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Research Brief

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Economic Impacts of a Regionalized Food System in the Southwest British Columbia Bioregion

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Abstract

This research brief presents findings from our investigation into the economic impacts of regionalizing the food system in the Southwest BC bioregion, which was conducted as part of the Southwest BC Bioregion Food System Design Project. Included is a description of our methods, highlights from our findings and a discussion of how different food system characteristics, theoretically, affect the regional economy. The results show that reconsidering what we produce and creating value added products results in great contributions to the economic vitality of the region. Additionally, there is potential to achieve higher positive economic impacts while also mitigating some adverse environmental impacts from farming if we conserve agricultural land for agricultural production. The results are not predictive of our food system future but rather aim to stimulate the discussion of means to achieve outcomes that enhance regional economy, environment and society as a whole.

Some recent studies provide evidence in support of the link between food system regionalization and regional economic growth, while others question it.

Background

The transnational food system is predicated upon liberalized global markets. Driven by efficiency, economy of scale and price competitiveness, consolidation and integration have occurred throughout the food system. As a result, individual regional food systems have become more entwined and dependent, thus creating the global food system that is increasingly being dominated and controlled by a handful of business corporations (Hendrickson 2002; Nesheim, Oria, and Tsai 2015; Norberg-Hodge, H., Merrifield, T & Gorelick 2002).

In this global food system, farmers have by and large become merely tools to produce raw products for the supply chain, and are increasingly economically marginalized. Concomitantly and consequently, consumers do not have a connection with either farmers or the land. As a result they have negligible awareness of environmental, economic and social impacts of the food they consume and the food system on the whole.

There are many ideas about how to best address these and other pressing food system challenges. Regionalization or localization is one (Chase, L. & Grubinger 2014; Clancy, K. & Ruhf 2015; Harris et al. 2016). A regionalized food system potentially contributes substantially to local economic vitality as well as environmental and social sustainability (Allen 2010; Macias 2008; Martinez et al. 2010). However, Born and Purcell (2006) cautioned policy makers to avoid the "local trap" -- the idea that local food system is always preferable to its larger scale alternative. Edwards-Jones et al.'s review of scientific literature compared nutritional quality and the energy use and greenhouse gas emissions associated with the production of fruits and vegetables produced locally and imported and illustrates the need for such caution (2008). They found that results on energy use and greenhouse gas emissions were more influenced by the season of production, scale of analysis, and research methodology than production location. Nutritional quality was affected by the time between harvest and consumption and the method of processing. They concluded that distance between producers and consumers had less of an impact on nutritional quality than other characteristic of the supply chain.

As for economic impacts, some recent studies provide evidence in support of the link between food system regionalization and regional economic growth while others question it. Brown et al. (2013) modeled the relationship between community focused agriculture (CFA) and economic growth in the United States. CFA was measured by the sales of farm commodities directly to consumers and farm income from agrotourism. To do so, they tested the contribution of CFA to the agriculture sector (measured by the change in total sales) and regional economic growth (measured by the change in personal income). At national level, the study did not find evidence that direct marketing and agrotourism contribute to the growth in farm sales and personal income. At regional scale, there was mixed evidence. Some regions showed a positive relationship while others showed negative or no relationships. The variation by regions was related to their unique socio-political-economic environments; however, the scope of the study precluded study of these differences in detail. The study concluded that, in the short run, CFA may not contribute significantly to the country's economic growth.

One special feature of food system regionalization is the increased incidence of local ownership of businesses. Fleming and Goetz (2011) found that, in the United States, areas with higher density (number per capita) of small (under 100 employees), locally owned businesses had higher per capita income than areas with a high density of large (over 500 employees) non-local businesses. Schmit, Jablonski and Mansury (2016) provided evidence from New York that this could be because small, locally owned businesses tend to support other local businesses within the region. They measured the impacts of the small scale direct market agriculture (SDA) sector compared to the non-SDA sector. In their model, the aggregate agriculture sector was separated into SDA and non-SDA as they believed that the sales and purchasing pattern of these two sectors are very different. The results showed that the SDA sector had lower impacts in the number of jobs and output, but higher impacts in the labour income and total payment to value added (e.g.: employee compensation, proprietor income, other property type income and indirect business taxes). This was because the SDA sector often relied on owner-operators' labour rather than hired labour. Additionally, the SDA sector exhibited lower intermediate input imports and higher local purchases for 'agricultural support activities, construction (repairs), utilities, and retail trade per dollar of output'. Hence, policies to support SDA and non-SDA sectors would result in differing economic outcomes.

In Canada, Econometric Research Limited and Harry Cumming and Associates (2014) estimated the impacts of regional agriculture and food systems in Southern Ontario for different food system scenarios. Results indicated that if Ontarians were to eat "a diet that is optimal for health", then additional land should be put into production and that Southern Ontario could reduce food import by "diverting exports to local consumption" and that this would provide positive economic impacts to the region. The study did not analyse all food crops consumed locally but used certain crops as examples to understand the Southern Ontario food system as a whole.

In this paper we add to the literature by estimating the economic impacts of food production in the Southwest British Columbia bioregion (Southwest BC), in different hypothetical food system scenarios in 2050 compared to the baseline year, 2011. Southwest BC is a region comprising five contiguous regional districts in the southwest mainland corner of British Columbia, Canada (Harris et al. 2016). Each scenario generated takes into account all food commodities consumed by the Southwest BC population. Each scenario also builds on the previous where we commit our food system to become more regionalized and increase care for the local environment. Economic impacts are estimated through the British Columbia Input-Output models and are described in standard economic terms: output, Gross Domestic Product (GDP), household income, employment and tax revenue. These hypothetical food system scenarios give us a view into our future to help us make decisions regarding what type of food system we would like to have and how we can achieve our food system and economic goals.

Methods

Food System Scenarios and Modeling

To explore the outcome of and options for regionalizing the Southwest BC food system in the future, ISFS developed two computational models to estimate current (2011) and future (2050) food production, food self-reliance, environmental impacts, and economic outcomes of various scenarios (Dorward, Smukler, and Mullinix 2016a, 2016b). The models employed two different calculation techniques based on agricultural land use allocation. In the first model (a spreadsheet model), future agricultural land use allocation followed 2011 agricultural land use patterns. In the second model (optimization model), future agricultural land use was reallocated and prioritized to meet food need[1] in Southwest BC, with maximizing Southwest BC food self-reliance as a goal. A key feature of the optimization model is therefore that land is allocated to foods that satisfy the highest level of local food need possible. The underlying assumption in both models was that bioregional consumers choose to purchase locally produced food whenever available (that is locally produced food is first sold to the local market, excess food is for exportation). When regional production cannot satisfy regional demand, importation of that food is necessary.

[1]See Dorward, Smukler, and Mullinix (2016a) for method of determining food consumption or food need and a list of all foods considered in the models.

To understand how regionalization affects economic performance of the food system, we followed the concept put forth by Clancy and Ruhf (Clancy & Ruhf 2015) that an ideal regional food system is one in which:

> *"As much food as possible to meet the population's food needs is produced, processed, distributed, and purchased at multiple levels and scales within the region, resulting in maximum resilience, minimum importation, and significant economic and social return to all stakeholders in the region".*

The underlying assumption of both food system models is that bioregional consumers choose to purchase locally produced food whenever available.

With these computational models, numerous food system scenarios were generated and five selected for comparison. Each scenario selected is predicated upon an incremental change from the previous scenario, and highlights outcomes of different approaches to the regionalization of the food system by increasing food self-reliance.

The first is the 2011 Baseline scenario (Baseline) which draws upon 2011 statistical data regarding amount of land farmed, land use for crop and animal production, population, and food need[1] (Dorward, Smukler, and Mullinix 2016a). The Baseline scenario represents our contemporary regionalized food system situation in Southwest BC as we assume that the bioregion's population chooses to consume local products over imported products whenever possible. Therefore the amount of food production for local consumption modeled in the Baseline is likely to be greater than what actually occurred, and the amount of food imported smaller.

In the second scenario, 2050 Business-as-Usual Food Production (BAU), future land use levels and the food production mix is the same as in 2011 while population increases by about 60% (Dorward, Smukler, and Mullinix 2016b). This scenario portrays the degree to which regional food need can be satisfied by land based food production in Southwest BC under the pressure of population increases given no changes in land use, production method, and yields. The 2011 Baseline and the 2050 Business as Usual scenarios were both generated by the spreadsheet model, whereas the following scenarios were generated by the optimization model.

The third scenario, 2050 Increase Food Self-Reliance (Increase FSR), represents a future in which farmable land is allocated differently; to the production of crops and livestock that satisfy regional food need and maximize food self-reliance. In this scenario, our theoretical food system becomes increasingly regionalized. Not only do consumers choose to purchase local products over imported products, the producers also aim to produce and process the types of food that would satisfy local food need.

The fourth is the 2050 Mitigate Environmental Impacts from Agriculture (Mitigate Impacts) scenario. This scenario is built on the Increase FSR scenario. It represents a future in which we attempt to alleviate some of the negative environmental impacts from agriculture; specifically reducing nitrogen and phosphorus surplus from animal manure[2] and enhancing wildlife habitat quantity, quality, and connectivity (via hedgerows and riparian buffers)[3]. This food system scenario shows how the regional economy is affected by the imposition of practices to mitigate adverse environmental impacts from agricultural production.

Finally, the 2050 Expand Agricultural Land in Production (Expand Land) scenario represents a future where farm land expansion plays a role in increasing food self-reliance. This scenario builds upon

[2]Nitrogen and phosphorus come from livestock manure. Excess amount of these nutrients occur in the soil may act as environmental pollutants. For more information on this topic, see Smukler, Dorward and Mullinix (2016).

[3]Compared to unfarmed areas, farmed land provides less habitat capacity for wildlife. However, if hedgerows and riparian buffers are introduced on the farms, they could provide habitat and travel corridors for wildlife. For more information on this topic, please refer to Mullinix et al. (2016).

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the Mitigate Impacts scenario. It shows the gain when we put currently unfarmed ALR land into production to serve our regional food need, while maintaining our efforts to alleviate some of the negative environmental impacts from agriculture.

While the Baseline 2011 scenario represents the current food system, the other scenarios offer a glimpse into different food system options for our 2050 future. This, however, does not mean that these are our only options. The scenarios are meant for illustrative purpose and to stimulate discussion about our preferred food system future.

The five food system scenarios and their assumptions are summarized in Table 1.

Economic Impact Estimation

The British Columbia Input-Output (I-O) model developed by BC Stats (the provincial government statistical agency) was used to calculate the potential economic outcomes of Southwest BC's food production activities (crop production, animal production, and food processing) in the BC economy. I-O models are a commonly used economic modelling tool that estimate impacts of a change in an economic activity on a national or regional economy (Bess and Ambargis 2011). The I-O model used also provides information on the flow of goods and services and inter-industry linkages of all sectors of the economy (BC Stats 2016).

The I-O Model reports three types of economic impacts according to their sources: direct, indirect and induced. In the context of Southwest BC food production, direct impact measures economic activities across BC directly generated by Southwest BC food production. Indirect impact measures additional economic activities generated by supplier industries in the supply chain. Induced impact measures the effect of food production workers and supplier industry workers spending their earnings.

Key indicators used to quantify economic impacts are output, gross domestic product (GDP), household income, tax revenue, and employment. Each indicator is described below.

- Output is the value of the final goods and services including the value of their intermediate inputs. However, the value of intermediate inputs get counted every time they change hands, causing double counting of the value of those inputs. This is an indication of the flow of goods and services within the economy as well as the linkages between different industries in the economy.

Table 1: Summary of theoretical food system scenarios modeled in the Southwest BC Bioregion Food System Design Project and reported in this brief

SCENARIO	TYPE OF MODEL	FARMLAND USE	POPULATION (MILLION)	FOOD NEED (MILLION TONNES)	FARMLAND MODELED (MILLION HECTARES)	ENVIRONMENTAL ENHANCEMENTS
2011 BASELINE	Spreadsheet	As Statistics Canada reported for 2011	2.7	2.6	101,000	No enhancements
2050 BUSINESS-AS-USUAL FOOD PRODUCTION	Spreadsheet	As in Baseline Scenario	4.3	4.2	101,000	No enhancements
2050 INCREASE FOOD SELF-RELIANCE	Optimization	Reallocated according to regional food need	4.3	4.2	101,000	No enhancements
2050 MITIGATE ENVIRONMENTAL IMPACTS FROM AGRICULTURE	Optimization	Reallocated according to regional food need	4.3	4.2	101,000	Nitrogen balance and habitat enhancements
2050 EXPAND AGRICULTURAL LAND IN PRODUCTION	Optimization	Reallocated according to regional food need	4.3	4.2	165,000	Nitrogen balance and habitat enhancements

- GDP is the unduplicated total value of the goods and services. GDP reflects the difference between the value of final products or services and the value of the input or intermediate costs of production. GDP does not double count the values of intermediate inputs. Therefore, GDP is smaller than the value of the output. GDP is calculated at "basic price". That is, using the prices received by producers as opposed to the prices paid by consumers. GDP is a useful indicator as it is a uniform measurement of the growth and productivity of the economy that can be compared across regions and countries.

- Household income measures income earned by workers in all industries affected by the production of food in Southwest BC. This includes income earned by self-employed individuals and unincorporated businesses. Income is an important economic indicator as it is a determinant of participation (consumer spending capacity) in the economy.

- Tax revenue refers to federal, provincial and municipal tax revenue collected through all production activities. Provincial and federal taxes include personal income tax, corporation income tax, taxes on products and taxes on factors of production. Municipal tax includes tax on products and on production such as tax on accommodation, business, licences, permits, fees and property tax.

- Employment measures the total number of jobs required to support all industries affected by production of food in Southwest BC. The total number of jobs includes seasonal/temporary, year-round, part-time and full-time positions. The employment indicator can also be conveyed by the number of full-time equivalent (FTE) jobs. One FTE assumes that a person works 35 hours per week for 50 weeks a year (or 1,750 hours annually). When the reported FTE is higher than the number of jobs, it implies that a typical worker in the industry works more than 1,750 hours annually.

The future scenarios that we generated from the models portray a possible food production system future for a projected 2050 population. The challenge of estimating economic impacts of any future food system is that there are many unknowns. Our economy is ever-changing and influenced by complex linkages between industries, fluctuating costs, dynamic demand and supply, and an evolving policy environment. As our economic activities change in the future, the relationship between these components will change as well. The 2011 I-O model used for economic modeling represents a static economic environment and generates estimates, in 2011 dollar value, of what impacts would result from the modeled activities if they had occurred in 2011. Economic results presented here are therefore not predictive of future economic impacts, but rather, can be used to compare scenario outcomes based on their performance in 2011's economic environment.

In order to estimate economic impacts, we first determined farm gate values for all crop and animal products by multiplying the amount of each commodity produced by its associated price per unit[4]. Additionally, we estimated the percentage of the value of each commodity that was processed (such as frozen vegetable, fruit juice, cheese, skim milk, and flour). That information was then used by BC Stats to generate a customized I-O model for each food system scenario. The I-O model reported economic impacts in terms of associated jobs, output, GDP, income generation and tax revenue as a result of regional food production levels in each scenario. The results indicated the relative impact, in monetary value, to the BC economy resultant of varying agricultural production and concomitant food self-reliance levels for our scenarios.

Results and Discussion

The economic outcomes for the five food system scenarios are divided into three sections. The first presents the relative amount, in tonnes, of Southwest BC's food production and importation of food. The information illustrates the bioregion's food production as well as its dependence on importation of food from other regions. The second presents the estimated values of bioregional food production and imports. The potential economic impacts are presented in the third section.

Estimated Quantity of Crop and Animal Production

Southwest BC farm products go to two markets – the local market and export market. The production for the local market is dictated by regional food need. Production for the export market is the amount that exceeds bioregional food need. The estimated quantity, by scenario, of crop and animal commodities produced in Southwest BC for local and export markets, and imported to meet outstanding food need, is presented in Table 2.

As import and export quantities are directly related to the assumption that bioregionally produced foods were consumed within the bioregion by the populace, the import and export outputs derived from the computational models varied depending on which model was applied. The optimization model always gave priority to growing crop and livestock that satisfy bioregional food need. Therefore, farmable land would be reallocated away from producing crops and livestock for export or from producing crops and livestock that were not directly for human consumption (because they did not contribute to bioregional food self-reliance). As a result, theoretically, there were no exports in the Increase FSR, Mitigate Impacts and Expand Land scenarios.

Economic results presented here are not predictive of the future but can be used to compare scenario outcomes based on their performance in 2011's economic environment.

[4]*When BC data from Statistics Canada was available, average annual price was calculated by dividing the amount of total marketed production (in tonnes) with the total farm gate values (in dollars). When BC data was not available, Western province or Canadian data were used.*

For all scenarios, the estimated amount of food consumed was greater than the bioregion's ability to product it.

For all scenarios the estimated amounts of food consumed was greater than the bioregion's ability to produce it. Even if 100% of all Southwest BC production served the bioregional market, it remained impossible for Southwest BC to achieve 100% food self-reliance (Mullinix et al. 2016). There are two main reasons why this is the case. First, certain foods, such as bananas and mangoes, cannot be grown in Southwest BC and if we continue to consume them, then we must import them. Secondly, local production cannot satisfy the population's food need given yields, the amount of available land, and production seasonality (given the climate of Southwest BC, most foods cannot be produced year-round).

The dependence on imports was highest in the BAU scenario. That is if we continued to use the land the way it was contemporarily allocated with the same yields, while population increases, the only way to feed our population was to keep importing more food. When the land was allocated differently, that is to produce food to satisfy the bioregional food need (Increase FSR, Mitigate Impacts and Expand Land scenarios), we found that the gap between the import and local production became smaller (compared to BAU).

When comparing the Baseline to BAU, the amount of total production remained the same. However, a smaller portion of total production was sent to the export market as more of the food produced in Southwest BC could be used to satisfy the local market as a result of the population increase. The production levels in both scenarios were the same due to several assumptions. First, the total amount of land in production was the same. Second, we assumed the same pattern for land use (i.e. crop and stock produced). And third, there was no change in yield per acre or per animal.

In the Increase FSR scenario, when agricultural land was reallocated to a different production mix, total food production increased, even though we had the same amount of farmable land in production. The main reason was because a portion of the land that was previously used as pasture land or to grow hay, silage and feed grain, was now used to produce food for human consumption. In the Increase FSR scenario, pasture land and the production of hay, silage and feed grain still existed but there was only enough to support Southwest BC dairy and other livestock production. There was no need to produce extra pasture, hay silage and feed grain. Hence, there was arable land left to produce other crops to satisfy bioregional food need. With the intent of satisfying bioregional food need as much as possible through local production of all food commodities, production for export markets became less dominant. The Increase FSR scenario presented an entirely different future use of agricultural land than the

Table 2: Estimated levels of food production and food import in Southwest BC, by scenario (1,000 tonnes)

SCENARIO	FOOD IMPORT	FOOD PRODUCTION		
		FOR EXPORT MARKETS	FOR SOUTHWEST BC MARKETS	TOTAL
2011 BASELINE	1,777	229	855	1,084
2050 BAU	3,241	132	952	1,084
2050 INCREASE FSR	2,232	0	1,952	1,952
2050 MITIGATE IMPACTS	2,543	0	1,641	1,641
2050 EXPAND LAND	2,094	0	2,090	2,090

BAU. In addition to reallocating land away from pasture, hay, silage and feed grain production, the land devoted to crops (or livestock) produced in great quantity for the export market was now reallocated to produce crops and livestock that served the food need of the bioregion's population. With all production being consumed locally, there were no food commodities left for export markets.

The difference between Increase FSR and Mitigate Impacts was the imposition of a nutrient balance and habitat enhancements (hedgerows and riparian buffers). The amount of food production in the Mitigate Impacts scenario was slightly reduced from that of Increase FSR scenario. This occurred mainly because the amount of total farmed area was reduced by approximately 8,000 hectares with the imposition of habitat enhancements. The effort to balance the supply of Nitrogen and Phosphorous from animal manures with crop demand for these nutrients minimally affected the amount of land in stock and crop production. With the nutrient balance imposed, the types of crops and livestock to be grown in the region changed so that the amount of N and P generated from livestock did not exceed the amount required by the crops grown in the region. For example, we were 100% self-reliant in egg production in Increase FSR scenario (Dorward et al. 2016). However, with the nutrient balance requirement (Mitigate Impacts scenario), we could not be 100% self-reliant in egg production without producing a surplus of N and P.

There was a direct correlation between the area in production and the amount of food produced. Assuming yield for animal and crop production did not change appreciably, when all farmable ALR land was in production (Expand Land scenario), there was a commensurate increase in bioregional food production capacity. In the Expand Land scenario, the higher production levels derived from having more arable land in production. Compared to BAU, total production in Expand Land scenario was nearly double. Two aspects differed in terms of agricultural land use. First, the land use pattern (i.e. crop and stock mix) changed and second, there was more land in production. As a result, food production was much higher in the Expand Land scenario. Continuing to use egg production as an example, in Expand Land, we now had enough land to expand both egg production (N and P producing sector) and the crop production (N and P consuming sector), hence balancing N and P in the system, and becoming self-reliant in egg production.

Estimated Value of Crop and Animal Production

The value of an import product was calculated by multiplying the total tonnes of import (calculated in the model) with the average annual import price (obtained through the Canadian International Merchandise Trade database (Statistics Canada 2015). Similarly, the farm gate value of a product was calculated by multiplying the total tonnes of production (calculated in the model) with the average annual farm gate price (Statistics Canada 2014a, 2014b, 2014c, 2014d, 2014e, 2014f, 2014g).

As noted, our computational models also estimated the value of crop and animal products that were consumed as processed products (such as frozen fruits, canned vegetables and dairy) based on the regional food need and food preferences. With this information, the I-O model was able to estimate the value of the total production of raw and processed food products. This value was then used in the I-O model to estimate the provincial economic impacts as a result of the food production and food processing in Southwest BC. The estimated valuesof imports, farm gate value of total crop and animal production, and value of total production of raw and processed food products are presented in Table 3.

Imports represent a leakage of local money out of Southwest BC. The leakage can be viewed as a loss of economic activity that could have occurred if this money had stayed within the bioregion. For example,

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Imports represent a loss of economic activity that could have occurred if the money spent on imports had stayed within the bioregion.

if we had more arable land to produce the foodstuff that we are importing we could generate more economic activity within Southwest BC. The leakage in our present food economy can be reduced in many different ways; for example, we can consciously alter our diet to consume more foods that can be grown locally.

In the BAU scenario, the value of imports almost doubled compared to the Baseline. As previously discussed, if we continued to use farmland in 2050 in the way we did in 2011, the only way to feed our population would be to increase imported food. Among the four future scenarios, the Expand Land scenario estimated the lowest amount of imports as we were able to produce the largest amount of food due to the expansion of agricultural land area in production.

In all scenarios, the value of total production of raw and processed food products was always higher than the total farm gate value. This was because processing activity added value to raw/fresh products. The presence of the processing sector also created additional linkages between industries in the economy resulting in more economic activities. As seen in Table 3, the estimated value of the total production of raw and processed products was slightly higher in the BAU scenario compared to the Baseline even though both scenarios produced the same amount of food (1,084 thousand tonnes). This was mainly because the estimated percentage of processed food was higher in the BAU scenario. Hence, even when two economies produced exactly the same amount of raw products, the economy which had more processing capacity would generate more total economic activity/output.

Farm gate value and value of raw and processed products became larger as we reallocated land from the Baseline land use pattern (BAU) to the new pattern that prioritized regional food need (Increase FSR). Results (not shown in the table) also indicated that the amount of processing activity in the Increase FSR scenario was also larger (compared to BAU). For example, the percentage of processed potato products went up from 2.7% in BAU to 46.63% in the Increase FSR scenario. As a result, the Increase FSR scenario yielded a much higher value of the estimated total production of raw and processed food products.

When some of the environmental enhancements were implemented, the estimated farm gate value in the Mitigate Impacts scenario appeared to be lower than that of the Increase FSR scenario. This was partly because when the nutrient balance condition was imposed, the production of egg and meat was reduced substantially, resulting in a decline in total

Table 3: Estimated value of imports, farm gate value of total production, and value of total production of raw and processed food products in Southwest BC, by scenario ($ billion, in 2011 dollar value)

	VALUE OF IMPORTS	FARM GATE VALUE OF TOTAL PRODUCTION	VALUTE OF TOTAL PRODUCTION OF RAW AND PROCESSED FOOD PRODUCTS
2011 BASELINE	1.56	1.62	1.92
2050 BAU	2.85	1.62	1.96
2050 INCREASE FSR	1.95	2.11	2.98
2050 MITIGATE IMPACTS	2.45	1.59	2.50
2050 EXPAND LAND	1.92	2.08	3.75

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farm gate value and the value of raw and processed products.

Economic Impacts

The difference between the spreadsheet model (Baseline and BAU scenarios) and the optimization model (Increase FSR, Mitigate Impact and Expand Land scenarios) was the pattern of land use. It should be noted that when land is reallocated from one crop to another, there are generally costs of reallocation. For example, when hay production is reduced in favour of vegetable production, the net economic impacts of the vegetable production sector should take into account the losses in the hay production sector as well as losses in the other sectors supplying to the hay production sector. These reallocation losses are accounted for in the I-O model results reported here.

The estimated economic impacts calculated by the BC I-O model is reported in Table 4. Direct output refers to the value of the (crop and animal production and food processing) industries whose economic impacts are being measured. The direct output impact is therefore the value of total production of raw and processed food products (Table 3). Other measures of economic impacts namely output, GDP, household income, tax revenue and employment (Table 4) are reported as total economic impacts which include direct, indirect and induced impacts. Detailed impacts of these indicators are discussed separately as appropriate.

Overall, the estimated economic impacts from the Baseline and BAU scenarios were very similar (Table 4). Having an increase in population did not automatically mean that we could stimulate our agricultural activity and increase production. If we continue to produce the same foods as we currently do without increasing yield per acre or putting more agricultural land in production, we will not be able to maintain food self-reliance level or generate significantly more economic impact from the agriculture sector.

If we chose a different future in which we moved toward a more regionalized food system by producing food according to our population's food need (Increase FSR scenario), we saw greater regional economic impact per output, GDP, income, tax revenue and employment. This was mainly due to the production of more

As the amount of bioregional food production increased, there was more economic activity generated with more linkages between industries, resulting in greater absolute economic impacts.

food. As the amount of bioregional food production increased, there was more economic activity generated with more linkages between industries, resulting in greater absolute economic impacts. Not only did the impact depend on the amount of food produced, it also was determined by the types of food produced. As previously mentioned, the model results suggested that the amount of processing activity was greater in the Increase FSR scenario than the BAU scenario. Hence, the economic impacts on the related sectors of the economy were different in each scenario. For example (results not shown in the table), in the BAU scenario, the primary agriculture (crop and animal production) sector generated higher total output and GDP compared to the food processing sector. In contrast, for the Increase FSR scenario the primary agriculture sector generated less total output and GDP compared to the food processing sector. In another example, the top three sub-sectors in the BAU scenario that had the highest employment impact are crop production (excluding greenhouse), animal production, and greenhouse production. On the other hand, in the Increase FSR scenario, the top three sub sectors were animal production, crop production (excluding greenhouse) and fruit and vegetable preserving and manufacturing.

The ability to produce food regionally, create value added products, and the willingness of the local population to consume regionally produced foods are very important to the economic vitality of the region. The ability to produce food and create value added products increases economic activities and linkages among the related industries. This in turn determines the size and extent of the economic impacts. The willingness to consume regionally produced food ensures that the region's agricultural sector is supported and remains an important contributor to the regional economy.

What would the future look like if we chose differently - a future where we had a higher level of food self-reliance (compared to the Baseline) and we also cared for the environment by trying to mitigate some detrimental environmental impacts from agricultural production (Mitigate Impacts scenario)?

When compared to BAU, the overall economic impacts in the Mitigate Impacts scenario were of greater magnitude. This implied that with a land use regime focusing on local markets, we could produce more food for our bioregion's populace and generate greater economic impacts while taking critical environmental stewardship actions. We also found that

TABLE 4: Summary of all economic impacts from the food production sector in Southwest BC, by scenario

IMPACT	2011 BASELINE	2050 BAU	2050 INCREASE FSR	2050 MITIGATE IMPACTS	2050 EXPAND LAND
Total Production (1,000 Tonnes)	1,084	1,084	1,952	1,641	2,090
Direct Ouput ($ billion)	1.92	1.96	2.98	2.5	3.75
Total output ($ billion)	3.49	3.56	5.40	4.44	6.66
Total GDP ($ billion)	1.23	1.25	1.92	1.62	2.38
Total household income ($ billion)	0.83	0.85	1.29	1.08	1.58
Total tax revenue ($ million)	230	235	362	307	456
Total employment (# jobs)	16,163	16,463	24,788	20,643	30,229
Total employment (FTE)	16,580	16,879	25,323	20,973	30,670

the economic impacts generated by the primary agriculture sector (crop and animal production) were smaller than the impacts generated by the food processing sectors (processing of fruit, vegetable, dairy and meat). For example (data not shown in the table), the household income in the primary agriculture sector increased $8 million, from $253 million in the BAU to $261 million in the Mitigate Impacts. Comparatively the household income in the fruit, vegetable, dairy and meat manufacturing increased $149 million, from $340 million to $ 489 million. Similar results could be seen when measured with other indicators.

When compared to the Increase FSR scenario, the results in the Mitigate Impacts scenario (as shown in the table above) indicated that shifting our agriculture production to include environmental stewardship efforts would consequently reduce the magnitude of associated positive economic impacts. The impacts from the Mitigate Impacts scenario were slightly lower compared to Increase FSR. Information from the above table indicates that there was a trade-off between the environmental enhancements we have modeled and economic benefits. Achievement of a nutrient balance and increased wildlife habitat resulted in somewhat reduced economic outcomes. The question is: do we, as a society, think that this trade-off (economic cost) is worth it?

It is beyond the scope of this study to answer the above question. However, by producing food at home, we take control of the food system. Then society as a whole can ensure that our population is fed, environmental stewardship objectives are met, and that our food system work force is paid well.

The Expand Land scenario represented a future where we expanded agricultural land area as well as accepted the environmental stewardship practices (balancing nutrients, providing riparian buffers and enhancing natural habitat). It was not surprising to see that the impacts were largest in this scenario as absolute economic impacts partly depended on the value of the production. Having more land in production yielded greater amounts of crop and animal products, hence generating larger impacts. The question however is where the additional agricultural land would come from? Currently, in Southwest BC, there are about 50,000 hectares of farmable ALR land that are not fully utilized. If we find ways to realize their production potential, our future food self-reliance could be improved and our regional economy enhanced substantially.

All in all, the Expand Land scenario is one of the many future scenarios illustrating that our Southwest BC bioregion has the potential to produce more food to satisfy our population's food need and create economic activity while also mitigating some adverse environmental impacts from agricultural production. The ability to achieve these goals is predicated upon our commitment to conserve our agricultural land for agricultural production and an agriculture sector dedicated to environmental stewardship.

In addition to comparing the overall impacts between scenarios, it is worth pointing out some common characteristics of all scenarios. As these scenarios were constructed based on the BC I-O model, they shared the same assumptions such as input costs including wages, tax structure, consumers' spending, inter-industries linkages and imports of supplier industries. Hence, these scenarios would share similar results. Detailed impact results accompanying the discussion below are presented in Appendix A, Appendix B, Appendix C, Appendix D, and Appendix E.

First, the direct total output and direct GDP from food processing sector (fruit, vegetable, dairy and meat manufacturing) were greater than output from the primary agriculture sector (crop and animal production). This was because, as is commonly known, processed products add substantial value to the raw/fresh products. Second, the FTE in the primary agriculture and all food processing sectors were greater than the total number of jobs. This implies that an average worker in these

The ability to produce food regionally, create value added products, and the willingness of the local population to consume regionally produced foods are very important to the economic vitality of the region.

We have the potential to satisfy more of our population's food need and create economic activity while also mitigating some adverse environmental impacts from agriculture.

industries generally worked more 1,750 hours annually (or on average longer than 35 hours per week). In comparison, the FTE in other industries such as retail trade, wholesale trade, finance, insurance, and real estate, was lower than the total number of jobs, implying that an average worker in the non-agriculture related industries works fewer hours than 1,750 annually. This is not surprising as workers in agricultural are known to work long hours especially during growing and harvesting season.

Third, an estimated average earning of a worker in the primary agriculture (crop and animal production) sector was lower compared to a worker in other industries (such as food manufacturing, wholesale trade, and transportation). This is not an uncommon trend in our economy.

Fourth, the largest portion of the tax revenue went to federal government. The smallest, about 10%, went to municipal government. This was due to the types of tax collected by each jurisdiction. For example income tax and corporate income tax went to the federal and provincial government while property tax went to municipal governments.

While Table 4 reports the absolute impacts of food production in Southwest BC, Table 5 reports impacts in term of multipliers. A multiplier is a coefficient that expresses the magnitude of economic impacts as a result of a change in an economic activity whose impacts are being measured. While absolute impacts show the total impacts generated from different levels of production, the multipliers show the impacts if their production levels were the same, in relation to each scenario. This way utilizing the multipliers allows for cross-comparison between scenarios. For example, the total GDP multiplier was 0.64 in scenario two and three implying that when there was a $1 increase in the production of raw and processed food products, it is estimated to generate a total of $0.64 in GDP for the province of British Columbia. Or the employment multipliers in scenarios two and three were 8.43 and 8.39 respectively, meaning that when there was a $1 million increase in the production of raw and processed food products, it is estimated to generate a total of 8.43 and 8.39 jobs, respectively.

Table 5 indicated that overall all five scenarios yielded similar multipliers (similar impacts) with only small differences. In general, the modest difference in the multipliers could be due to a number of reasons such as the types of affected industries, linkages between industries, or labour capital ratio within the affected industries. For example, shorter linkages between industries resulted in smaller multipliers. Industries with higher percentage of local inputs resulted in larger multiplier. Labour intensive industries resulted in larger employment multiplier comparing to industries with capital

Table 5: Summary of economic multipliers from the food production sector in Southwest BC, by scenario

SCENARIO	MULTIPLIER				
	TOTAL OUTPUT	GDP	HOUSEHOLD INCOME	TAX REVENUE	EMPLOYMENT (JOBS/$MILLION)
2011 BASELINE	2.82	0.64	0.43	0.12	8.43
2050 BAU	2.81	0.64	0.43	0.12	8.39
2050 INCREASE FSR	2.81	0.64	0.43	0.12	8.32
2050 MITIGATE IMPACTS	2.77	0.65	0.43	0.12	8.25
2050 EXPAND LAND	2.78	0.63	0.42	0.12	8.06

intensive industries.

According to Table 5 there seemed to be a slight decline in the employment multiplier as we moved from Baseline to Expand Land. For example, the absolute employment impact (in Table 4) indicated that Expand Land generated more jobs compared to BAU (because we were able to produce more food). Contrary, the multipliers suggested that for every one million dollars increase in production, BAU generated 8.39 jobs while Expand Land generated 8.06 jobs. As it was estimated that less than 20% of the total farm gate value went into processing in BAU but this percentage increased to more than 60% in Expand Land, we hypothesize that the increase in the value of production in Expand Land could be satisfied by mechanization (especially in processing sector), resulting in a smaller employment multiplier.

Conclusion

This study provided comparisons of economic outcomes for different food system scenarios in Southwest BC bioregion. These hypothetical scenarios helped us understand how regionalization of the food system might benefit the provincial economy. The key aspect of food system regionalization considered in this study was the bioregion's crop and animal production sector; producing food according to the food requirement of its population with a goal of maximizing bioregional food self-reliance. Five scenarios were generated and selected from the ISFS's novel food self-reliance computational models. The economic impacts were estimated using the Input-Output model developed by BC Stats. The economic impacts indicators were output, GDP, household income, tax revenue, and number of employment. The five scenarios modeled were (1) Baseline- representing our contemporary food system in 2011, (2) Business as Usual- representing a future where the food system was not regionalized, (3) Increase Food Self-Reliance- representing a future regionalized food system, (4) Mitigate Impacts- representing a regionalized food system future where some environmental impacts from agriculture were reduced, and (5) Expand Land- representing a regionalized food system future with environmental enhancement and increased farmed land.

The results conclusively indicated that given current limitations of population, yield, and available land, the bioregion would not be able to produce all the food required by its populace. By changing what we produce however, the bioregion could increase its food self-reliance. Not only would local markets be better served but the bioregion could reduce food imports and retain this money (food expenditures) within the local economy (reduce monetary leakage). When the bioregion produced more food locally (both fresh and processed products), it stimulated higher and more diverse economic activity. The retention of money that circulated within the local economy created a ripple effect in various industries such as the production of inputs and supplies used in the production and manufacturing of crop and livestock products. It also created activities in other industries that were not directly related to food production, such as housing and accommodation and insurance, all from the local spending of income by workers in food production industries.

Furthermore, our study revealed that the development of bioregional food processing activities would increase the value of the food produced and the magnitude of food system economic impacts to a greater extent than the production of raw products would. Increasing food processing activities adds additional linkages between industries in the economy, resulting in higher economic impacts. Hence, if the aim is to increase our food self-reliance and economic contribution of food the food system, Southwest BC needs more infrastructure that can support a variety of processing activities.

We also established that arable land is one of the most important factors in generating economic impacts from a bioregional food

The ability to produce food regionally, create value added products, and the willingness of the local population to consume regionally produced foods are very important to the economic vitality of the region.

system. All things being equal, the more land in production, the more food produced, the higher the economic impacts. Therefore, conservation of ALR land as well as keeping ALR land productive are essential to achieving any reasonable level of bioregional food self-reliance and concomitant regional economic growth.

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When the bioregion produced more food locally (both fresh and processed products), it stimulated higher and more diverse economic activity.

Food self-reliance may not be the only rationale or motivation for regionalizing our food system. Other goals may be equally or more compelling. By no means does this study indicate that the only way to achieve increased regional food sector economic prosperity is for all producers to only produce what we consume regionally or that all arable land must be farmed. An appropriate balance should be sought. For example, if we want to protect our environment, we may have to reduce our income or produce less food. If we want to prioritise regional food self-reliance, our export sector may be deemphasized and become smaller. If we want to keep agricultural land in production, there will be less land for other economic and non-economic purposes. To achieve an appropriate balance, we will have to decide, based on the best knowledge we have, what path we are to take. This analysis provides, in the least, some insight into the economic outcomes of food system regionalization.

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APPENDIX A: Detailed Output Impact Estimates

SCENARIO	OUTPUT ($MILLION)			
	Direct	*Indirect*	*Induced*	*Total*
SCENARIO: 2011 BASELINE				
Crop, greenhouse & animal production	568	373	1	942
Fruit, vegetable, dairy & meat manufacturing	1,101	73	2	1,176
Other food processing, including animal food	245	126	2	372
Other industries	4	796	195	995
TOTAL	1,918	1,368	200	3,485
SCENARIO: 2050 BUSINESS AS USUAL FOOD PRODUCTION				
Crop, greenhouse & animal production	562	373	1	937
Fruit, vegetable, dairy & meat manufacturing	1,138	74	2	1,213
Other food processing, including animal food	258	127	2	386
Other industries	4	816	199	1,019
TOTAL	1,962	1,390	204	3,555
SCENARIO: 3050 INCREASE FOOD SELF-RELIANCE				
Crop, greenhouse & animal production	716	545	2	1,263
Fruit, vegetable, dairy & meat manufacturing	1,928	96	2	2,026
Other food processing, including animal food	332	190	3	524
Other industries	4	1,278	303	1,586
TOTAL	2,980	2,109	310	5,399
SCENARIO: 2050 MITIGATE ENVIRONMENTAL IMPACTS FROM AGRICULTURE				
Crop, greenhouse & animal production	528	404	1	933
Fruit, vegetable, dairy & meat manufacturing	1,641	67	2	1,710
Other food processing, including animal food	331	123	2	456
Other industries	4	1,083	254	1,340
TOTAL	2,504	1,677	259	4,439
SCENARIO: 2050 EXPAND LAND IN PRODUCTION				
Crop, greenhouse & animal production	667	566	2	1,235
Fruit, vegetable, dairy & meat manufacturing	2,507	86	3	2,596
Other food processing, including animal food	571	217	3	791
Other industries	6	1,660	374	2,041
TOTAL	3,751	2,529	382	6,663

APPENDIX B: Detailed Gross Domestic Product Impact Estimates

SCENARIO	GROSS DOMESTIC PRODUCT IMPACT ($MILLION)			
	Direct	*Indirect*	*Induced*	*Total*
SCENARIO: 2011 BASELINE				
Crop, greenhouse & animal production	243	105	-	348
Fruit, vegetable, dairy & meat manufacturing	307	21	-	328
Other food processing, including animal food	51	19	1	71
Other industries	2	356	123	482
TOTAL	603	501	124	1,229
SCENARIO: 2050 BUSINESS AS USUAL FOOD PRODUCTION				
Crop, greenhouse & animal production	241	105	-	346
Fruit, vegetable, dairy & meat manufacturing	319	21	-	340
Other food processing, including animal food	55	19	1	75
Other industries	2	366	126	494
TOTAL	617	511	127	1,255
SCENARIO: 3050 INCREASE FOOD SELF-RELIANCE				
Crop, greenhouse & animal production	296	153	1	450
Fruit, vegetable, dairy & meat manufacturing	547	27	1	575
Other food processing, including animal food	95	30	1	125
Other industries	2	576	190	769
TOTAL	940	786	193	1,919
SCENARIO: 2050 MITIGATE ENVIRONMENTAL IMPACTS FROM AGRICULTURE				
Crop, greenhouse & animal production	244	113	-	358
Fruit, vegetable, dairy & meat manufacturing	470	19	1	489
Other food processing, including animal food	96	21	1	118
Other industries	2	489	159	650
TOTAL	812	642	161	1,615
SCENARIO: 2050 EXPAND LAND IN PRODUCTION				
Crop, greenhouse & animal production	270	160	1	430
Fruit, vegetable, dairy & meat manufacturing	726	24	1	751
Other food processing, including animal food	168	37	1	207
Other industries	4	753	235	992
TOTAL	1,168	974	238	2,380

APPENDIX C: Detailed Household Income Impact Estimates

SCENARIO	HOUSEHOLD INCOME IMPACT ($MILLION)			
	Direct	*Indirect*	*Induced*	*Total*
SCENARIO: 2011 BASELINE				
Crop, greenhouse & animal production	178	76	-	254
Fruit, vegetable, dairy & meat manufacturing	187	14	-	201
Other food processing, including animal food	34	12	-	47
Other industries	1	242	90	332
TOTAL	400	344	90	834
SCENARIO: 2050 BUSINESS AS USUAL FOOD PRODUCTION				
Crop, greenhouse & animal production	176	76	-	253
Fruit, vegetable, dairy & meat manufacturing	194	14	-	208
Other food processing, including animal food	37	12	-	50
Other industries	1	249	92	340
TOTAL	408	351	92	851
SCENARIO: 3050 INCREASE FOOD SELF-RELIANCE				
Crop, greenhouse & animal production	216	111	-	328
Fruit, vegetable, dairy & meat manufacturing	329	18	-	347
Other food processing, including animal food	63	19	1	83
Other industries	2	391	139	530
TOTAL	610	539	140	1,288
SCENARIO: 2050 MITIGATE ENVIRONMENTAL IMPACTS FROM AGRICULTURE				
Crop, greenhouse & animal production	179	82	-	261
Fruit, vegetable, dairy & meat manufacturing	279	12	-	291
Other food processing, including animal food	64	13	-	78
Other industries	1	331	116	448
TOTAL	523	438	116	1,078
SCENARIO: 2050 EXPAND LAND IN PRODUCTION				
Crop, greenhouse & animal production	197	116	1	314
Fruit, vegetable, dairy & meat manufacturing	430	15	-	445
Other food processing, including animal food	112	24	1	136
Other industries	2	511	170	683
TOTAL	741	666	172	1,578

APPENDIX D: Detailed Employment Impact Estimates (Number of Jobs)

SCENARIO	EMPLOYMENT IMPACT (# JOBS)			
	Direct	*Indirect*	*Induced*	*Total*
SCENARIO: 2011 BASELINE				
Crop, greenhouse & animal production	4,400	2,067	7	6,474
Fruit, vegetable, dairy & meat manufacturing	3,161	232	4	3,397
Other food processing, including animal food	651	210	8	869
Other industries	29	4,190	1,204	5,423
TOTAL	8,241	6,699	1,223	16,163
SCENARIO: 2050 BUSINESS AS USUAL FOOD PRODUCTION				
Crop, greenhouse & animal production	4,350	2,070	7	6,427
Fruit, vegetable, dairy & meat manufacturing	3,300	234	4	3,538
Other food processing, including animal food	703	214	9	926
Other industries	31	4,312	1,229	5,572
TOTAL	8,384	6,830	1,249	16,463
SCENARIO: 3050 INCREASE FOOD SELF-RELIANCE				
Crop, greenhouse & animal production	5,358	3,021	10	8,390
Fruit, vegetable, dairy & meat manufacturing	5,687	294	7	5,988
Other food processing, including animal food	1,243	334	13	1,590
Other industries	33	6,917	1,871	8,820
TOTAL	12,321	10,566	1,901	24,788
SCENARIO: 2050 MITIGATE ENVIRONMENTAL IMPACTS FROM AGRICULTURE				
Crop, greenhouse & animal production	4,314	2,203	9	6,526
Fruit, vegetable, dairy & meat manufacturing	4,879	200	6	5,084
Other food processing, including animal food	1,249	239	11	1,498
Other industries	32	5,941	1,560	7,535
TOTAL	10,474	8,583	1,586	20,643
SCENARIO: 2050 EXPAND LAND IN PRODUCTION				
Crop, greenhouse & animal production	4,967	3,153	13	8,133
Fruit, vegetable, dairy & meat manufacturing	7,605	251	8	7,864
Other food processing, including animal food	2,175	420	16	2,611
Other industries	57	9,258	2,307	11,621
TOTAL	14,804	13,082	2,344	30,229

APPENDIX E: Detailed Employment Impact Estimates (Number of Full Time Equivalent Jobs)

SCENARIO	EMPLOYMENT IMPACT (# FULL TIME EQUIVALENT JOBS)			
	Direct	*Indirect*	*Induced*	*Total*
SCENARIO: 2011 BASELINE				
Crop, greenhouse & animal production	4,472	2,176	7	6,655
Fruit, vegetable, dairy & meat manufacturing	3,414	258	5	3,677
Other food processing, including animal food	694	231	8	932
Other industries	28	4,182	1,104	5,316
TOTAL	8,608	6,847	1,124	16,580
SCENARIO: 2050 BUSINESS AS USUAL FOOD PRODUCTION				
Crop, greenhouse & animal production	4,422	2,179	7	6,608
Fruit, vegetable, dairy & meat manufacturing	3,557	260	5	3,821
Other food processing, including animal food	748	235	8	992
Other industries	30	4,300	1,128	5,458
TOTAL	8,757	6,974	1,148	16,879
SCENARIO: 3050 INCREASE FOOD SELF-RELIANCE				
Crop, greenhouse & animal production	5,461	3,181	11	8,653
Fruit, vegetable, dairy & meat manufacturing	6,053	326	7	6,387
Other food processing, including animal food	1,300	364	13	1,677
Other industries	34	6,856	1,717	8,606
TOTAL	12,848	10,727	1,748	25,323
SCENARIO: 2050 MITIGATE ENVIRONMENTAL IMPACTS FROM AGRICULTURE				
Crop, greenhouse & animal production	4,361	2,323	9	6,693
Fruit, vegetable, dairy & meat manufacturing	5,146	220	6	5,372
Other food processing, including animal food	1,304	258	11	1,573
Other industries	34	5,869	1,432	7,335
TOTAL	10,845	8,670	1,458	20,973
SCENARIO: 2050 EXPAND LAND IN PRODUCTION				
Crop, greenhouse & animal production	5,068	3,318	13	8,400
Fruit, vegetable, dairy & meat manufacturing	7,958	275	9	8,242
Other food processing, including animal food	2,270	453	16	2,739
Other industries	59	9,115	2,117	11,289
TOTAL	15,355	13,161	2,155	30,670

APPENDIX F: Detailed Tax Revenue Impact Estimates

SCENARIO	TAX REVENUE ($MILLION)			
	Federal	*Provincial*	*Local*	*Total*
2011 Baseline	133	76	21	230
2050 Business as Usual Food Production	136	78	22	235
2050 Increase Food Self-Reliance	206	121	35	362
2050 Reduce Environmental Impacts from Agriculture	173	104	30	307
2050 Expand Land in Production	254	156	46	456

About ISFS

The Institute for Sustainable Food Systems (ISFS) is an applied research and extension unit at Kwantlen Polytechnic 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.

About the Southwest BC Bioregion Food System Design Project

The Southwest BC Bioregion Food System Design project was conceptualized at ISFS in 2012 and concluded in 2016. The project was conceived as a "research project within a research project," with the broad goals of developing a method to delineate the interconnected economic, food self-reliance, and environmental stewardship potentials of a bioregional food system and applying the method to the Southwest BC bioregion. To our knowledge, this project is the first of its kind. Project research briefs are one means used to present project findings. They are intended to report detailed, topic specific project methods and results. For other research briefs from the project, as well as the project report and summary, and peer-reviewed publications, please visit kpu.ca/isfs.

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