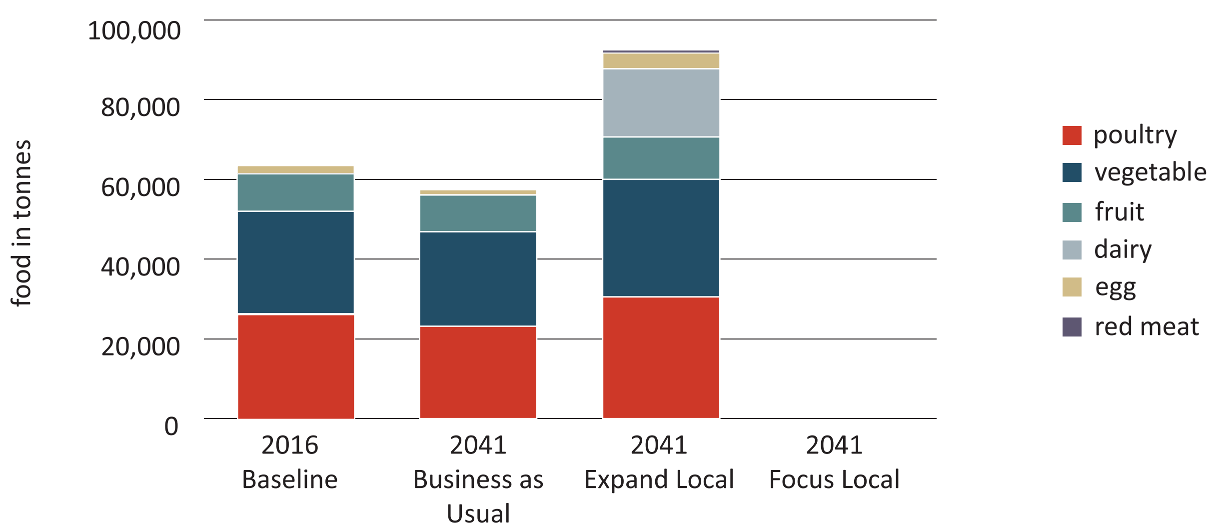


Figure 35: Tonnes of food produced for export, by food group



Along with the potential to achieve a high level of food self-reliance, the Township has potential to export food. By producing food for export to other communities in the Southwest BC bioregion, the Township could also contribute to greater food self-reliance across the bioregion. Figure 35 illustrates the amount of food produced for export, and provides a breakdown by food group for each of the four scenarios. There are no exported crops in the 2041 Focus Local scenario because all food is consumed by the local market.

6.5. Environmental Impacts

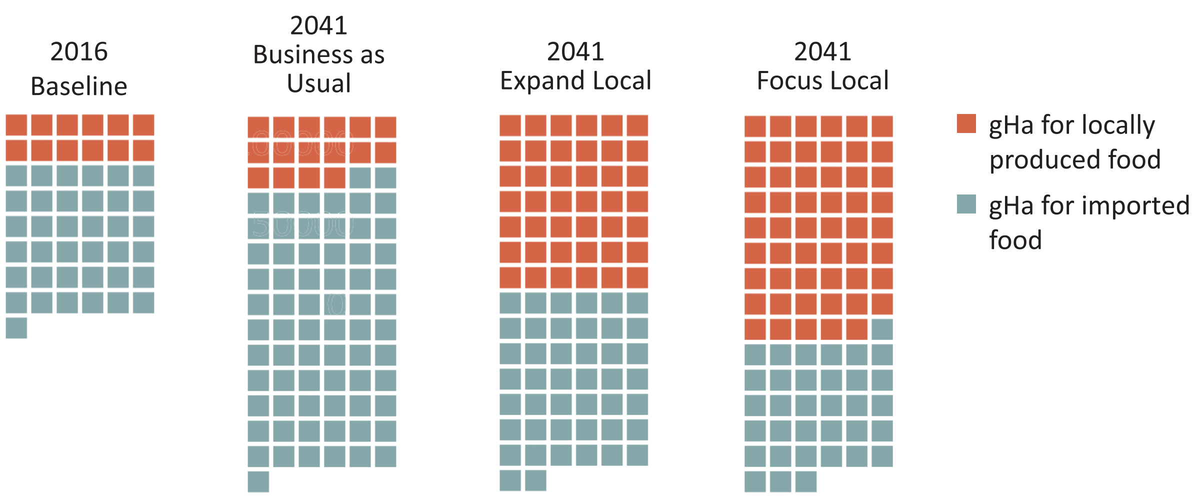
Agriculture, and other activities necessary to produce food are intensive processes, using significant amounts of energy, land, and human resources. Measuring possible environmental impacts of local food systems is a critical step in understanding the kinds of policies that will be necessary to protect local landscapes, resources, and help farmers adapt to climate change.

6.5.1. Ecological Footprint

The measure of ecological footprint in this study is directly connected to the population's food need and diet type. The amount of food required to satisfy food need is consistent across all scenarios and only changes when the population increases (therefore food need increases). The only significant change seen across scenarios is in the proportion of the ecological footprint dedicated to locally produced or imported food. This corresponds directly to the proportion of food in the local populations diet coming from those sources. Figure 36 compares the ecological footprint for food consumed in the Township for each scenario. The total ecological footprint does not significantly change in the three future scenarios (when population is constant) because each of these scenarios is based on the same diet for the local population.

Increasing food self-reliance, by producing a higher proportion the local population's diet locally, has little effect on the size of the ecological footprint for food consumption. The Southwest BC Project compared ecological footprints for food produced in the bioregion with food produced outside and imported to the bioregion. This analysis demonstrated that the ecological footprint of food need is

Figure 36: Ecological footprint for food consumed in the Township for locally produced and imported food, measure in global hectares (gha)



more heavily influenced by the kinds of foods consumed (i.e. proportion and type of animal products in the diet) than by where they are produced (Mullinix et.al. 2016). This study does not explore the impact of diet alternative on the Township's ecological footprint for food consumption.

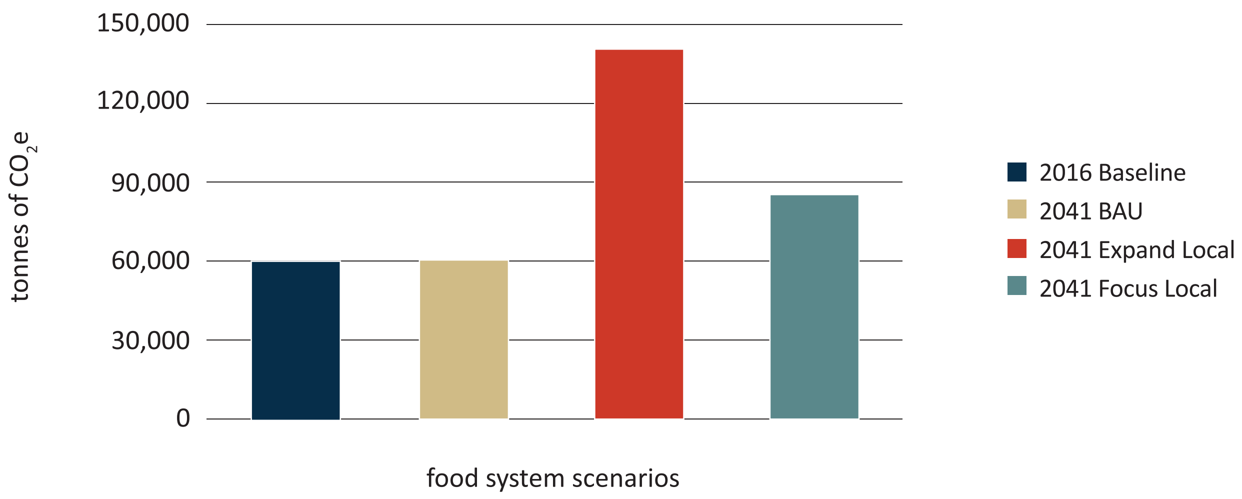
6.5.2. Greenhouse Gas Emissions

The results of the model suggest that an increase in production of food for a local market will increase the amount of GhG emissions attributed to agriculture in the Township, due to the increase in farming activities. The model results consider only the emissions from food production which means there are emissions not captured here that are associated with processing, packaging, and distribution.

The results of this study show that when more land is available for farming, and food production is increased in the Township the associated GhG emissions from the agriculture sector will also increase. The emissions are highest in the 2041 Expand Local scenario at 140,574 tonnes of CO_2e, because of a significant increase in total food production. However, this scenario also involves more production of livestock for meat and dairy which produce more CO_2e per tonne of food produced than other food products (i.e. vegetable and fruit). In the 2041 Focus Local scenario, emissions decrease to 85,302 tonnes of CO_2e which corresponds with lower total food production. However, the decrease in emissions may also be due to more production diversity that is necessary to satisfy local food need, and therefore the concentration of livestock production is lower. Figure 37 shows the greenhouse gas emissions associated with food production for each scenario.

This study shows an increase in GhG emissions associated with an increase in food production in the Township. However, increasing the amount of food that is grown and consumed locally presents a number of opportunities to reduce emissions through local initiatives focused on changes in dietary preference and farming practices. Reducing the use of fossil fuel based fertilizers, in favour of composted animal manure, as well as incorporating cover crops, and other strategies to increase the carbon capturing potential of soils can all decrease emissions associated with food production.

Figure 37: Total greenhouse (GhG) emissions associated with food production, by scenario



Climate Change Impacts on Local Food Production

Agriculture is both a primary contributor to climate change from greenhouse gas emissions produced as a result of food system activities (Moreau, Moore, and Mullinix, 2012), and one of the sectors most impacted by climatic changes (Prairie Climate Centre, n.d.). As such, climate change mitigation and adaptation should be at the forefront of any policy to strengthen agricultural viability and food security. Climate change is expected to increase the variability that producers must account for during the growing season. These include drier summers, wetter winters, as well as an increase in the intensity and frequency of hot days and extreme precipitation events (Metro Vancouver, 2016). While the region can expect a longer growing season, the assumption that higher average summer temperatures will be a "boon for agriculture in northern climates is now recognized as false" (Crawford and Beveridge, 2013). While the region can experience longer growing seasons, the viability of an agricultural season is dictating by extremes; a single extreme event (i.e. frost, extended drought, heat wave) can remove any potential advantages offered by more favourable average conditions (NRC, 2008). Producers will be required to adapt to this variability with new crop varieties, planting/harvesting schedules, and water and pest management strategies etc. Canadian producers, including those growing in the Township of Langley are already feeling the impacts of these changes.

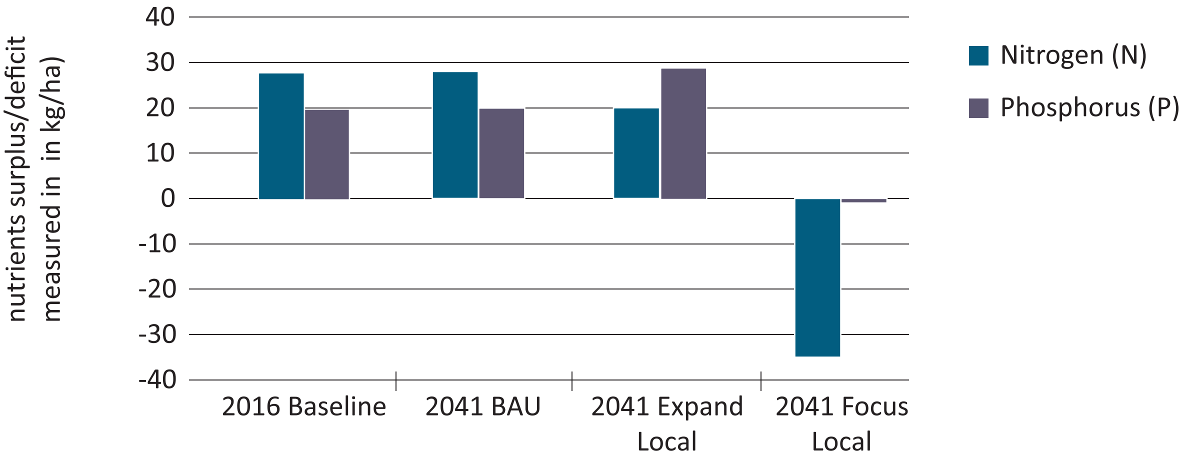
6.5.3. Nutrient Balance

As agricultural production has become more specialized, animals and crops are now commonly produced by different farms and the utilization of manures as a nutrient source has become more complicated and expensive (Smuckler et al., 2018). Nutrients, including nitrogen (N) and phsophorus (P) that are applied to crops are often done so at rates beyond what the plant can use. This means that they are most often lost to the environment, either to the atmosphere contributing to climate change and air pollution, or as surface water run-off or leaching that contaminates drinking water and aquatic habitat. A study of agricultural land use practices and N contamination in the Abbotsford aquifer found that a surplus of 100kg/ha of N may result in groundwater nitrate levels that exceed the provincial drinking water guideline of 10mg/L of N in groundwater (Zebarth et al., 1998). However, the risk of groundwater contamination from N surpluses depends on a number of factors including geology, climate and agricultural practices, etc. and is spatially variable. For example, an assessment across Austrian municipalities found mean nitrogen levels of 20 mg/L in drinking water which mean N surpluses of 40 kg/ha (Wick et al., 2012).

The Southwest BC project found that balancing nutrients supply and demand across the region could be achieved, but would result in a slight decrease in food self-reliance when compared to optimized scenarios (Smuckler, et al., 2018). The model however does not address the logistical challenges of moving nutrients (i.e. manure) around the region in order to achieve this balance. However, because the Township is a smaller geographical area, than Southwest BC, where the challenges of moving manure from where it is produced to where it can be used could be more feasible.

The study suggests that there is often a surplus of nutrient with the Township's food system. Although there is a change in the amount of surplus N and P in the system the total nutrient surplus in the first three scenarios is relatively constant. The 2041 Focus Local scenario sees a decrease resulting in a deficit of Nitrogen at -35kg/ha and Phosphorus at -1kg/ha. Diversification of farming operations in the Township could more closely connect the supply of N and P with the

Figure 38: Nutrient balance shown as surplus or deficit in kilograms per hectare



demand and decrease the potential of leaching into the environment. More effective management of manure through composting is also important and could be achieved through farmer education and providing access to resources. Similarly, to nutrient surplus, there are environmental impacts to serious deficits in food systems. When there are not enough nutrients available from natural sources, farmers must rely on imported, and often synthetic, fossil fuel based fertilizers to meet crop needs.

Nutrient Management on Horse Farms in the Township

The model does not account for the manure from non-food producing animals such as horses. Based on data from the 2016 Census of Agriculture we calculated that approximately 114.9 tonnes/year of Nitrogen (N) and 20.42 tonnes/year of Phosphorus (P) is produced from horses in the Township. To have a better understanding of how large the supply of N and P from the equine industry is we will compare it to the nutrient demand of the fruit production sector. The amount of N produced by the equine industry in 2016 is enough to supply nutrient needs for all fruit production in the Township. The amount of P produced can serve about half of the P required for production of all fruit production in the Township.

7. Conclusion

This study adopted the bioregional food system design methodology outlined in Mullinix et. al. (2016) to estimate current food system capacity and food self-reliance potential for the Township of Langley. The food self-reliance model provides a high level of food system analysis that uses the best available production information (supply), and national data to approximate what people in the Township consume (demand). This report demonstrates the potential outcomes and implications of a local food system, demonstrating different land use and production regimes. Within this study there are many assumptions made and nuances about the local food system that cannot be captured, either because they are immeasurably complex, or because no data is currently available.

For the Township of Langley Food Self-Reliance Study, we modelled a variety of food system scenarios and selected scenarios that best illustrate the potential of the Township's food system. Although the Township cannot be 100% food self-reliant due to its limited growing season, existing production technology, and consumer preferences it is demonstrated that food self-reliance could increase with changes to land use and production regimes were considered. Study results suggest that if more farmable land in the Township was brought into production and was reallocated to grow food that its citizens consume locally, there would be an increase in food self-reliance, by as much as 51%.

If land in the Township that is suitable for food production is removed from the Agricultural Land Reserve to be used for residential, commercial or industrial purposes, the food production capacity of that land could diminish, or be permanently lost. Creating viable agricultural enterprises that contribute to the local economy, and provide food for the local population will help protect land for agriculture, and increase food self-reliance in the Township.

Food self-reliance research is a valuable part of the study of food systems because it can tell a data driven story about the relationship between agricultural activities in a region and the food systems that provides sustenance for the people living there. The findings from this research demonstrate that if we continue with the status quo, in terms of farmland availability and use, there could be serious implications for food self-reliance in the future. This means that communities may be more reliant of imports, decreasing food security and overall resilience, especially in area with rapidly growing populations. Additionally, areas like the Township of Langley with significant food production capacity will not be able to capitalize on the economic potential of the food system sector, especially in the profitable post-production, distribution and retail areas.

Currently, our dominant food system depends on a highly globalized network of supply chains. As such, shocks and stresses experienced internationally can be felt locally through shifts in price and availability of food and related commodities (Charlebois et. al., 2018). While the global food trade will continue to be a significant part of the food system, strengthening regional food systems, and increasing food self-reliance, represents a significant opportunity increase the resilience of our food system in the face of climate change. Local and regional food systems may be able to respond better to climate stress and change, while ensuring a local food supply, and ensuring the viability of farming in the area. Local food markets in Canada are still growing. This presents significant opportunities to not only expand production, but also invest in infrastructure to support other value chain steps including post-production processing, distribution, and retail.

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9. Appendicies

Appendix A: Land Use Category Classifications and Descriptions

	ALUI Category	ALUI Classification	Description
Currently Farmed Area: Refers to land that is directly contributing to agricultural production (both actively farmed and inactively farmed). Does not include natural pasture of rangeland.	**Actively Farmed**	**Cultivated field crops**	Vegetation under cultivation for harvest or pasture including land temporarily set aside from farming and perennial crops that were not harvested or grazed in the current growing season.
		Farm Infrastructure	Built structures associated with farming such as barns, stables, corrals, riding rings, and their associated yards.
		Greenhouses	Permanent enclosed glass or poly structures with or without climate control facilities for growing plants and vegetation under controlled environments.
		Crop Barn	Permanent enclosed structures with non-translucent walls for growing crops such as mushrooms or bean sprouts.
Under-utilized Farmable Land: Land not currently being farmed, but can be used for agricultural purposes without displacing a current use and without significant topographical, physical or operational constraints to farming such as steep terrain, land under water, or built structures.	**Inactively Farmed**	**Unused pasture**	Crop is cultivated but has not been cut or grazed this year. Must have realistic probability of being used as pasture or forage in the foreseeable future.
		Unmaintained field crops	Land under cultivation for field crop which has not been maintained for several years and probably would not warrant harvest
		Unmaintained greenhouse	Built object is not in use and is in poor structural condition OR crop is not being maintained and probably would not warrant harvest.
		Unmaintained crop barn	Built object is not in use and is in poor structural condition OR crop is not being maintained and probably would not warrant harvest.
	Anthropogenic	Managed vegetation	Vegetated lands seeded or planted for landscaping, dust or soil control but not cultivated for harvest or forage. Includes parklands, golf courses, landscaping, lawns, vegetated enclosures, remediation areas.
		Nonbuild or bare	Human created bare areas such as extraction or disposal sites. Includes piles, pits, fill dumps, dirt parking or storage areas. Includes piles, pits, fill dumps, waste disposal areas, dirt parking or storage areas.
	Natural and semi natural	Vegetated	Lands with > 10% vegetative cover that is seeded, planted or cultivated and requires human activity to maintain. Includes fallow farmland, all lands under cultivation or planted with annual crop species, landscaping, vegetated enclosures and lands seeded for remediation. In transition, the surface can be temporarily without vegetation.
Land in Parks			Land that is designated for parks and therefore not considered farmable, regardless of soil class.

10. Endnotes

1 For more information please visit http://www.kpu.ca/isfs/swbcproject

2 This method assumes that residents continue to eat foods that are not grown in BC (e.g., mango), and to eat fresh foods out of their season of local availability (e.g., fresh strawberry in January), therefore imports are required.

3 Age and gender categories align with Canada food guide recommendations

4 Data Source: http://www23.statcan.gc.ca/imdb-bmdi/pub/document/3475_D1_T9_V3-eng.htm

5 Data Source: Statistics Canada Catalogue no. 98-400-X2016003

6 There is no recommended number of food guide serving for children under the age of 2

7 At the time of the study 2016 ALUI report for the Township was not yet published so ALUI data was obtained directly from the Ministry of Agriculture. The ALUI is conducted by the BC Ministry of Agriculture every 5 years.

8 The Township of Langley has a land mass of 31,600 ha, approximately 75% of which is located within the Agricultural Land Reserve (ALR). The ALR is a Provincial “zone” in which agriculture is a priority use and non-farm uses are restricted.

9 Provicnial climate data available at: https://www2.gov.bc.ca/gov/content/environment/climate-change/data/provincial-inventory

10 CO_2e or carbon dioxide equivalent, is a standard unit for measuring carbon emissions. The idea is to express the impact of each different greenhouse gas in terms of the amount of CO2 that would create the same amount of warming.

11 BC Assessment Custom data