

Food insecurity is a worrying topic around the globe. Food insecurity is the lack of access to safe, plentiful, healthy, nutritious food due to cost or physical availability. Although it is extremely prevalent in developing countries, food insecurity can also plague developed nations. As the fifth largest agriculture and agri-food exporter in the world, one might not think that Canada experiences food insecurity, but four million Canadians are food insecure (Proof, 2018). Recently, the Canadian government evaluated their food system, and identified income support programs, climate adaptation, and agriculture innovation as areas where policy makers can improve (Food Security Canada, n.d.). Access to affordable food in remote regions of northern Canada adds additional challenges to food security that must be addressed. Solving food insecurity in Canada will require many diverse approaches, but a combination of economic support to families in need and the implementation of sustainable agriculture that is designed to improve the overall environmental health by combating erosion, soil depletion, and minimizing environmental degradation will improve the long-term security and sustainability of Canada's food system.

How the Living Wage Affects Food Insecurity in Canada

An unmet living wage is leading to a significant amount of families who have food insecurity in Canada. The traditional Canadian family consists of two adults and two children and requires a living wage of \$14-\$20 per hour with two working adults (Haener, 2015). As of the 2016 census, 26% of these households' experience food insecurity; this is directly correlated to the living wage (Proof, 2018). One out of every eight households in Canada have food insecurity. The family structure that is the most vulnerable to food insecurity are single-person households (43%). Employment is not an indicator of food security, as 60% of those who are food insecure are currently employed (Proof, 2018). Household diversity is growing in Canada, the number of indigenous multigenerational families are increasing. Indigenous families are 74% more likely to experience food insecurity than those who are not indigenous (Canadian Feed the Children, n.d.). The family's location can also play a role in food insecurity as 62.6% of Inuit households in arctic Canada experience food insecurity (Huet, Rosol, & Egeland, 2012).

In the remote regions of northern Canada, specifically Nunavut and the Northwest Territories, the infrastructure and logistics of transporting essential supplies present additional challenges, affecting the cost and physical availability of food. These conditions are not improving; the University of Toronto conducted a study that found food insecurity in North Canada increased by 46.8% from 2005 to 2014 (Garfield, 2017). The cost of transporting over such significant distances is expensive, and the harsh climate of this area creates added costs. These issues lead to high prices on products that otherwise would be reasonable, and they raise the living wage in many areas. People who reside in remote regions of Canada spend twice as much on essentials compared to other Canadian citizens. The high food prices due to location heavily impact the living wage, this is clearly exhibited with a study conducted in Yellowknife, Northwest. For a four-person household yearly food costs are roughly \$12,124, that is 4.73% more than a four-person family that resides in Edmonton, Alberta (Haener, 2015). The cost of food in northern Canada is drastic because the climate is less suitable for planting and growing crops.

Traditionally, inhabitants of northern Canada have been meat eaters due to their inability to grow plants. However, the presence of fruits and vegetables in their diet has increased in recent years. After the 1940s the price of gasoline reduced, which fostered a reliance on shipped foods (Noble, 2013). A change in the

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climate is predicted to expand the growing season in the future this will increase the availability of these foods, which will have a profound impact on the diet in this area.

Educational outreach programs and gardening are often suggested as viable solutions to fight food insecurity. Food insecurity data collected through a section of the Canadian Community Health Survey (CCHS), have led to reasoning that states that the outreach programs based on food education and gardening have little chance of affecting Canada's food insecurity rates (Proof, 2018). This is due to the fact that most Canadians utilize budgeting and have the ability to cook nutritious foods. One million Canadians utilize food banks; an increase that has occurred in the past ten years. Reasoning deducted from aforementioned data has led the Canadian government to recognize how significant income support could be in their society to increase food security (Food Security Canada, n.d.).

Government Policies Regarding Sustainable Agriculture

Reducing food insecurity will require a change in government policies. Department of Agriculture and Agri-Food Minister Marie-Claude Bibeau announced last year that Canada was creating a Food Policy. Since this announcement, they have been reviewing applications to form the Food Policy Advisory Council. Minister Bibeau said the Food Policy Advisory Council "will bring together the expertise and diversity needed beyond government to address the challenges of today" (Binkley, 2020). The Food Policy is designed to help Canada meet its commitment to the United Nations' Sustainable Development Goals that include promoting good health, ending hunger, cutting food waste, and creating a sustainable food system.

In Canada, the Department of Agriculture and Agri-Food plays an important role in food security, handling all soil conservation and sustainable agriculture. Originally named the Bureau of Agriculture of the Pre-Confederation Province of Canada, the Department of Agriculture and Agri-Food was established in 1868 to regulate the incoming diseases that were affecting Canadian livestock. They also handled the nation's publicly funded health care system until 1919 when the Department of Health was created. Today, the Department of Agriculture and Agri-Food carry the responsibility of federal agriculture and food policies, fertilizer and pesticide regulations, gradings and inspections, marketing programs, farmer outreach and assistance, and seed certifications. The department also runs experimental farms located in different climate and soil areas that perform agricultural research.

How Earth Disturbance Affects Soil Condition

"Earth disturbance" is a term used today when someone changes the land through an activity that may contribute to or result in soil degradation and erosion. Often used in the context of construction, it may fit certain agricultural practices as well. From the day that farmers began planting a crop that required the soil to be overturned, a disturbance was caused. The tillage equipment used determines the level of destruction that occurs to the soil. Traditional tillage involved numerous steps each continuously disturbing the soil. Today, sustainable practices are centered around the idea that consistent primary and secondary tillage is harmful to the environment; however, occasional secondary surface tillage can be beneficial to soil tilth.

When the soil surface is disturbed, carbon is released. Keeping carbon within the ground is key to healthy soil conditions. The carbon cycle is what rebuilds topsoil. By utilizing sustainable agricultural practices, like cover crops that limit the time frame that soil is vulnerable to erosion, you are also providing key tools that work to convert carbon back into the ground. If farms were able to convert more carbon than they release, then not only is sustainable agriculture working to combat current food insecurity, but it is also protecting and preparing the industry to prevent future food insecurity. All activities that restore farmland to a healthy productive state are going to provide protection to the farmer. Shifts in temperature and precipitation caused by an increase of carbon in the atmosphere present difficulties to farmers. Sustainable agriculture provides a natural diversity opposed to traditional farming that is often heavily focused on monoculture.

How Environmental Degradation Led to Current Conditions

It took less than 100 years of traditional tillage practices in North America before the environmental degradation accumulated and the soil literally fell apart. Constant plowing removed vital roots and moisture that were holding the ground together. It was believed during the late 19th and early 20th centuries that the rain would follow the plow. The belief was reinforced when wet weather occurred (History, 2020). Unfortunately, high winds and drought followed these rains proving this false. The timing of this was detrimental in many ways. When Wall Street fell in 1929 sending the United States into a depression, the effects were felt suddenly for Canadian farmers. The high wheat prices quickly took a downturn and Canadians who purchased new machinery on credit, now could not afford the payments (Belshaw, 2015). One third of Canada's economy was reliant on exports and the collapse of international trade caused devastation (Struthers, 2020). Canada was very soon spiraling into an unemployment catastrophe. Thousands of single men wandered the country looking for work and food (CBC Learning, n.d.). Many Canadian people were now poor, unemployed, and homeless. After a decade of struggling, the occurrence of WWII began dragging the economy from the grips of the depression. The conditions that literally swept North America during this time exposed just how drastic environmental devastation, and food insecurity, can get if we do not pay attention to the impacts of our agricultural practices.

The dust storms that occurred in the Prairie Provinces due to the lack of sustainable agriculture in the 1930's triggered a rise of government involvement. The Prairie Farm Rehabilitation Administration (PFRA) established in 1935 used sustainable practices to combat soil depletion, erosion, and even desertification. The PFRA was the government's response to the large number of farms that were abandoned in the first half of the 1930's. By 1935 the government was urging those who remained to hold on and the PFRA began working with them to deal with soil erosion, soil conservation and the lack of water resources. While their soil conservation duties were reassigned in 1946, the PFRA continued to work with farmers across Canada on water reserves and grazing lands until 2009 when they were dissolved into another department (Gilson & Baker, 2020). In recent years, food insecurity, sustainability, and climate change have become hot topics. The Canadian government is making strides to reach the farmers of their country not only through the Department of Agriculture and Agri-food, but municipalities and provinces.

Sustainable Agricultural Practices

When sustainable agriculture is discussed, it is often referred to in terms of restoring issues from past industry standards and utilizing practices that improve current conditions. The goals of sustainable agriculture are better soil quality, less environmental degradation, higher yield, lower fertilizer costs, and more profit.

Effective conservation techniques that the PFRA encouraged included shelterbelts, and the replanting of barren fields. Shelterbelts or windbreaks are tree lines that are planted to create protective wind barriers. Also encouraged was strip farming, the planting of rotating crops in thin strips to preventing soil erosion. Their seedling program supplied seeds for farmers to plant trees creating shelterbelts (Gilson & Baker, 2020). These sustainable agricultural practices are still utilized today. Additional techniques that combat the environmental effects of poor management are utilizing cover crops, implementing conservation tillage practices, restoring organic material, and the use of conservation buffers.

Cover crops are utilized to increase fertility through the addition of organic material, and they keep nutrients in the ground. This helps to reduce fertilizer costs. Cover crops reduce the amount of time soil is exposed to the elements and controls weeds, which prevents soil erosion and reduces pesticide and herbicide use. The integration of brassicas into cover crop cocktails increases pollination, infiltration, and aeration. Cover crops have the ability to protect water quality, conserve soil moisture (SARE, n.d.), and improve overall soil tilth (USDA, 2010).

Prior to the 1990's, no-till practices were highly impractical because traditional tillage limits weeds, while no-till requires external weed control. However, the sale of herbicide-tolerant canola encouraged farmers to switch to no-till practices. By 2003, Canada was home to more no-till acres than acres that were traditionally tilled (Farms.com, n.d.). Currently, that is over 36 million acres of no-till. This is important as the most popular production in Canada is grain and oilseed farming, and the average farm in Saskatchewan is 1668 acres (StatCan, 2018).

Conservation tillage practices are more feasible for farmers to implement than a true no-till or direct drilling operation. When implementing conservation tillage, a variety of implements and strategies are used to create healthier soils. Strip tillage leaves the most residue behind as it reveals less than a third of the field. Implements that are going to leave less residue behind include chisel plowing, disking, ridge planting, stubble mulching, and moldboard plowing. Conservation tillage practices are utilized to create the desired soil condition per the existing soil type. When calculating to find a balance between the soil health of a working field and the "perfect" natural soil health; economics, yield, weed control, soil type, soil infiltration, soil moisture content, compaction, soil food web/microorganisms, and desired sustainability level are all brought into consideration. The implementation of this constitutes as sustainable agriculture.

In discussion of soils, soil horizons must be brought into consideration. When evaluating a soil profile from a longtime farmed field you are going to look at the depth of the O Horizon, or organic material, and

evaluate the A and B horizons in relation to the plow pan. The organic matter/residue is important to soil as it increases microorganism activity, provides compaction protection from rain, and improves moisture levels. By implementing best farming practices, organic material can be restored to 60-70% of its original natural levels (Sundermeier, Reeder, & Lal, n.d.). When looking at the A and B horizons, the location of the plow pan is going to affect the crops' access to nutrients and water. This is especially important in summer months during the drought season. The plow pan can effectively seal roots off from accessing moisture. The plow pan is caused by compaction and frequent tillage. Brassica cover crops are one of the few plants whose roots are strong enough to break through the pan, providing cash crops a way to access the moisture in the ground.

Conservation buffers are another important sustainable practice; they are put into place to intercept pollution, provide protection against the elements, and offer habitat to wildlife and pollinators. Conservation buffers may be grass strips, areas of native plants, or trees. Riparian buffers and alley cropping are both important conservation buffers that involve trees. Field runoff is one pollution that conservation and riparian buffers may intercept. Field runoff may contain soil, pesticides, herbicides, or excess fertilizer. This can be dangerous as it can upset a balanced environment by creating issues like algae blooms. Depending on the height of the vegetation, buffers provide protection to the surrounding area from wind and rain. The planting of natives in buffers can be used to cultivate habitat for native pollinators such as bees whose presences can increase yield.

Implementing Sustainable Practices Across Canada's Diverse Geography

Due to the variety of landscapes that Canada hosts, it takes a diverse portfolio of sustainable agriculture practices to achieve sustainability across the country. Sustainable agriculture covers a complex variety of farming practices that offer the best results when used in conjunction with each other.

Within British Columbia, needs are highly varied due to the intensity of specialty crops. The uniqueness in the Fraser Valley comes in the form of high rainfall. The Peace River Region has steep topography and highly erodible silty soils which snow melt-off affects. Brassica cover crop cocktails are a sustainable practice that can counter the intensity of specialty crops. The use of terracing, contour farming, and strip farming are all effective ways to mitigate the steep topography in Fraser Valley, while grass waterways offer a way to control the influx of water. These practices have effectively been implemented in other locations including the United States (Getting More on the Ground, 2016) and the European Union (Wikipedia, 2020). Cover crops protect soil from the high rainfall in the Fraser Valley and the snow melt-off in the Peace River Region.

In the Prairie Provinces, challenges come in the form of historic soil abuse. Although soil conservation increased post dust bowl era, by mid-century the vigilance had decreased, and serious erosion issues emerged once again. The implementation of sustainable agricultural practices such as cover crops, conservation tillage, field buffers, alley cropping, shelterbelts, contour, and strip farming, are going to combat soil erosion, desertification, soil depletion, and minimize environmental degradation. Utilizing best farming practices improves soil health, tilth, and increases organic material. The rotation of crops in

areas that have traditionally been farmed using excessive monoculture allows the ground to rejuvenate. This is a widespread practice utilized in many different areas across the world including Europe (Friends of the Earth Europe, 2012) and Asia (Asia Pacific Adaptation Network, 2015). The aids of additional organic matter, higher levels of microorganism activity, and a reduction of erosion are going to assist in returning the prairie provinces to a healthier state.

The lands located in Quebec and Ontario are primarily farmed in corn and soybeans. Manure management, when correctly prescribed, is a highly effective sustainable practice that allows farmers to create healthier soil in which they can farm. Due to the growing seasons that corn, and soybeans require, field operations are often carried out when the fields have a high moisture content, this leads to soil compaction. Practices used to limit the soil compaction are no-till and planned field patterns to reduce the amount of machinery impact. Crop rotation and fertilizer application also contribute to making sure the soils contain balanced nutrients. Grass waterways can be utilized in this area to direct influxes of water. To prevent any wind damage, shelterbelts and tree lines are used to reduce wind speeds, and crop residue provides protection to vulnerable soils.

In the Atlantic Provinces, high acidity has occurred due to an extreme monoculture of potatoes and other vegetable crops. Currently, terracing is being implemented to assist the recovery of soils that have been subject to organic material loss and erosion (Acton, Coote, & Eilers, 2015). The application of terracing has changed the direction the rows are being planted – across versus with the topography. The addition of limestone is being used to boost the level of nutrients. Grains and clover are being rotated with the potatoes to change the levels of nutrients being consumed by the plants. Grass waterways are being implemented here too. Sustainable agriculture practices will stabilize the soil conditions allowing farmers to slowly rebuild the years of damage. The restoration of these fields is key to feed Canada.

In northern Canada, issues do not stem from soil overuse, but the soil's inability to sustain crops. Paired with a short growing season and cool temperatures, the climate and soils are not productive in supporting agriculture without the assistance of a greenhouse. Currently, the Canadian Government's food policy has allotted \$15 million to the Northern Isolated Community Initiatives Fund (Government of Canada, 2019). This funding is available for communities in northern Canada to install community greenhouses, freezers, and education opportunities. As the climate warms it may offer an opportunity to expand agriculture into northern Canada. The implementation of sustainable agriculture here would be ecologically and economically beneficial.

How Sustainable Agriculture Reduces Food Insecurity

Adam Smith, a Scottish economist, said “The cultivation and improvement of the country ... must necessarily be prior to the increase of the town” (Combee & Thompson, 2015). Sustainable agriculture is an improvement to the rural countryside that is going to impact the Canadian people. This is an impact that improves food security. The current work to restore, repair, and maintain healthy soils through sustainability practices is helping Canadian farmers to create a balanced, constant yield allowing them the flexibility to face challenges head on and to keep a steady stream of harvested plants on the market.

Sustainable agriculture practices that combat erosion, desertification, soil depletion, and minimize environmental degradation paired with new biotechnologies, digital technologies, and help from people will carry us into a time where food insecurity is no longer an issue that plagues us. It will assist us in growing the food we need, while we work on the infrastructure that will allow everyone easy access to food. This will require the reduction of food waste, the affordability of nutritious foods, and consumer knowledge. Encouraging actions that are going to foster a cultural change that allows for a shift in perspective that reorders our priorities to including the longevity of the environment and the health of the future over personal gains are going to require momentum from everyone across the country. Cooperation between the Canadian government, Provincial government, First Nation, Métis Nation, and Inuit Nation will be vital in informing and educating all citizens to revolutionize and initiate the change needed to achieve the day when food insecurity is no longer an issue that plagues Canada. Movements like the 'love ugly fruits and veg' campaign that work to change perceptions, associations like Alberta Farm to Food Bank that assist farmers in getting edible harvests to those who will use it, and organizations like Canadian Feed the Children working to educate and teach, are where change will happen to make things better for all.

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