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Article

GOVERNMENT SUPPORT FOR AQUAPONICS SYSTEMS FOR CREE COMMUNITIES IN NORTHERN ONTARIO

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Abstract

Cree communities in Northern Ontario face food insecurity due high food costs, accessibility issues, and lack of food availability that ultimately leads to health concerns. The communities are actively involved in initiatives to reduce or eliminate food insecurity. Aquaponics systems are a solution that could reduce food insecurity because it is an environmentally beneficial method with commercial success and it permits the development of local, fresh, and culturally appropriate fish, fruits, and vegetables. Using the principles of good governance and working in collaborative partnerships, the Government of Ontario could develop a subsidized program that implements aquaponics systems in Indigenous homes or in a community.

Key Words: Aquaponics, Governance, Food Insecurity, Interdisciplinary, Ontario

An essential part to people's well-being is eating healthy foods. Unfortunately, Indigenous communities, one of the most vulnerable groups susceptible to food insecurity in Northern Ontario face the inability to eat healthy foods (Veeraraghavan et al., 2016; University of Toronto, n.d.). Currently, the federal Nutrition North Program (NNP) should help northern Indigenous communities have enough food. However, in Attawapiskat, the NNP only reduced the cost of food by 10% since 2011 and inflation continues to rise (White, 2018a). In 2014, the Auditor General determined that the program was only partially effective (Office of the Auditor General in Canada, 2014). Since then, the federal government has committed to establishing a food policy (Fraser, 2013), but it has not yet crystallized. Food Secure Canada (2017) states that a food policy should

invest in collaborative governance and community-led innovations, increase food access, improve health and food safety, conserve soil, water, and air, and grow high-quality food. In addition, Power (2008) suggests that Indigenous individuals also need to have "cultural food security" (p. 95). Aside from creating policies, government-led and subsidized programs can improve food insecurity. A possible solution is a program developing an aquaponics system. Using the towns of Attawapiskat, Fort Albany, and Moose Factory, this paper provides a population and traditional food background, identifies the current status of food insecurity including food cost, accessibility issues, and health concerns, and discusses current community initiatives that attempt to curb or eliminate food insecurity. Considering the advantages, challenges, and current progress of aquaponics systems, the paper also proposes that the Government of Ontario (Ontario) uses the components of good governance; develops collaborative partnerships interministerially, with the federal government, and with the First Nations; and should consider creating a subsidized in-home or community aquaponics program to foster food security.

Background

It is important to first clarify the needs of the community with regards to traditional food consumption. Attawapiskat, Fort Albany, and Moose Factory are Cree communities. Fort Albany has a population of 760 people (715 with Aboriginal identity (AI)), Moose Factory has a population of approximately 2,500 people, and Attawapiskat has a population of is 1,500 people (1,465 AI) (Moose Cree First Nation, n.d.; Goyette, 2010; Rioux, 2018; Chakasim, 2018). In order to sustain themselves, the communities historically ate and continue to make an effort to eat traditional foods. According to Dieticians Canada (2018), First Nations traditionally eat blueberries, strawberries, blackberries, raspberries, beans, corn, squash, potatoes, hickory nuts, wild rice, pickerel, trout, salmon, perch, and bass. Specifically, Cree may eat wild red currants and low sweet blueberries and Attawapiskat First Nation eat "low bush" cranberries (Kuhnlein & Turner, 1991). The Attawapiskat Cree people also used to rely on the land, primarily harvesting goose, moose, caribou and fish, and now still try to eat wild fish, game and berries. Resident John Tomagatick notes that "[It's] a lot of help to get wild food in the community. But some people really like it and other

people don't like it very much." (White, 2018b; Veeraraghavan et al., 2016). The quote suggests that some Attawapiskat people have a tradition of gathering foods and while some like foods being imported into the community, others prefer to harvest the food locally. For the First Nations "traditional food systems place value on spiritual connections and relationships, nourishment, and physical well-being… [and] a sense of purpose and place…" (Veeraraghavan et al., 2016, p. 20). There is a need to ensure that traditional methods of harvesting and traditional foods are maintained for the wellbeing of Indigenous people in the communities. Altogether, the communities' populations are not large but they need to sustain themselves independently with culturally appropriate foods.

Current Status of Food Insecurity in Northern Ontario

Current research exists identifying why there is food insecurity and highlights the health concern of food insecurity. However, research does not identify specific First Nation challenges. The communities in Northern Ontario are food insecure because the food costs are high, there is a lack of access due to geographical location (Veeraraghavan et al., 2016), and the food available is not always healthy. Regarding food cost, Food Secure Canada (2016) states the Revised Northern Food Basket (RNFB) for a family of four for one month in Attawapiskat is $1,909.01 (after the Nutrition North Canada subsidy); in Fort Albany it is $1,831.76; and in Moose Factory it is $1,639.42. In comparison, the cost in Toronto is $850. Also, the median income for Fort Albany is $39,053 (there is no information available for Attawapiskat and Moose Factory) and in Toronto it is $65,829 (Veeraraghavan et al., 2016; City of Toronto 2017). The data suggests that the people in Fort Albany are spending 56% of their income on food (not including traditional food gathering like hunting and fishing) and in Toronto people spend 15% of their income on food. Therefore, most of their income is being allocated to food, leaving less income for other needs. In Attawapiskat, an example of a culturally appropriate food with a high cost is raspberries that cost $11.00 for 170 grams (White, 2018a). In comparison, in Toronto, at Basic Foods 170 grams of raspberries costs $2.88 (Foodbasics, 2018). Clearly, there is a significant difference between the prices in Northern and Southern Ontario. Altogether, the low income and in turn purchasing power

and the high price of culturally appropriate foods leaves the communities struggling to maintain food security. There should be food cost ratio equality for all Ontarians and culturally appropriate foods should be in the forefront of inexpensive foods available.

Summer access generally allows for food transport into the communities, however, there are more challenges during the winter. In Attawapiskat, the only ground transportation during the winter is the James Bay Winter Road, a 300-kilometre stretch of thick ice to Moosonee (Gollom, 2016). An alternative access method is by plane. However, bad weather can restrict access which leads to stores not being stocked (Upstream, 2016). Thus, it may be difficult to transport food into the communities or drive to gain access to food. Between late fall and early spring, travel and shipping to Moose Factory can be achieved by helicopter, or shipping by drone (Moose Cree First Nations, n.d.b; NetNewsLedger, 2018). Both may be costly and may not be available in bad weather conditions. Fort Albany has limited accessibility by air, water, and winter road (Edge of Humanity Magazine, 2017). Altogether, in the winter season, food may not be transported into the northern communities and the communities may not be able to travel outside of the community to buy or gather food.

Lack of nutritious food because of prohibitive cost or inaccessibility can lead to health problems. Individuals that live with food insecurity are more likely to have or develop chronic physical and/or mental health conditions that in turn, increases healthcare costs (Leckovic, 2018). In Northern Ontario, the Indigenous are facing many health issues due to the lack of nutritious food (Goffin, 2017). Many individuals subsidize their food through the NNP. The RNFB provides a list of subsidized foods. Fish are not among the foods that are subsidized. With respect to fruits and vegetables, the RNFB contains oranges, frozen concentrated orange and apple juice, Tetra Paks of orange and apple juice, canned tomatoes and sauce, apples, bananas, grapes, canned fruit (fruit cocktail, peaches, and pineapple), potatoes, french fries, carrots, onions, cabbage, turnips, frozen vegetables (broccoli, carrots, corn, mixed vegetables), and canned vegetables (green peas, kernel corn, green beans, carrots, mixed vegetables) (Nutrition North Canada, 2018). As indicated by the traditional food list, the foods in the RNFB do not include traditional foods and some of the items increase Indigenous health problems. For example, frozen and canned vegetables may be

seasoned and have high sodium (Dlugos, 2017). A bag of mixed vegetables contains 6% sodium and canned peas contain 6% sodium (Green Giant., n.d. a&b). High sodium can cause bone, kidney, and heart issues, including high blood pressure, heart attacks, and strokes (Harvard University, 2016). According to the Heart Research Institute (2009), Aboriginal people are twice more likely to get cardiovascular disease and have heart attacks earlier in life than non-Aboriginal Canadians. The Cree have found that when they eat Western food they are weaker and are not as able to participate in traditional activities (Adelson, 2000). The Cree recognize the prevalence of malnutrition and should return to eating their traditional foods.

Overall, the NNP subsidizes foods that are unhealthy and lacks culturally appropriate foods. The research suggests that there is a need for a sustainable way of providing foods to Indigenous communities by reducing the cost, providing fresh food, and ensuring that it is accessible to improve and maintain Indigenous health.

Local Initiatives

Food insecurity is not a new issue in the North and there are many initiatives that attempt to improve food security. The Indigenous communities participate in programs and initiatives independently within the community and in partnerships with other organizations. Independent initiatives include a school breakfast program, farmer's market, and a school greenhouse in Fort Albany. However, all these programs need expansion to fulfil the growing demand. People have been creating backyard gardens, raising chickens, and buying food from Cochrane and Timmins as well, but there remains a lack of enough fresh food at affordable prices (Onexone, 2015). Some of the programs also have limitations, such as the seasonality and limited output of the school greenhouse program. To increase community growing capabilities, the Mocreebec Eeyoud Council of the Cree Nation in Moose Factory teaches vertical gardening and aeroponics (growing in an air/mist environment) (Bohunicky, 2018). The implementation of the initiatives mentioned above illustrate that the communities are actively learning about innovative solutions, engaging in

activities, and working towards becoming food secure. Still, while all of the projects help curb food insecurity, none are being done to a scale that completely meet the needs of the community.

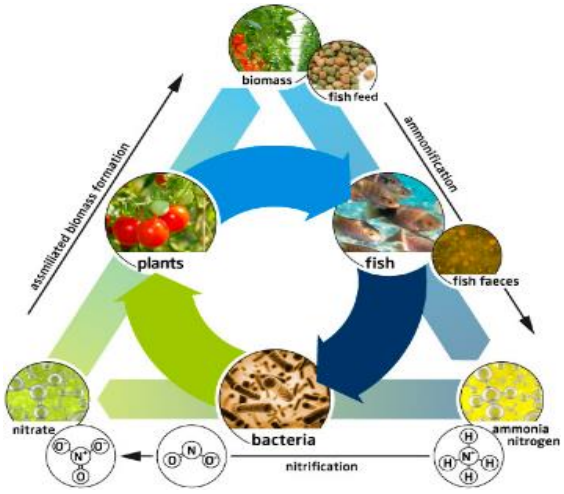
Regarding partnerships, the community and Foodshare, a non-profit group in Fort Albany, created a program that delivers quality foods including apples, garlic, Yukon gold potatoes, mangos, bananas, and kiwis by truck, train, and plane (a 3-day journey) (Bain, 2012). It allows the community to access fresh and nutritious food, however, the food is only delivered if weather permits transportation (Bain, 2012). Altogether, sustainable accessibility remains an issue and transportation by the three methods is not environmentally considerate. Moreover, the cost of the food remains high: a 10-lb bag of white potatoes sells for $14.99 in Fort Albany (Bain, 2012). In comparison, in Toronto at a local No Frills, the sale price of a 10-lb bag of potatoes is $1.00 (Nofrills, 2018) and in other stores it costs $2.99 (Freshco, 2018; Starsky, 2018). Therefore, even with importing food, there is a lack of price equality. From a cultural perspective, some of the foods provided by the program like cabbages, mangos, swiss chard, and eggplants needed an introduction to the community because residents were not familiar with the foods (Bain, 2012). The introduction of Western foods is therefore not culturally appropriate, nor does it ensure that individuals attain better nutrition if the food is not accepted and consumed.

In Attawapiskat, the Northern Store provides fruits and vegetables to school kids and helps with breakfast programs (White, 2018b). If the store is unable to gain the inventory then the program cannot function. In Moose Factory, there is a pilot project that allows children to exchange sweets for Ontario-grown food. Then, the students sell the foods and 40% of proceeds are given to the school (CBC News, 2018). The project is not permanent and the challenge of accessing food remains as well, since the cost of foods may be increased to support the schools. Current and future partnerships may not be permanent, food that is transported into the area is not always accessible, and seasonal initiatives leave a gap in food security. The need for partnership highlights the lack of self-sustainability. On the other hand, participation in partnership suggests that the community may be open to engaging in partnerships for other programs.

Aquaponics Defined

A possible solution to provide self-sustainable, accessible, and culturally appropriate food is for the northern Indigenous communities to have an in-home or community aquaponics system. This section will identify an aquaponics system's functionality and identify harvesting capabilities. Aquaponics is a uniquely integrated process for food production because it is the combination of aquaculture (fish farming) and hydroponics (soilless plant culture) (Nelson and Pade, Inc., n.d.a, pr. 1). In aquaculture, fish are grown and kept in a confined area like a pond or a cage (Goddek et al., 2015). As a result of the fish "digesting their food and excreting waste" while remaining in the confined area, the water becomes nutrient rich (Nelson and Pade, Inc., n.d.a). Aquaculture operators need to filter or dispose of the wastewater (Nelson and Pade, Inc., n.d.a). In hydroponics, plants are grown in a soilless solution of water and nutrients. Combining aquaculture and hydroponics creates a sustainable environment because the fish waste provides the nutrients for the plants while the plants purify the water (See Figure 1) (Nelson and Pade, Inc., n.d.a; Postma, 2017). The aquaponic system is two farming techniques merged into one mutually beneficial system. Plants can be grown on top of a pond or tank or the water from the tank can be flowed towards hydroponic beds for the plants to consume.

Figure 1. Symbiotic aquaponic cycle.



Source: (Goddek et al., 2015, p. 4201)

Regarding aquaponics capabilities, compatible fish include: tilapia, blue gill/brim, sunfish, trout, carp, barramundi, silver perch, yellow perch, catfish, and large-mouth bass. Aquaponic compatible plants include: lettuce, kale, swiss chard, potatoes, onions, carrots, arugula, basil, mint, strawberries, watercress, chives, tomatoes, peppers, cucumbers, beans, peas, squash, rice, broccoli, cauliflower, and cabbage (Nelson and Pade, Inc., n.d.b; Brook, n.d.a&b). There is an excellent variety of foods and some are culturally acceptable, though some plants like blueberries prefer high acidity levels and are not ideal for the system (Brook, n.d.a). In the winter when conditions are not suitable for outdoor growing, fish, fruits, and vegetables can be harvested from the system. In the summer, the communities can continue their traditional practice of fishing and gathering fruits and vegetables, possibly supplemented with aquaponics output.

Aquaponics Advantages and Disadvantages

Before implementing an aquaponics system it is important to know the advantages and challenges to determine if it is a viable option. Aquaponics has many advantages such as it provides high quality, locally-grown fresh food on a year-round basis; it produces healthy food due to no antibiotics or pesticides being used; it creates minimal waste (no nutrient-rich waste-water discharges); it conserves and recycles water; it does not deplete any non-renewable resources; it can contribute to the local economy and employment; it can use solar and geothermal energy; and it can be incorporated into existing infrastructure (Nelson and Pade, Inc., n.d.a; Bradley, 2015; Goddek et al., 2015; Junge, König, Villarroel, Komives, & Jijakli, 2017). It aligns with Cree values surrounding environmental stewardship, as there is no significant environmental degradation associated with the system (Royer, 2016). Using a system that incorporates community values may increase buy-in and acceptance. The possibility of building into existing infrastructure could allow for people to introduce aquaponics systems into their homes – a scenario that entirely solves the problem of accessibility. Lastly, beyond fulfilling their immediate needs, households or communities could even reap financial benefits by selling excess product. For example, if a family over produces or chooses to produce during the summer, the excess about could be sold or given

to the community. Altogether, there are multiple benefits for the communities to support the system.

Along with advantages, there are challenges to aquaponics systems. An aquaponics system needs consistent monitoring, optimal conditions, expertise, and a need for consumer acceptance. Insufficient monitoring or maintenance could lead to insect or disease outbreaks (Goddek et al., 2015; Brook, n.d.c; Rakocy et al., 2010). In turn, these outbreaks may lead to human health risks and a loss of yields. Optimal conditions are needed to ensure that chemical levels of ammonia nitrates and phosphorus are maintained, and water temperature is appropriate (Goddek et al., 2015; Brook, n.d.c). If either of these components fluctuate excessively, there is a possibility that the fish will die. Expertise is needed because the system is new and not a traditional technology used by the Indigenous communities. To determine the viability of an aquaponics system within a given community, experts like researchers, entrepreneurs, technicians, and scientists need to work together to assess requirements for the system, technology, and financing (Goddek et al., 2015; Brook, n.d.c; Junge, et al., 2017). These experts will need to train the communities. The cost of introducing and maintaining aquaponics may present a challenge because of climatic and geographic conditions (Goddek et al., 2015): if there is an in-home (or backyard) aquaponics system, community members need to ensure that they can provide the environment to raise and harvest the plants and fish. For example, they may need to increase the temperature of their homes to accommodate plant growth. In turn, there may be increased heating costs. Lastly, there is a need for consumer acceptance. There is no current data regarding whether Indigenous communities would be supportive of having an in-home aquaponics system, maintaining the system, harvesting the plants and fish, and consuming the plants and fish. Thus, while the system would be beneficial to the environment, community development, and providing food security, there are challenges of maintenance, expertise, and consumer acceptance to be addressed.

Aquaponics in Practice

To determine potential aquaponics success, it is important to examine current aquaponics systems. Aquaponics has ancient roots and is a practice that stems from the Aztec chinampas in 1,000 AD (Moreno, 2007; Bradley, 2015). Since the 1980s, in the United States and Canada, there has been a rise of predominantly commercial aquaponics, harvesting food like arctic char, trout, and lettuce (Bradley, 2015; Fletcher, 2017). Three case studies that allude to the viability of an in-home or community aquaponics system are compared in Table 1.

Table 1:

Operator, Location:	**University of Virgin Islands, The Virgin Islands**	**Traders Hill Farm, Florida**	**Lily Pad Farms, Texas**
Type of System:	Deep Water Culture	Similar to Deep Water Culture	Altered Deep Water Culture
System Details:	• Four fish rearing tanks • Six hydroponic beds • Total plant growing area is 2,300sqft • Total land area used is 1/8th an acre • Uses 131,800L of water	• Four fish rearing tanks (8ft diameter by 4ft height) • Three hydroponic beds (100ft long by 4ft wide) • Uses 227,300L of water	• Three greenhouses (100ft long by 30ft. wide) on pads (105ft long by 35ft wide) • One system has two fish rearing tanks (12ft diameter) with around 1,450 tilapia per tank and two growing beds.
Construction Cost:	$40,520.10	$104,450	$131,621.04
Variable Cost:	$67,041.97	$179,350	$105,960.02
Net Income:	$47,700	$134,900	$134,297.98
Yearly Production:	• 592 cases of lettuce • 3,000kg of basil • 4,324kg of tilapia	• 25,000 plants • 2,500 fish	• 12,000 plants • 11,000 fish
Considerations:	• Climate restricts production of plants	• Reduced construction costs due to: - pre-existing infrastructure (hen house) and own land - heated by clay stove using property harvested timber	• Farm struggled with crop failure due to heat and high winds

Source: (Heidemann, 2015, a,b,&c)

The case studies are examples of economically viable aquaponics operations. The main consideration amongst all three cases is the cost of construction, cost of operation, and the weather considerations. If successfully executed, a community aquaponics facility could present economic benefits for the Northern Ontario communities.

Recently, aquaponics has expanded across various geographies and settings. In Norway, at the Norwegian Institute for Agricultural and Environmental Research, there is a site testing a variety of different plants and growing brown trout (Tjomsland, 2014). The institute can suggest how to maintain foods in northern climates. In Mississauga, Ontario, there is a 500 square foot aquaponics food bank that provides "646 servings of fish (tilapia) and 10,800 servings of greens each year" (The Mississauga Food Bank, n.d.). As a not-for-profit, the food bank is sustainably able to provide food to low-income local communities. The Northern Ontarian communities could develop a similar community-led system. In Indiana, United States, a correctional facility has implemented an aquaponics system (Rakocy, Bailey, Shultz, & Danaher, 2010), supporting the case for the feasibility of the system in public spaces like community centres and schools. The use of aquaculture has expanded past commercial use. The next possibility is for people to grow in-home aquaponics systems. There is no current research on the effectiveness and viability of in-home aquaculture systems.

To increase accessibility to healthy and fresh foods for communities, it would be ideal for residents to have in-home aquaponics systems. A commercial system compared to an in-home aquaponics system has some differences like the yields and costs, which would need to be adapted to the scale. Unless there is excess production, it is not stipulated that the system would bring an economic benefit. An in-home aquaponics system (16 square foot media bed and 16 square foot raft area) is estimated to cost about $1,000 ($554.40 for the system and $400 for materials). The system can harvest 32-50 heads of lettuce and 20 lbs of tilapia (at 20°C) (JustAquaponics, n.d.a; Sayson, 2018.a). The amount of fish and produce harvested and the cost of maintenance will vary depending on the selected types. For example, bass, a traditional fish, can be reared in colder temperatures but will not be able to be harvested as often as tilapia (Backyard Aquaponics, 2010). The approximate minimum feeding cost (cost of pellets) for fish will be $167.00 per year and

lettuce seeds start at $25 for 72 seeds (JustAquaponics, n.d.b; Sayson, 2018.b). Therefore, the Indigenous will need to consider the systems operation when choosing the products to harvest. Also, individuals may consider sustainable energy solutions like solar panels to develop systems that do not deplete renewable resources to maintain their cultural values. More research is needed regarding start-up costs; yearly maintenance for selected products including feed and part replacements; identifying labour required; best system types and development; and calculating costs of home and water heating and cooling. If an in-home system is not favoured by the communities, a community system could be implemented that could have an economic component. Community systems may need to be at a commercial scale or similar to the scale of the Mississauga Food Bank. Altogether, an in-home aquaponics or community system could provide healthy, culturally acceptable foods to the Indigenous communities in Northern Ontario.

Ontario Leadership and Partnership

It is important to note that under the current government, there an absence of a viable food security strategy. However, previously, Ontario was involved in a food strategy initiative (Ministry of Natural Resources and Forestry, 2018). In addition, Ontario has opted out of an annual survey that measures the number of households struggling to get enough to eat (Syal, 2017). The lack of a strategy and a lack of survey participation suggests that Ontario has no interest or is unaware of the need to address the issue of food insecurity. However, due to the prevalence of food insecurity and the recent change in government, Ontario should play an active role to eliminate it.

A way for Ontario to enable food security is by creating an aquaponics program. A successful aquaponics program can be led by the Government of Ontario due to its technical expertise by the Ministry of Natural Resources and Forestry (MNRF) to implement an aquaponics program as a way to increase food security. Ontario must use the principles of good governance to ensure that the program is effectively developed and operated. However, Ontario should not lead the program, along with the five components of good governance independently. Due to the

complexity of food insecurity and aquaponics systems, Ontario needs to develop collaborative partnerships interministerially with the First Nations and the federal government.

The MNRF is currently involved in aquaculture and aquaponics. The MNRF licenses and regulates all aquaculture operations under the *Fish and Wildlife Conservation Act, 1997*. Therefore, the province has a strong foundation on how to regulate and understands the feasibility of aquaculture in aquaponics. If Ontario were to consider a program for community and in-home aquaponics, it could follow current aquaculture licensing practices. In addition, since there is no licensing for aquaponics systems, it can be an opportunity to develop legislation, regulation, and policies for aquaponics systems. A consideration would be for the MNRF to subsidize maintenance costs for a period of time to help establish an effective system, since the targeted communities generally have low incomes.

To ensure effectiveness, a government-led aquaponics program needs to operate using the components of good governance. The components include direction, accountability, performance, fairness, and legitimacy and voice (Graham, Amos, & Plumptre, 2003; Callahan, 2007); these will be explained in this section. Firstly, regarding direction, this paper highlights that after considering disciplinary complexities like history, public health, environmental sciences, etc. an aquaponics program could benefit the communities. However, further research is needed to review technology and innovation options as well as future trends for aquaponics. Concerning accountability, Ontario needs to be accountable to all Ontarians in ensuring that the program follows the law. Also, Ontario needs to transparently provide the program details and progress updates. Moreover, the program needs to show that it is performing. Effectively measuring program outcomes is difficult when there is a partial influence (Callahan, 2007). Since the program will have many multiple stakeholders, each may have a different impact on the results or expectations for the results. It is important that the program is planned to minimize negative impacts or constraints. For example, since the communities will be in control of maintaining the systems, an inspector may periodically review the aquaponics system to ensure that the fish and plants are meeting health standards. During the duration of the program, Ontario will need to determine if the food growth and maintenance is worth the sustainability cost. Ontario can do this by using project management

tactics including setting goals and outcomes, surveying participants, and budgeting (Callahan, 2007). Ultimately, if there is a lack of effectiveness, then the government needs to decide if the program should be altered or stopped. Regarding fairness, the program needs to have set standards to ensure that all participants receive the appropriate (determined equal) subsidies and aid throughout the program. Lastly, concerning legitimacy and voice, governments have the duty to consult the Indigenous people (Northern Affairs Canada, 2010). Consultation is important because stakeholders can identify their support, opposition, identify concerns, and provide feedback and the governments can identify their expectations, perceptions, and gather information to make the program as effective as possible. Altogether, the principles of good governance ensure that a program is developed appropriately and responsibly.

The MNRF should consider collaborating with Ministry of the Environment, Conservation, and Parks (MECP), Ministry of Municipal Affairs and Housing (MMAH), and Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). The MECP can review environmental considerations such as the need for an Environmental Compliance Approval for any wastewater or pesticide use review (Moccia & Bevan, 2018). The system should not have any wastewater or pesticide use, but consultation with the ministry can help ensure that there are no gaps in planning the program. Moreover, collaboration with the MMAH as well as the local municipalities is needed to ensure that all the proper permits are requested and approved (Moccia & Bevan, 2018). If homes need to be adjusted or a community system is built, the law still needs to be applied and followed. Lastly, consultation with the Ministry of Agriculture, Food and Rural Affairs may be necessary to identify the impact of the *Nutrient Management Act, 2002*, *Veterinarians Act, 1990*, and *Fish Inspection Act, 1990* (Moccia & Bevan, 2018). The ministry can assist with the health of plants and animals. Altogether, multiple ministries need to coordinate and work together towards making the program feasible and effective.

Since the program should benefit the Cree communities, it is important that they are part of the partnership. As primary users, the community members will have first-hand experience of the program. The communities need to have consistent input and the opportunity to actively make

changes. With the support of all the stakeholders, the communities can feel safe and encouraged that everyone is working towards making the program effective to reduce food insecurity.

Lastly, a partnership with the federal government is required to determine if there is any legislative overlap or need for expansion and to review the relationship with the federal government's responsibilities with the First Nation communities. Regarding legislative overlap, expansion, and compliance, the departments of Crown-Indigenous Relations and Northern Affairs Canada, Indigenous Services Canada, Canadian Food Inspection Agency and Environment Canada may need to be consulted (Moccia & Bevan, 2018; Northern Affairs Canada, 2018). All of these departments may have applicable legislation that needs to be complied with and programs or projects that may be impacted by the development of an aquaponics program. Moreover, the federal government supports infrastructure development on First Nation Reserves (Indigenous Services Canada, 2018). Attawapiskat is in a reserve and the other towns may have members that live on the nearby reserve (Government of Ontario, 2017). For on-reserve infrastructure, there is a precedent that if the infrastructure supports the well-being of First Nation communities, then the federal government may assist in funding the program's component of infrastructure. The federal government may provide these funds from the 2016 budget, which is dedicated to improving First Nation infrastructure and innovating housing initiatives (Indigenous Services Canada, 2018; Building, 2018). The government could budget funds to support in-home systems or developing new homes with built-in systems. Alternatively, funds could support a community system. In any case, the federal government should be an active partner in the initial stages of the program. Finally, the importance of sector-wide partnerships should be considered specifically with technical experts, universities (research and development), other provinces that have effective aquaponics programs and private organizations that can aid with developing infrastructure and eliminating aquaponics systems challenges.

In conclusion, the Cree in Northern Ontario have specific traditional foods that allow them to connect with their culture. The communities face unequal food costs, accessibility issues, and food quality concerns that in turn, lead to increased health issues. However, the communities have independent initiatives and are in partnership with organizations that attempt to curb food

insecurity. Aquaponics is a possible solution to reduce food insecurity because it has a cooperative system that can produce a variety of environmentally considerate, healthy, and culturally appropriate foods. On the other hand, the system faces several risks that need to be taken into consideration before attempting to develop an operation. Aquaponics is an expanding practice with commercial success. However, in-home aquaponics has not yet been researched to determine long-term sustainability and feasibility. Because of this lack of research, Ontario will need to take an interest in food insecurity through the MNRF, so the province can lead a subsidized aquaponics program using the principles of good governance. Aside from the principles, Ontario will need to develop strong collaborative partnerships to address issues and work towards the program being effective. It is recommended that Ontario consider an aquaponics program for the First Nation communities that could potentially expand to other food insecure Ontarians or people across Canada.

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Appendix

Emails

Citation: Sayson, D. (2018, October 3) (a). Canadian Aquaponics - Canada's Source For Aquaponic Information and News [E-mail].

From: David Sayson <david@justaquaponics.ca>

Sent: Wednesday, October 3, 2018 10:03 PM

To: Karolina

Subject: Re: [Canadian Aquaponics - Canada's Source For Aquaponic Information and News] New message received.

Hi Karolina,

It varies widely of course depending on the type of system you install. The biggest operating costs are energy and labour.

Here is an example of small mom and pop style farms that can be profitable and the costs in Ontario would be similar if you take into account exchange rate.

http://www.canadianaquaponics.com/2015/10/economic-analysis-of-3-commercial.html

We have a DIY backyard or garage system which can grow around 32-50 heads of lettuce a month here

http://www.justaquaponics.ca/hybrid-system-32-diy-barebones-kit/

You would have to purchase around $400 worth of lumber and supplies from a hardware store to complete the project.

Best Regards,

David Sayson

www.justaquaponics.ca

www.canadianaquaponics.com

604.629.5017

Reply all

On Oct 3, 2018, at 5:28 AM, Blogger Contact Form <no-reply@blogger.com> wrote:

Hello,

What is the approximate cost of operating a commercial aquaponic system in Ontario?

And what is the cost of a hobby/at home aquaponic system?

Kindest Regards,

Karolina

Note: This email was sent via the Contact Form gadget on http://www.canadianaquaponics.com

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Citation: Rioux, M. (2018, November 08). Indigenous Population [E-mail].

Hello,

We thank you for contacting Statistics Canada.

Population numbers for Attawapiskat 91A, Indian Reserve (Census Subdivision), Ontario are:

Total: 1500

Aboriginal identity: 1465

Non-Aboriginal Identity: 35

Population numbers forFort Albany (Part) 67, Indian Reserve (Census subdivision), Ontario are:

Total: 760

Aboriginal Identity: 715

Non-Aboriginal Identity: 45

We have no population numbers available for Moose Factory.

If you have any other questions, do not hesitate to contact us at STATCAN.infostats-infostats.STATCAN@canada.ca or at 1-800-263-1136. Our agents are available Monday to Friday (except holidays) from 7:30 am to 7:30 pm Eastern Time.

Regards,

Martine Rioux

On behalf of Infostats | Au nom d'Infostats

Statistical Information Service | Service de renseignements statistiques

STATCAN.infostats-infostats.STATCAN@canada.ca

[../../../../../../Documents%20and%20Settings/beaudan/Application%20Data/Microsoft/Word/www.statcan.gc.ca]www.statcan.gc.ca

Statistics Canada | Statistique Canada

Government of Canada | Gouvernement du Canada

Reply all

De : Karolina Stecyk

Envoyé : November-08-18 11:28 AM

À : Infostats / infostats (STATCAN) <statcan.infostats-infostats.statcan@canada.ca>

Objet : RE: statistics

Good morning,

I am having some trouble reading your data.

What is the total population and broken down into Indigenous and non-Indigenous in Attawapiskat, Moose Factory, and Fort Albany.

Thank you.

Kindest regards,

Karolina

Citation: Sayson, D. (2018, November 15) (b). Costs of Aquaponics [E-mail].

From: David Sayson <david@justaquaponics.ca>

Sent: Thursday, November 15, 2018 4:32 PM

To: Karolina Stecyk

Subject: Re: DIY Hybrid System Kit

Hi Karolina,

The cost to maintain a system includes the inputs (fish feed, supplements, maintenance, seed starting components), energy (for heaters, lights, dehumidification etc), and labour. Of course you may not need many of the things listed in brackets depending on your environment.

If you are growing around 2 square meters of plants, you need around 60 grams of feed in per day. You can see the cost of feed for Tilapia and other carp species here

http://www.justaquaponics.ca/fish-feed/

So that works out to around only 26 cents a day for the feed, or less than $100 a year. The larger costs will likely be energy costs.

If you're growing lettuce for example, you want to keep the air and water temperature around 20 C and if you have Tilapia you can even keep the water warmer.

If you need lights, you will also have energy costs for that as well.

If you're growing from seed, you may want seed starting kits like this.

http://www.justaquaponics.ca/sunshine-seed-starting-kit-with-coir-pellet/

That would be $25 for every 72 seedlings.

Best Regards,

David Sayson

www.justaquaponics.ca

www.canadianaquaponics.com

604.629.5017

On Nov 13, 2018, at 11:47 AM, Karolina Stecyk wrote:

Good afternoon David,

Regarding the Hybrid System 32 DIY Barebones Kit, what would be the yearly cost to maintain the system?

Best,

Karolina

Citation: Chakasim, P. (2018, November 08). Indigenous Population [E-mail].

From: Paul Chakasim <paul.chakasim@moosecree.com>

Sent: Thursday, November 8, 2018 2:45 PM

To: Karolina Stecyk

Subject: Re: Question

Hi Karolina,

It's actually difficult to find an accurate population figure for Moose Factory, because participation in the census program is typically fairly low. However, a rough population estimate is 2,500. I can do some digging to try to confirm a number though.

Regards,

Paul Chakasim

Communications Officer

Moose Cree First Nation

(705) 658-4619 ext. 274

paul.chakasim@moosecree.com

From: Karolina Stecyk

Date: Thursday, November 8, 2018 at 2:34 PM

To: Paul Chakasim <paul.chakasim@moosecree.com>

Subject: RE: Question

Good afternoon,

I am looking for information regarding the population of Moose Factory specifically the total and then branch into how many Indigenous and non-Indigenous (if available)?

Kindest regards,

Karolina