MORE FREQUENT, MORE INTENSE, MORE UNPREDICTABLE.

ADDRESSING FOOD RESILIENCY ON BOWEN ISLAND IN AN ERA OF PANDEMICS AND CLIMATE CRISES.

Prepared By:
THRIVE Bowen

THRIVE Bowen is comprised of a dedicated group of Bowen residents with extensive local, and global experience in sustainability, CED, regenerative economies, environmental strategies, leadership, and managing initiatives/organizations with budgets into the millions of dollars.

We are a new unincorporated group/association who look to substantively 'move the needle' on food resiliency and security on Bowen Island. In light of the ongoing pandemic and the consequences of the global climate crises that will occur over the next years and decades, we look to develop/implement practical local solutions.

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Disclaimer

This report has been complied with the best available data at the time of its writing. The information in this report is intended solely for the personal non-commercial use of the reader who accepts full responsibility for its use. While we have taken every precaution to insure that the contexts is both current and accurate, errors can occur. THRIVE Bowen, its contractors and funders, and the authors of this report assume no responsibility or liability for any errors or omissions in the content of this report. The information contained herein is provided on an "as is" basis with no guarantees of completeness, accuracy, usefulness or timeliness. Further due diligence and detailed analyses are required if interested in pursuing the options outlined in the report.

EXECUTIVE SUMMARY

When the floods of last November (2021) cut the Lower Mainland off from the rest of Canada, the threats of climate change became all the more real. Such events are only going to become more frequent, more intense, more unpredictable.

Given our dependency upon the ferry, Bowen Island is particularly susceptible to the uncertainties and unpredictability of climate change. Without pre-planning, Bowen could in the flash of a flood, freeze, or fire become a community stranded, separated, disconnected from the basic necessities of life, including adequate food for our families and community.

“How do we produce enough local food?” is a key question to community resiliency. We know that agricultural technologies, such as greenhouses, are essential to local year-round food production. For example, are community-owned, commercial greenhouses or other technologies viable on Bowen Island? Are they part of the solution? This feasibility study sought to find out.

In partnership with the Institute for Sustainable Food Systems (ISFS) at Kwantlen Polytechnic University (KPU), THRIVE Bowen conducted an independent Implementation Analysis of soil-based options [pp. 14-67].

The ISFS findings herein affirm that Bowen Island can address on-Island food security and resiliency in significant and meaningful ways.

“The theoretical land requirements to produce 11 staple crops consist of 28.4 acres of farming area and 9.4 acres of support facilities such as housing, barns, washing stations, and roadways. This brings the total land requirement to 37.8 acres. This means that the current ALR on Bowen Island, classified as ‘available for farming’ (51.4 acres), encompasses enough land to significantly increase Bowen Island's food production capacity.”

The Grafton Commons, Arbutus Ridge, and other sites on Bowen can play vital roles as Community Assets, and in terms of being agricultural resource hubs for the greater community. These hubs could support a network of small and larger producers on-Island, including individual gardeners, neighborhood ‘Victory Gardens’, or larger scale on-Island growers.

KPU’s report states that with less than 40 acres of land, Bowen Island’s food production capacity can be significantly increased. Are there roles for non-soil based systems in the expansion of this localized production on Bowen?

As climate change has the potential to disrupt traditional agricultural production and consumers are increasingly seeking unique products, Controlled Environment Agriculture (CEA) is considered to be an important part of a robust and nutritious food supply across the globe - and is attracting a significant amount of attention and investment. There are numerous benefits and drawbacks to these technologies for Bowen Island that we've included in this report [Page 4].

If THRIVE Bowen or the Bowen community were to proceed with any system, proper due diligence is required, including full business, operational, and competitive analyses for any non-soiled based system or provider under consideration.

There is a high level of complexity in these systems (excluding the small hydroponics systems); and considerably more research, education, and community consultation would be required before investments and land use planning could even be considered to accommodate them.

Small containerized or tower systems could be ideal (given the right one) for a community group/co-operative/social enterprise interested in taking on the project.

On page 8, we include next steps and recommendations for moving forward.

THRIVE BOWEN

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Why food resiliency is critical to Bowen Island and beyond.

Just a short time ago, British Columbians faced a reality that had previously been unimaginable: the continuous flow of food and other necessities, brought in through long supply chains from all over the globe, suddenly felt shaky and uncertain. In the face of COVID-19, its ongoing variants, and climate change, uncertainty is a fact of life.

From farm labour shortages to slaughterhouse closures, from our dependency on an oligarchy of suppliers to the potential nationalization of critical food exports by other countries, these seamless global supply chains have come into question with COVID-19. Food inflation is a growing reality.

When the floods of last November (2021) cut off the Lower Mainland from the rest of Canada, the threats of climate change became all the more real. Such events are only going to become more frequent, more intense, more unpredictable.

Given our dependency upon the ferry, Bowen Island is particularly susceptible to the uncertainties and unpredictability of climate change. Without pre-planning, Bowen could literally in the flash of a flood, freeze, or fire become a community stranded, separated, disconnected from the basic necessities of life, including adequate food for our families and community.

It's not going to be good enough, in a year or five months or five years from now to say, 'Oh, we didn't know.' We do know. And it's up to us now to be responsible and to do something about it. We must prepare now for the inevitable consequences on our food supplies of climate crises, the ongoing COVID-19, as well as future pandemics.

So how do communities such as Bowen Island ensure that we have access to the food that we need?

Overwhelming evidence shows that food production/consumption and agricultural practices are at the heart of mitigating climate change. "How do we produce enough local food?" is a key question to community resiliency. We know that agricultural technologies, such as greenhouses, are essential to local year-round food production. For example, are community-owned, commercial greenhouses, viable on Bowen Island? Are they part of the solution? This feasibility study sought to find out.

Soil-based Options For Food Resiliency.

In partnership with the Institute for Sustainable Food Systems (ISFS) at Kwantlen Polytechnic University (KPU), THRIVE Bowen conducted an independent Implementation Analysis of soil-based options [pp. 14-67].

ISFS led the analysis of Bowen Island's environment/locations, resources (ex. water), soil suitability, greenhouse options, suitable production systems, and crop selection/diversity for maximum food resiliency and financial viability/ROI.

Along with the five sites that participated in our analysis, THRIVE invited the following farms and/or landowners to be part of the study (though each declined for various reasons):

- Alderwood Farm
- Bowen Island Golf Course
- Bowen Island Municipality
- Bowen Island Properties
- Collins Farm
- Endswell Farm

The ISFS findings herein affirm that Bowen Island can address on-Island food security and resiliency in significant and meaningful ways.

Building on previous reports by Sage et al, KPU assessed the food production potential on Bowen Island. "According to the Agricultural Land Use Inventory, there are 51.4 acres of ALR on Bowen Island classified as 'available for farming' (but are currently in a natural/semi- natural state).

"The theoretical land requirements to produce 11 staple crops consist of 28.4 acres of farming area and 9.4 acres of support facilities such as housing, barns, washing stations, and roadways. This brings the total land requirement to 37.8 acres. This means that the current ALR lands classified as 'available for farming' (51.4 acres) encompass enough land to significantly increase Bowen Island's food production capacity."

KPU also points out the significant contributions that sites such as The Grafton Agricultural Commons (The Commons), Arbutus Ridge, and others can play in addressing food security on Bowen.

The Commons "has a significant potential" to "support and educate backyard growers, to support existing and future farmers on Bowen Island and the production of locally grown sustainable food on Bowen Island."

The Commons, Arbutus Ridge, and other sites on Bowen can play vital roles as Community Assets. They can be agricultural resource hubs for the greater community by offering for example the following:

- educational/health classes
- commercial kitchens
- locations for non-soil based container options, such as Freight Farms
- tool and/or farm truck rentals, and/or
- cold storage/flash freezer facilities, to name a few.

These and/or other resources could support a network of small and larger producers, including individual gardeners, neighborhood 'Victory Gardens', or larger scale on-Island growers.

As KPU points out, much of the land both in and out of the ALR has been broken down into small parcels that are often less than 10 acres [reference]. “Unless significant land ownership changes happen, we [KPU] envision the future of agriculture on Bowen Island as a mosaic of small producers. Small farms are diverse, and when intensively managed can be much more productive on a per acre basis than larger farms.” Small steps lead to bigger ones, small pieces add up. All are meaningful and important.

Non-soil based Options For Food Resiliency.

KPU’s report states that with less than 40 acres of land, Bowen Island’s food production capacity can be significantly increased. Are there roles for non-soil based systems in the expansion of this localized production on Bowen Island?

As climate change has the potential to disrupt traditional agricultural production and consumers are increasingly seeking unique products, Controlled Environment Agriculture (CEA) is considered to be an important part of a robust and nutritious food supply across the globe - and is attracting a significant amount of attention and investment.

Controlled Environment Agriculture (CEA) is a term for using different technologies to grow food indoors. In CEA, these technologies ensure the best growing conditions and protection for specific crops. This is slightly different to just indoor farming - by nature, indoor farms simply protect crops from external forces such as weather and pests. A container farm would be an example of CEA, as would other indoor farms such as vertical farms and high-tech commercial greenhouses.

Plants are often grown in a soil-less media to supply the proper amounts of water and nutrients to the root zone; as well as the usage of supplemental lighting to ensure a sufficient daily light integral. CEA optimizes the use of resources such as water, energy, space, capital and labor. CEA technologies include hydroponics, aeroponics, aquaculture, and aquaponics.

What are the benefits and drawbacks of these technologies?

Potential/Perceived and Real Benefits of CEA:

1. A controlled environment - food growth is not dependent on weather, which is becoming increasingly erratic and unpredictable.
2. Significantly reduced water usage - currently, agriculture accounts for 80% of the water usage in the USA.
3. Significantly reduced use of pesticides and fertilizers - preventing pollution to waterways and soils which has massive health and environmental impacts.
4. Not reliant on healthy soils (the UN predicts a majority of the world's top soil will have been lost to degradation within 60 years).
5. Year-round growing - an indoor and controlled environment means there is no longer a "growing season".
6. Proximity to consumers - fresh vegetables available year-round, grown in small contained spaces (you don't need to go out into the country or chop down trees to replace them with fields!) and therefore less energy required to transport food.
7. Potential for profitability, return on investment, as food prices continue to rise due to environmental breakdown and supply chain disruptions.
8. CEA can play a positive role in shaping food and health policy due to the fact that it can be used easily incorporated into hands-on educational activities.
9. Less spoilage and wastage than conventional agriculture (roughly one-third of edible produce in California is left unharvested).
10. They can bring new life to spaces that have lost their purpose (ie: old factories and shipping containers).
11. These systems are can be very large (think sprawling factories), or very small (think shipping containers).

Drawbacks and criticism of CEA:

1. Many of the foods that are grown in these environments (ie: lettuce, cucumber, herbs) have a high-water content, which would have little impact on increasing the food resilience/security of a population. (Foods that contain a higher volume of carbohydrates & fats are required to meet that need.)
2. Almost no vertical farms or urban-based greenhouses are in the fruiting produce space (think tomatoes). This is because energy costs are high, and while nearly anything can be grown in these systems, it may not be cost effective or environmentally sustainable to do so.
3. The sustainability and profitability of CEA systems are vastly reduced by their reliance on energy inputs. While the future points towards these systems being powered by solar (considered to be a positive progression in terms of sustainability) the space taken up by solar panels then negates the space-saving benefits that these systems are lauded for.
4. The financial viability of these farming systems remains unproven. As David Roberts writes in Vox, "the landscape is littered with the corpses of vertical farming startups that thought they could beat the odds." In a WWF report on CEA, Japan has embraced vertical farming, but 60% of these farms remain unprofitable and are sustained through subsidies.
5. The yields of these farms are often inaccurate and overblown, leading people to make unwise investments.
6. Systems require often require continuous inputs, which are often tied to a single supplier (large multinational dependence, lack of farmer autonomy).
7. While many of these systems are scalable (and can be as small as a single shipping container) the trend with these systems seems to be about moving towards really massive factory-like farms that are controlled via complex robotix systems and automation.

General advantages and drawbacks to system types:

SYSTEM	UNIQUE ADVANTAGES	INITIAL INVESTMENT	OPERATING COSTS	SUSTAIN ABILITY	IMPACT ON FOOD RESILIENCE	COMMUNITY ENGAGEMENT
CONTAINER FARMING, EX. FREIGHT FARMS (BOSTON)	Small footprint; easy set-up.	Medium (container farms units can be purchased for under $250K)	Potential to be high (regulating a growing environment in a 'box' that was not built to grow food in).	Reduced water usage; low-use of fertilizers and pesticides; hyper local.	Minimal; most foods produced are high water; low fat/carb/protein.	High (visible farm, could be demonstration, employment opportunity).
RECIRCULATING AQUACULTURE SYSTEMS, (RAS) EX. PR AQUA (NANAIMO)	High protein; mass volume; food production - larger impact on food system.	Very High ($10M+)	High (highly complex system requiring a team of engineers to run).	No concerns about pathogens infecting wild fish; access to sustainable fish feed.	Very High	Highly industrial; not very 'Bowen'.
TOWER SYSTEMS / SMALL SCALE HYDROPONICS, EX. TOWER SYSTEMS (COLORADO)	Can be scaled up or way down to the level of individuals, families, schools, groups, neighborhoods, etc.	Low (can be as low as $300, or as high as $5,000 per system).	Low (but in terms of the size of the initial investments payback terms vary and can be quite long).	"Hyper local" means clamshell-like packaging is unnecessary; energy inputs vary based on system; refill materials have associated environmental costs.	Low to Moderate (depending upon usage and volume of uptake within community. Accessible to a wide range of demographics in that systems can be as low as $300, or as high as $5,000).	Very High (Gives individuals a gateway into growing food, educational opportunities abound.)
VERTICAL FARM, EX. NULEAF FARM (CALGARY)	Efficiency and control of growing environment, consistency, and reliability.	High ($2-$2.5M+)	High (either a lot of labour or high level of robotics/AI).	Can be completely organic; efficient use of resources and minimal waste.	Minimal; most foods produced are high water; low fat/carb/protein.	Minimal (think of a food growing factory).

Non-Soil Based Growing Providers:

Container Systems	Recirculating Aquaculture Systems (RAS)	Tower/ Small Hydroponics Systems	Vertical Farming Systems
Cold Acre Farms	Habitat	Agrotonomy	Agriplay
Freight Farms	High Comp	Fork Farms/Flex Farms	Cubic
Growcer	Integrated Aqua	Nutritower	NuLeaf Farms
Growpod Solutions	PR Aqua	Rise Gardens	NetLed, Vera Technology (Finland, Calgary)
		Tower Garden	

In-depth business/financial, operational analyses et al have not been conducted on any of the above systems nor providers (except for Growcer and Habitat within Carbon Free Group's (CFG) report (see Appendix 1)). CFG's report does not provide any competitive analyses between Growcer and its competitors such as Freight Farms, Cold Acre, etc. Similarly, CFG has not compared Habitat to any competitors within the larger context of RAS providers, such as PR Aqua.

On a cursory level, Freight Farms would appear to have a competitive advantage over other providers such as Growcer, given Freight Farms cheaper financial outlay, its longer track record in business, and its larger global reach in terms of commercial experience.

At this point, any comparison of competitors is speculative given the absence of any data-driven comparative analyses.

If THRIVE Bowen or the Bowen community were to proceed with any system, proper due diligence is required, including full business, operational, and competitive analyses for any system or provider under consideration.

There is a high level of complexity in these systems (excluding the small hydroponics systems); more research, education, and community consultation is required before investments and land use planning could be considered.

A small containerized or tower system could be ideal for a community group interested in taking on the project.

Each conversation with a supplier has the potential to shift the thinking about where such a container fits into the food resilience puzzle on Bowen Island (see Cold Acre notes in Appendix 2). Ultimately, the business strategy and the right technical support will likely determine the success of any project.

NEXT STEPS & RECOMMENDATIONS:

- **1. Convene** a gathering of Bowen Island stakeholders to address the questions raised in KPU's report (and to identify relevant solutions) around the ALR land and creating self-sufficiency for Bowen Island.
- **2. Support** the Grafton Commons, Arbutus Ridge et al. as Agricultural Community Assets, and being agricultural resource hubs for Bowen and beyond.
- **3. Determine** a baseline around demand for local produce, our local need, etc.
    - What are the Bowen communities' actual local food needs?
    - Do we know what produce and food products are consumed on Bowen?
    - How would THRIVE's work address the Bowen communities' felt & perceived local food needs?
    - Are people concerned about food security/resiliency, etc? Are these issues for residents? Why? why not?
- **4. Support** the development of an on-Island produced, open-source app/platform that can assess on-Island agricultural demand and supply, including non-soil based options, and to further community engagement. (See Appendix 3).
- **5. Conduct** community research project(s) on non-soil based growing options, such as tower systems. Through grants, donations, sponsorships, etc, acquire the bulk purchase of tower/panel growing systems for residences, schools, restaurants and/or community organizations (ex, Caring Circle, Health Center, BIRCH, Community Centre, the Hearth, Legion, etc).

Tower growing systems are relatively low in cost and offer a potentially high level of community engagement. They give individuals a gateway into growing food, and educational opportunities abound. We may also use the towers within schools as an engagement strategy for students, teachers et al around food production, security, etc.

Along with promoting local food production and consumption, self-resiliency and reliance, the towers address waste disposal, food loss and food waste reduction, eco-friendly food packaging (there is no packaging!), supply chain insecurities as well as fuel and trucking challenges.

By comparing/prototyping various providers on a small scale, we can then use the data gathered to figure out 1) which system(s) best suit community members/organizations; 2) whether a larger bulk purchase is of interest; and, 3) what the impact of their wider availability might be on the Bowen Island food system.

- **6. Match** potential sites with potential partners/investors to meet the needs of these various partners and systems.
- **7. Increase** the level of education about container, vertical, tower and RA systems within the community. Online courses such as this one are a low barrier to entry. Knick Knack Nook sustainability grants could encourage residents to enter into various fields of study (ie: engineering, aquaculture) that would be useful for these systems.
- **8. Grow** interest, connections, and awareness about non-soil based systems, especially amongst those looking for partnerships in terms of land/investment.
- **9. Explore** zoning and environmental requirements for CEAs systems, such as RAS and vertical farms, to determine which parts of Bowen Island would be suitable/appropriate. Would a designated industrially zoned area to address food resiliency be realistic or ideal? Realistically, this kind of project should be taken on by a private enterprise or possibly by a very ambitious community group.

DEVELOPMENT OF A BOWEN ISLAND FOOD BASED SOCIAL ENTERPRISE

Prepared By:
Buy Social Canada

buy social CANADA

THRIVE Bowen invited Buy Social Canada to support their social enterprise journey.

There are five key elements in the development of a social enterprise business plan:

- **Mission** - why? What is the purpose of the social enterprise?
- **Market** - selling what to whom? Production and Distribution issues.
- **Manage** - corporate culture and structure
- **Money** - capital from start up to sustainability to growth
- **Measure** - telling the story, learning and improving

Currently THRIVE sees its 'mission' as to substantively 'move the needle' on food resiliency/security on Bowen Island. To that end, it includes the potential development of a social enterprise(s).

Although there does seem to be general consensus on the big picture of purpose, the implementation options, the actual food production process(es)(including agritech options such as greenhouses, vertical, container, and tower systems) present the challenge. This challenge is exacerbated by not having a designated 'farmer' in place who can lead the next steps.

David Adams' leadership in organizing step one has been dynamic and irreplaceable; now when choosing and moving on to the next step of "Market", there is a significant decision point. It involves several important processes to move further on in the business development journey.

Integrating the elements of the market decision involves the supply side and the demand side of the product in the marketplace. As evidenced in all the related research from the THRIVE partners and contractors, the potential food growing options vary across methodology, in-puts and out-puts, resources, and outcomes. **Capacity is not a challenge, rather it is the what, how, and where on Bowen that is the issue.**

Demand will drive many of the next decisions on production methodology.

If the key purpose is to contribute to the food resiliency/security of the Island residents, it will be necessary to assess what will be purchased by residents. We know what foods could be grown on the island through the multiple different production methods and options as indicated elsewhere in the larger THRIVE report.

The next vital question to address is what are the food items currently being 'imported', bought off-island by residents?

In a supply chain analysis this would be referred to as 'import substitution.' However, since several of the food production systems that will work on a land-limited, seasonally challenged island such as Bowen. Will likely produce well beyond local need. Secondary off-island sales of surpluses will need to be considered.

Entry into the non-Island competitive market of wholesale food sales from a smaller producer has proven to be not a likely option. Vancouver Farmers' Market attempted this approach through Farm Direct from 2016-2019 and the experience was not viable as a business nor as a community development service. Currently SPUD's parent company is in receivership, having to restructure in a new competitive market of delivery services, meal services and food consumption.

Collaboration with other social enterprise food entities was another option considered and explored; but currently they represent either a tiny market share or an extremely cost competitive market segment.

Entry into the non-Island competitive market of wholesale food sales at volume through investment in a major production system, such as a Recirculating Aquaculture System (RAS) was considered. From our assessment it did not currently resonate with the discussions and purpose of 'local' and Bowen Island based community purposed food resiliency. Perhaps, in the longer term such options as a RAS may be viable, but not as an initial first step.

Therefore, we would recommend that the next step in the business plan is to assess the current level and types of food that are 'imported' by the residents and visitors to Bowen Island, the commercial food providers (restaurants, etc.), and by any institutions on the Island.

This assessment of current import would help determine and lead to a decision on the production needs by product and volume. Such analysis will lead to an informed decision on the production method(s)(supply) that will suit the need(s) (demand) of Bowen Island.

The culture of THRIVE Bowen values local community as a top priority. Once the market assessment is completed then integrating 'community culture' into a governance structure will be possible.

Definition of "community" will need clarification in proceeding. In the THRIVE arena, it is not a geographic definition. As with many community development projects, the community is likely concentric circles of decreasing levels of engagement, with a core group of like-minded stakeholders leading the process, and then engaging and/or impacting larger segments of people on Bowen Island and beyond.

Currently, that would lead to principles of a social enterprise, a business with a social value that reinvests any profits back into the 'community'. In terms of corporate structure, THRIVE could likely form either a local member community co-operative or a non-profit member-based society.

Social enterprise is a verb, it is a process to support achieving a goal. To date the 'process' has been successful in bringing clarity of purpose and determining key basic market elements that are the beginning of a feasibility analysis for the "market" elements of the THRIVE social enterprise business plan.

###

Every purchase has an economic, environmental, cultural, and social impact, whether intended or not. The collective effort of leveraging social value from purchasing has a powerful and positive ripple effect on our communities.

At Buy Social Canada, we believe in building community capital: healthy communities that are rich in human, social, cultural, physical and economic capital. We are redefining how goods and services are bought and sold. By building relationships between social suppliers and purchasers, Buy Social Canada is leading the movement for community capital creators across the country.

Buy Social Canada is a social enterprise with the purpose to promote, advocate and consult on social procurement policy and implementation.

ASSESSMENT OF LAND-BASED FOOD PRODUCTION POTENTIAL ON BOWEN ISLAND

Prepared By:
Institute for Sustainable Food Systems, Kwantlen Polytechnic University
June 2022

KPU | Institute for Sustainable Food Systems

KPU | Institute for Sustainable Food Systems

The Institute for Sustainable Food Systems (ISFS) is an applied research and extension unit at Kwantlen Polytechnic University that investigates and supports sustainable agriculture and regional food systems as key elements of sustainable communities. We focus predominantly on British Columbia but also extend our programming to other regions. Our applied research focuses on the potential of regional food systems in terms of agriculture and food, economics, community health, policy, and environmental integrity. Our extension programming provides information and support for farmers, communities, business, policy makers, and others. Community collaboration is central to our approach.

www.kpu.ca/isfs

Assessment of Land-Based food production Potential on Bowen Island

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Disclaimer

Opinions expressed in this document are those of the authors and not necessarily those of landowners, Bowen Island Food Resilience Society Society (BIFS), or THRIVE Bowen. Landowners, and members of BIFS and THRIVE Bowen will not be liable for any claims, damages, or losses of any kind whatsoever arising out of the use of, or reliance upon, this information.

Executive Summary

Our dependence on the global food supply chains makes communities in Canada vulnerable to external threats such as climate change, diseases, political unrest, and volatile international energy markets. The past few years have been living proof of the failure of the global food system in nourishing people and the planet. There is no time like the present to act and build stronger local food systems so that we can create a brighter future for our children.

This study was supported by a group of passionate individuals who are determined to act and find ways to increase Bowen Island's food security and resiliency. The goal was to assess aspects of food production capacity on the island. The study synthesized secondary data on agricultural land reserve (ALR) and observational data from physical site visits. We hope that results from this study would provide information that could help residents and local policy-makers in making decisions regarding soil-based food production capacity and practices.

First, to assess the food production potential on Bowen Island, we investigated the availability of agricultural lands. The total area of Bowen Island's ALR is 425 acres, representing 2.7% of Bowen Island's total area. According to the Agricultural Land Use Inventory, there are 51.4 acres of ALR on Bowen Island classified as "available for farming" (but are currently in a natural/semi-natural state). The theoretical land requirements to produce 11 staple crops consist of 28.4 acres of farming area and 9.4 acres of support facilities such as housing, barns, washing stations, and roadways. This brings the total land requirement to 37.8 acres. This means that the current ALR lands classified as "available for farming" encompass enough land to significantly increase Bowen Island's food production capacity.

Next, moving from theoretical thinking to actual land parcels, we evaluated five different parcels for the possibility of soil-based food production. These parcels were nominated by landowners who were interested in using their land to contribute to building food sovereignty on Bowen Island. The five parcels were located at The Cape, Bowen Wild, Grafton Agricultural Commons (The Commons), Arbutus Ridge, and Xenia. Using various criteria important for soil-based food production, it was determined that the sites which had the most potential in the short run were The Commons and Arbutus Ridge.

Finally, using The Commons and Arbutus Ridge sites as examples, we provided key recommendations on food production practices that can be utilized on these sites. For example, a mobile high tunnel system was recommended for The Commons in order to ensure a year-round production and crop rotations to improve soil health. For a smaller operation at Arbutus Ridge, caterpillar tunnels would be suitable to extend the growing season. Recommendations suggested for these two sites are general guidelines and could also be applied to other lands which have similar characteristics.

In addition to the potential of the lands, there is also room for collaborations among local producers (current and future). Shared infrastructure, input purchases, and marketing are a possibility. Cooperation among growers, in fact, should be an essential part of Bowen Island's food security plan. It will not only contribute to a vibrant local food scene but also create long-term economic viability for farmers through economy of scale.

I. INTRODUCTION

Background

Food is central to and reflects the nature of all cultures and communities - who we are, and what and how we want to be. In North America, food - wherever it came from - has been abundant and unrealistically inexpensive for generations. Food abundance, affordability, quality, supply, where it came from were never in question - barely a thought given. The emerging reality of a very different food future motivates many to pause and think about the resiliency, the ultimate sustainability of our food system. They are concerned. And for good reason. Global climate warming is severely impacting weather patterns in the world's major agriculture regions resulting in an inability to produce food (Thornton, 2012).

In Canada, we obtain the majority of our fresh fruits and vegetables from the United States (US). In 2019, Canada spent nearly 5 billion dollars on fruits and vegetables imported from the US (Agriculture and Agri-Food Canada, 2019 and 2020). During the past several years, vast areas of the southwest US are experiencing extreme drought, water is being diverted to cities and by the thousands upon thousands of acres' farmers are abandoning their farmlands. Political unrest and war in eastern Europe is, right now, precluding staple crop production and disrupting global suppliers of needed fertilizers. Both severely threaten global food supplies. Globally all the arable land that can be farmed is being farmed, yet farmland destruction from erosion and salinization, and farmland loss from (urban, industrial) encroachment is rampant resulting in alarming rates and quantities of arable farmland loss. Agriculture, increasingly dependent on irrigation, utilized about 70% of all available freshwater for crop and livestock production (UNESCO, 2021) - there is no more, we are tapped out.

The Covid-19 pandemic revealed the fragilities of the global food supply chain - notably its length and substantial concentration. Within days grocery stores shelves emptied of critical foodstuffs. Scarcity resulted in increased food insecurity for Canada's most vulnerable and increased food costs for all. Simultaneously, the concentrated food retail sector (60% of all Canadian food retail is controlled by four corporations) generated record profit.

Today, in Canada, food cost inflation far outpaces general inflation (Charlebois et al, 2022). Fresh fruits and vegetable cost leads the way. The era of inexpensive, abundant reliably supplied food it seems clear, is at an end. Doing more of the same, and expecting a different outcome is not realistic. Yet, industrialization, globalization, and concentration of our food system continue largely unabated.

However, for these reasons and others, thoughtful communities, dependent upon the global food supply chain, seek to determine ways they can enhance their food system resilience via enhanced localization of production, and supply. In March 2019, the Islands Trust declared a climate emergency (Islands Trust, 2021). The Islands Trust area, including Bowen Island, is vulnerable to strong windstorms, droughts, intense rain events, temperature changes, rising sea levels, warmer oceans, and a more acidic Salish Sea. With these growing climate concerns and our dependence on food imports, food security and a sustainable food system have become important issues for local residents.

Bowen Island represents an example of such a community whose citizens are concerned about how the global food system has impacted their livelihood. They are interested to learn more and find out ways to advance their community's food resiliency and sustainability. As a result, this research project was initiated. Led by THRIVE Bowen, a group of passionate individuals came together to support the Institute for Sustainable Food Systems's effort in conducting a study to assess aspects of local food production capacity on Bowen Island. Several landowners were interested in participating in the project. They agreed to have their lands be evaluated for food production suitability. The study aims to provide residents with evidence-based information that would further their understanding of Bowen Island's capacity to support their food security aspiration.

Research questions

The overarching goal of this research is to demonstrate the food production potential on Bowen Island. Three key research questions are the following:

1. Does Bowen Island have sufficient agricultural land to substantively increase food production?
2. Given example sites, which sites are most suitable for soil-based food production?
3. For select sites (deemed most suitable for soil-based food production), what recommendations can be provided to ensure that the lands can be efficiently used to produce food?

Study outlines

To answer each of the research questions, the study is divided into three parts. The first part (Chapter Two) provides a theoretical analysis of agricultural land on Bowen Island. Data on agricultural land reserve (ALR) were used to estimate the amount of land area needed to produce select 11 staple crops to satisfy Bowen Island's population food needs.

The second part (Chapter Three) provides an analysis of important considerations to evaluate if a parcel of land is considered suitable for soil-based food production. Five site visits were conducted. An evaluation is based on six key dimensions: soil, water access, light, runoff concerns, space availability, and land access. A simple scoring method was then developed and used to compare across five sites.

Finally, part three (Chapter Four) addresses how a site can be improved to enhance their food production capacity. Site-specific recommendations were provided based on best practices that have been observed to work well for farmers in this region. These recommendations are meant to be used as general guidelines for site improvements. We hope that this information can offer other residents (who may have similar types of land) a glimpse of what can be done with their land if they were to use it for food production and contribution to Bowen Island's increased food security.

Bowen Island's key characteristics

Nexw̱lélexm̱, named “Bowen Island” by settlers, is located in the unceded territory of the Squamish Nation. Bowen Island is unique in its close proximity to Vancouver, BC, while still maintaining rural qualities and supporting a small population of 4,256 residents (Statistics Canada, 2021). Current farming activity on Bowen Island encompasses lands located within and outside of the Agricultural Land Reserve (ALR). Pastureland accounts for 83.9% of all farmed areas (or 46.2 acres). Vegetable production, nursery and tree plantation, and berry production together account for the remaining 16.1% of farming activity on the island (Metro Vancouver, 2016). Active farming for soil-based food production represents a small portion of the current farming activity on Bowen Island. This section discusses Bowen Island's key characteristics which are important to food production.

Climate

Climate Classification

Bowen Island is located in the Georgia Depression Eco province characterized by mild dry summers, and moist mild winters. With its Southern Exposure and location on the South-East corner of Bowen Island, this site may show warmer than average annual temperatures as compared to the rest of the island.

Average Annual Temperatures

Buffered by the ocean the temperature typically varies from 3 °C to 22 °C and is rarely below -3 °C or above 25 °C. The warm season The warm season lasts for 2.8 months, from June 17 to September 11, with an average daily high temperature above 19 °C. The hottest month of the year in Bowen Island is August, with an average high of 21 °C and low of 16 °C. The cool season lasts for 3.9 months, from November 14 to March 12, with an average daily high temperature below 10 °C. The coldest month of the year in Bowen Island is January, with an average low of 3 °C and high of 7 °C.

Rainfall

Both average annual precipitation and the timing of the majority of precipitation events play a pivotal role in the success of agriculture in a given area. Without both significant and useful (timed during the growing season) precipitation events agricultural production in a given area is forced to rely on other sources of irrigation.

Mean annual precipitation for Bowen Island is 1573mm, but the bulk of this happens between late fall and early spring, outside of the typical growing season. Significant summer rainfall events are rare, and precipitation during the summer can be as low as 88mm. Typically spring and summer have rainfall deficits.

Average First and Last Frost Dates

The average first and last frost dates are typically used as a general measure of the length of the growing season for a region. The longer the period between the more time during the year crops can be grown.

Last Frost Dates: March 21 – 31.
First frost dates Nov 15

Growing Degree Days

Growing degree days are a measure of heat accumulation over a given time. Typically, a base unit is decided upon, and growing degree days reflect time in an annual period during which temperatures are above the base value. As the growth and development of both plants and major insect pests are driven by heat accumulation, we can use growing degree days to estimate both the timing and success of crops in a given area. Five degrees is often used as a standard base when considering overall crop growth potential. Using the Farmwest's growing degree days calculator, With a base of 5 degrees, the average year on Bowen Island accumulates ***2,484 growing degree days***. This represents enough heat accumulation to grow all staple crops for this region.

Effects of Climate Change

Climate change is a looming reality for agricultural producers and the effects of it are already being felt year in and year out. The major consequences for the Metro Vancouver region will be an overall increase in growing degree days, drier summers, increased precipitation in winter, and higher incidence of extreme weather events. This will impact agricultural production in both good and bad ways. More growing degree day accumulation will allow new crops to be grown, and other crops to be grown year-round. Areas of specific concern for agricultural producers include the following:

Pest Populations: Much like plants insect pests' metabolisms are primarily driven by the accumulation of heat from external sources. With increasing temperatures so too will there be earlier and extended periods of insect pest pressure. As well in typical years insect pest populations are managed through cold events over the winter. The loss of these will allow increasing numbers of pests to survive year to year.

Late and Early Frosts: As producers see more variability in weather systems they will also see increasing variance in year to year frost dates. These dates are significant and impactful when planning agricultural operations. Farmers need to know when it is safe to plant and when crops need to come out of the field. With higher levels of frost date variability also comes increased risk and losses.

Precipitation: The increased severity of precipitations events increases the risk of runoff and erosions on bare soils. Bowen island has limited native soils already and much of Bowen island is located on steep slopes so this risk is exacerbated even further.

To find out more about the threats of climate change to Bowen Island and its agricultural producers see *Toward A Resilient Food System for Bowen Island Agrarian Analysis - Julie P. Sage*

Wildlife

While well-functioning agroecosystems include the inclusions of native wildlife it is important to take note of wildlife with the potential to significantly damage agricultural operations. Deer are plentiful on Bowen Island. They represents a significant pest to any potential soil-based productions systems. Any soil based production would likely require a large deer exclusion fence.

Pest Pressures

The most common pests in our region include cabbage looper moth, diamond back moth, flee beetle, aphids, powdery mildew, and wire worm. To adhere to the principles of regenerative agriculture, the best way to manage pests is to understand pest life cycles and practice integrated pest management. In terms of beneficial insects, our region sees bumblebee, lacewing, dragonfly, wood bug, solitary bee, beetle, spider, and flies. These insects play a vital role in managing and reducing the pests listed above. Using IPM guidelines and following regenerative practices, allows for increased populations of beneficial insects to flourish, reducing pest pressures on agricultural crops.

II. AGRICULTURAL LAND USE POTENTIAL

One way to improve Bowen Island's food security is increased local food production (Sage, 2019). However, to increase food production on the island an understanding of land availability and its potential is needed. In this chapter, we aim to do the following:

- provide an overview of Bowen Island's Agricultural Land Reserve (ALR)
- estimate the amount of land needed to produce 11 staple crops to satisfy the need of all Bowen Island's current and future populations

The results in this section demonstrate, in theory, the food production potential on Bowen Island. Additional investigations are necessary to assess agricultural suitability and illustrate how these lands can be used in practice.

Bowen Island's Agricultural Land Reserve

According to Metro Vancouver's 2016 Agricultural Land Use Inventory (ALUI) database, the Agricultural Land Reserve (ALR) of Bowen Island covers a total of 425 acres, broken into 27 parcels (Metro Vancouver, 2016). The ALR area represents 2.7% of Bowen Island's total area. Figure 1 shows the area of ALR on Bowen Island.

Figure 1: Map of Bowen Island's ALR (highlighted light green)

Source: Metro Vancouver, 2016, Agricultural Land Use Inventory

Land cover information is categorized into four groups:

Natural/semi-natural - Land cover not originating from human activities or not being maintained by human actions, includes regenerating lands

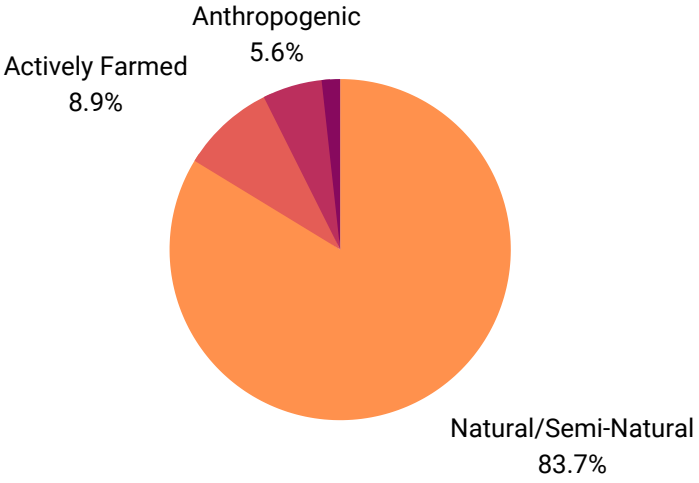
Actively farmed - Land cover includes cultivated crops, farm infrastructure, greenhouses and crops barns

Inactively farmed - Forage or pasture crop land which have not been harvested or grazed this season

Anthropogenic - Land cover originating from human activities and maintained by human activities

Figure 2 presents the land cover information of Bowen Island's ALR. The majority of Bowen Island's ALR is in a natural or semi-natural state (83.7% or 355.8 acres). Actively farmed ALR land on Bowen Island accounts for only 8.9% (37.8 acres).

Figure 2: Land cover of Bowen Island's ALR



Total ALR area
425 acres

Natural/Semi-Natural
355.8 acres

Actively Farmed
37.8 acres

Anthropogenic
24.0 acres

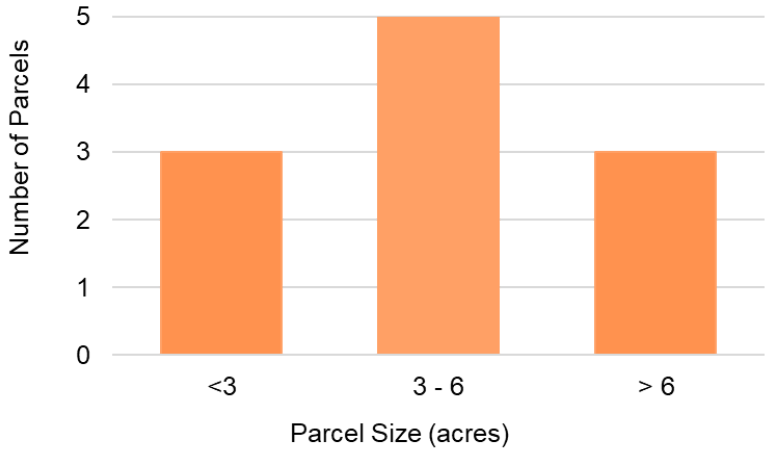
Inactively Farmed
7.4 acres

Source: Metro Vancouver, 2016, Agricultural Land Use Inventory

Theoretically, areas in Natural/Semi-Natural land cover could potentially be used for farming if cleared. However, there are natural areas of Bowen Island's ALR that are unavailable for farming due to existing land use. An example of this is Crippen Regional Park. Crippen Regional Park covers "almost half of the surface of ALR on Bowen Island... under the jurisdiction of Metro Vancouver and zoned as unavailable for farming" (Sage, 2019). Bowen Island's Crippen Regional Park encompasses a total area of 545.1 acres (Metro Vancouver, 2022), with approximately 215 acres of Crippen Regional Park located on Bowen Island's ALR.

According to the ALUI database, of the 355.8 acres in Natural/Semi-natural land cover, 51.4 acres are available for farming. The land is categorized as "available for farming" if it is not already being used for farming and has at least 1 acre with potential for farming. Additionally the land must not have a current land use that excludes agriculture (such as parkland).

Figure 3: Parcels 'available for farming' on Bowen Island's ALR



ALR area categorized as "available for farming":
51.4 acres

Number of parcels categorized as "available for farming":
11 parcels

The largest parcel "available for farming" on Bowen Island's ALR is 8.62 acres (Metro Vancouver, 2016)

Source: Metro Vancouver, 2016, Agricultural Land Use Inventory

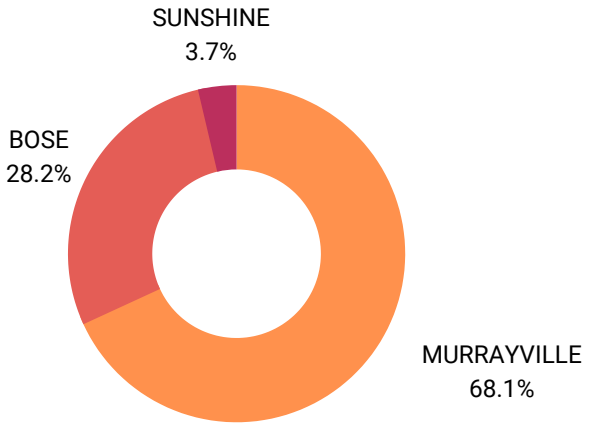
While land availability is the first consideration for increased food production, soil is the next consideration and important in determining land's suitability for food production. Table 1 and Figure 4 present the soil types and their characteristics of Bowen Island's ALR.

Table 1: Soil types and classification of Bowen Island's ALR

Soil Name	Soil Type	Drainage
MURRAYVILLE	Loam	Imperfectly Drained
BOSE	Sandy Loam	Moderately Well Drained
SUNSHINE	Sandy Loam	Well Drained

Source: Metro Vancouver, 2016, Agricultural Land Use Inventory

Figure 4: Soil types of Bowen Island's ALR



Overall, the soil of the Bowen Island's ALR has potential to support agriculture - with 68.1% of the soil being *Murrayville Soil*, a loam soil categorised by imperfect drainage. The second most common soil type of the ALR is sandy-loam, moderately-well drained *Bose Soil* representing 28.2% of the total ALR. The remaining 3.7% of ALR is *Sunshine Soil* categorised by sandy-loam, well-drained soil.

Source: Metro Vancouver, 2016, Agricultural Land Use Inventory

Select staple crops for the analysis

For this research, 11 “staple crops” were considered. These staple crops were selected based on their high consumption rate in the average Canadian diet, popularity, and suitability for growth on Bowen Island. The staple crops for Bowen Island are beet, broccoli, cabbage, carrot, cucumber, kale, onion, pea, potato, squash, and tomato.

While lettuce is a highly consumed vegetable with an average of 22lbs of lettuce consumed annually per person, it has been excluded from this report as Thrive Bowen is interested in container-based production for lettuce.

Select staple crops:

Beet	Cucumber	Potato
Broccoli	Kale	Squash
Cabbage	Onion	Tomato
Carrot	Pea	

Table 2 and Table 3 summarize per capita average annual consumption and average annual yield per acre of the 11 selected crops.

Table 2: Average annual consumption per person of staple crops based on Canadian average consumption rates

Crop	Average annual consumption per person (lbs)
Potato	46.2
Onion	21.6
Tomato	16.4
Carrot	15.9
Cucumber	10.5
Squash	7.7
Cabbage	6.5
Broccoli	6.4
Pea	2
Kale	1.9
Beet	1.4

Table 2 presents estimated average annual consumption per person in pounds. This data is based on the calculations utilized in the Southwest British Columbia Bioregional Food System Design project. It should be noted that consumption rates for these crops are based on Canadian average consumption patterns, while Bowen Island consumption patterns may differ.

Source: Mullinix et al, 2016, The Future of Our Food System: Report on the Southwest BC Bioregion Food System Design Project

Table 3: Average annual yield per acre (lbs/acre) for staple crops

Crop	Average annual yield per acre (lbs/acre)
Potato	21,200
Onion	42,000
Tomato	19,500
Carrot	33,000
Cucumber	17,500
Squash	30,000
Cabbage	22,000
Broccoli	7,250
Pea	5,000
Kale	16,000
Beet	14,000

The average annual yield per acre presented in Table 3 was calculated based on a 10-year average of crop yield to take into account yield variability over time.

Source: Mullinix et al, 2016, The Future of Our Food System: Report on the Southwest BC Bioregion Food System Design Project

Current and projected population

Over the last decade Bowen Island's population has been increasing at a rate of 2.2% annually (Statistics Canada, 2021). Using this population increase rate, the future population of Bowen Island can be projected for 2026 and 2031 (Table 4).

Table 4: Projected future population of Bowen Island

Year	Population of Bowen Island
2021	4,256
2026	4,745*
2031	5,290*

**projected population*

Source: Statistics Canada, 2021

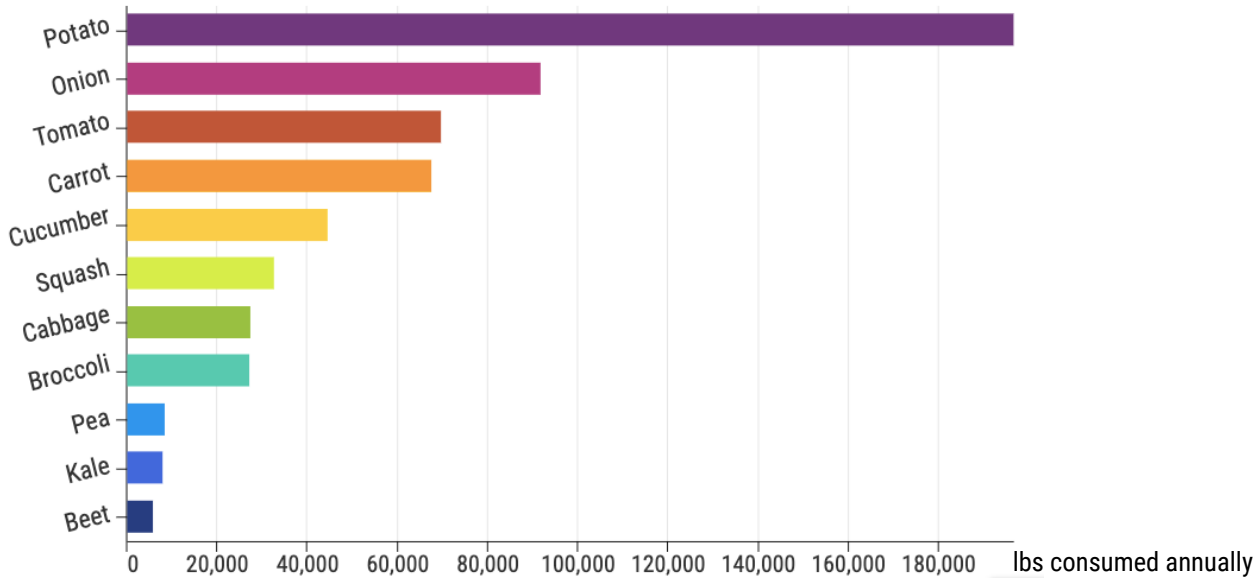
Theoretical land requirement to increase food production on Bowen Island

To estimate the amount of land required to produce food consumed by Bowen Islanders annually, we used the following formula:

$$\textit{Amount of land required (acres)} = \frac{\textit{Total annual consumption (lbs)}}{\textit{Average crop yield(lbs/acre)}} \quad \text{---------- Equation (1)}$$

To calculate the total annual consumption needs for each crop, we multiply the population (Table 4) to the average annual consumption per person (Table 2). Figure 5 presents the estimated annual consumption pattern of staple crops by Bowen Island's 2021 population of 4,256 people.

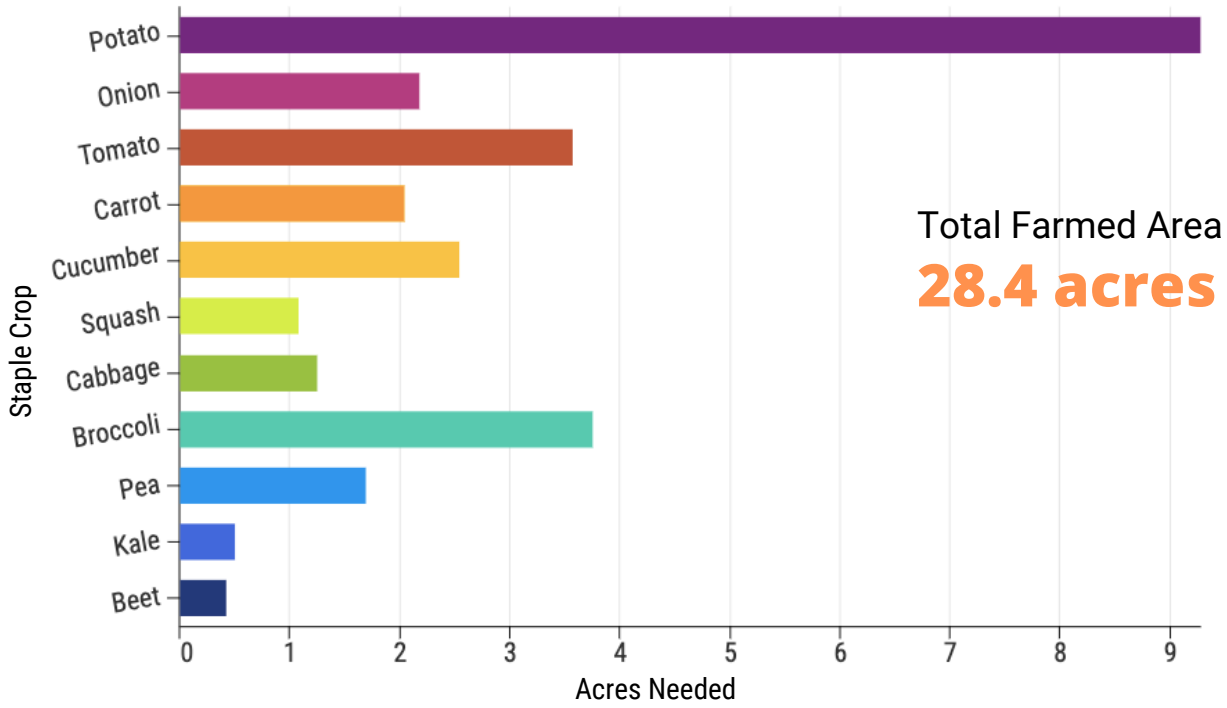
Figure 5: Bowen Island's estimated annual consumption of staple crops, based on 2021 population



Using equation (1), the data presented in Figure 5 was used to estimate land requirements to feed Bowen Island's current population and projected future populations by dividing them by average crop yield (Table 3) .

The results show that in order to produce enough staple crops to feed Bowen Island's current population of 4,256 people, a total of 28.4 acres are required (Figure 6).

Figure 6: Estimated farmed area required to produce staple crops to satisfy 2021 population food needs



As new farmed lands are established, there will be an increased need for supporting structures and facilities such as roads, parking, enclosures, storage and housing. On average, the proportion of anthropogenic land in Metro Vancouver is 33% of the total actively farmed land (Metro Vancouver, 2016). Using this proportion, we estimate that another 9.4 acres are needed to support the 28.4 acres of farmed land, bringing the total land requirement to 37.8 acres.

Currently, there are existing farming activities on Bowen Island (predominantly pasture). If we assume that these activities do not change, this implies a conversion of natural land in order to produce enough staple crops to feed Bowen Island's population. Such conversion would require clearing and preparing the land for farming. As a result, there would be a reduction in natural habitats for wildlife.

As there are no singular ALR parcels available for farming over 37.8 acres, a single farm is unlikely to meet the food needs of Bowen Island's population. A more likely outcome will be a network of small-scale farms working together to meet the Island's food needs.

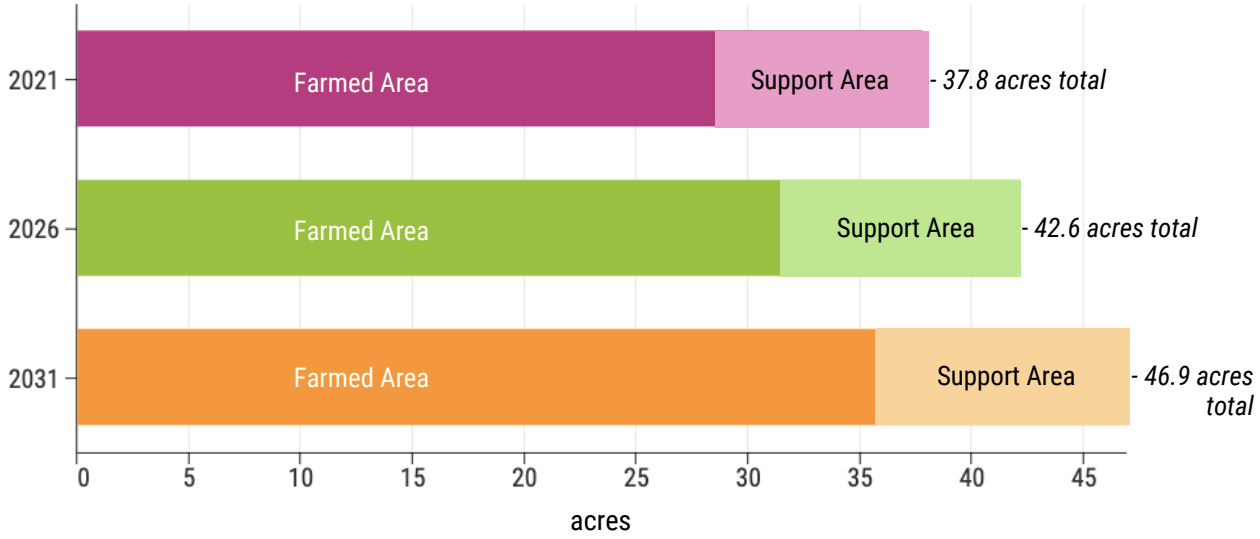
Farmed area
28.4 acres

Support structure area
9.4 acres

Total area needed
37.8 acres

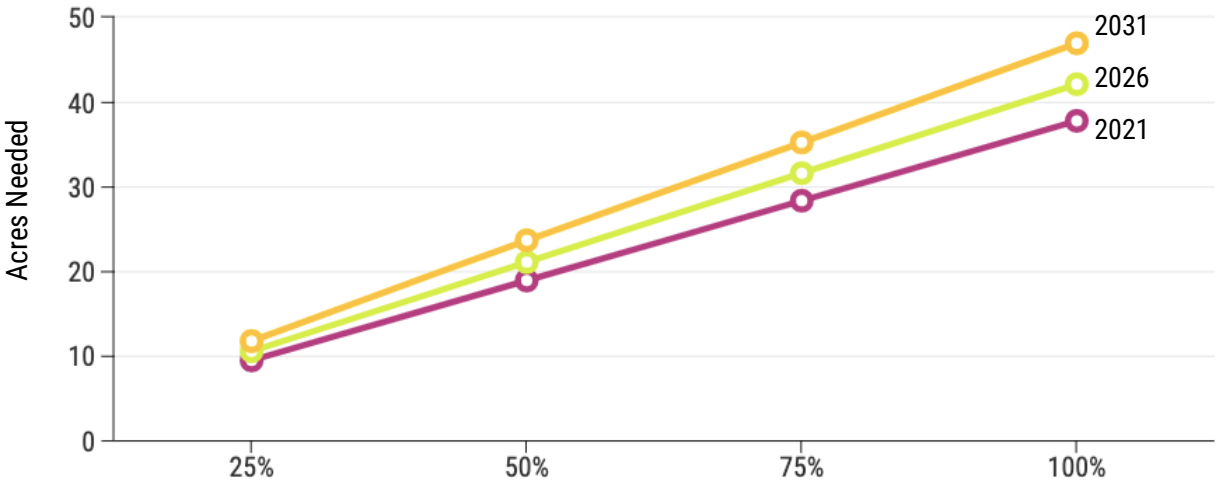
Next, using the projected future population in Table 4, we estimated the total area needed to produce the same 11 staple crops for increased populations in 2026 and 2031 (Figure 7). These future calculations were based on assumptions that crop yields and consumption amounts do not change. We estimated that approximately five acres are needed in 2026 and another five acres are needed in 2031 bringing the total in 2031 to about 47 acres. This implies that by 2031 Bowen Island can still produce these 11 staple crops enough for its population if it utilizes all "available for farming" ALR lands.

Figure 7: Projected farmed area, support area and total area (acres) needed to support Bowen Island's current and future population staple crop food needs



Alternatively, if satisfying 100% of population food need is not feasible right away, Bowen Island can slowly build its production capacity slowly. Figure 8 illustrates total areas needed to satisfy population's food need at different levels in 2021, 2026 and 2031. For example, to satisfy the food need of 50% of the population in 2026, the total area needed is about 20 acres.

Figure 8: Acres needed to meet different percentages of Bowen Island's population's staple crop food need



Takeaways

As stated in the previous section, there are currently 11 ALR parcels classified as available for farming, altogether a total of 51.4 acres. We need 37.8 acres to support the production of 11 staple crops for the current population. It is unlikely that we could find one large parcel on Bowen Island to produce all this food. Realistically, we envision several small-scale or mid-size-scale farm enterprises involved in food production. Cooperation among these new farmers will be essential so they could operate at a scale that has been well demonstrated to be functional and profitable. Many local examples exist, including KPU Farm Schools, Close to Home Organics, and Laughing Crow Organics. These farms range between 5-10 acres of production which serves to allow some level of mechanization, while still allowing a deep level of management and intimacy of the land. Additionally, such cooperation will set a better strategic direction to improve Bowen Island's food security, resiliency, and food sovereignty goals.

The land requirement estimation presented in this chapter takes into account only ALR land. It should also be noted; however, that there are areas outside of the ALR on Bowen Island that could be suitable for food production. Our results simply illustrate theoretical possibility. We do not mean to prescribe what farmers should produce or how landowners should use their lands.

The production systems used for the general yield and land use calculations are that of row cropping, outdoors, with no significant succession cropping. Considering this the adoption of practices that would improve yields, such as season extension with high tunnels, or improved crop planning to allow for multiple successions, could reduce the needed acreage below the 37.8 acres highlighted in this report.

The next chapter provides information on five different sites (both within and outside of the ALR) regarding their suitability for soil-based food production.

III. SITE ASSESSMENTS

The previous chapter illustrates in theory the amount of land needed to increase Bowen Island's food production. In practice, a thorough investigation of the lands is needed to determine which areas are suitable for soiled-based food production. For this study, five landowners were interested and had allowed their lands to be included in the evaluation. This chapter provides an analysis of each site in terms of its agriculture capability, soil type, environmental surroundings, historical use of the land, and other observations from a physical site visit. The objectives of this site assessment are to:

- Evaluate the agriculture capability and soil information of this parcel to determine the potential and limits of a productive agriculture operation
- Conduct a site visit to understand the most current state of the parcel
- Recommend management considerations to improve the soil and site in preparation for this agriculture development

The sites and visit dates

The five sites considered in this report are: The Cape - Lot 40, Bowen Wild, Grafton Agricultural Commons, Arbutus Ridge, and Xenia. Information on visit dates and those in attendance for each site is described below:

The Cape on Bowen
Date of Site Visit: December 10, 2021
Attendees: Candy Ho, Caroline Chiu, David Adams, Micheal Robinson and Wallapak Polasub

Bowen Wild
Date of Site Visit: December 10, 2021
Attendees: Caroline Chiu, David Adams, Mark Shieh, Micheal Robinson and Wallapak Polasub

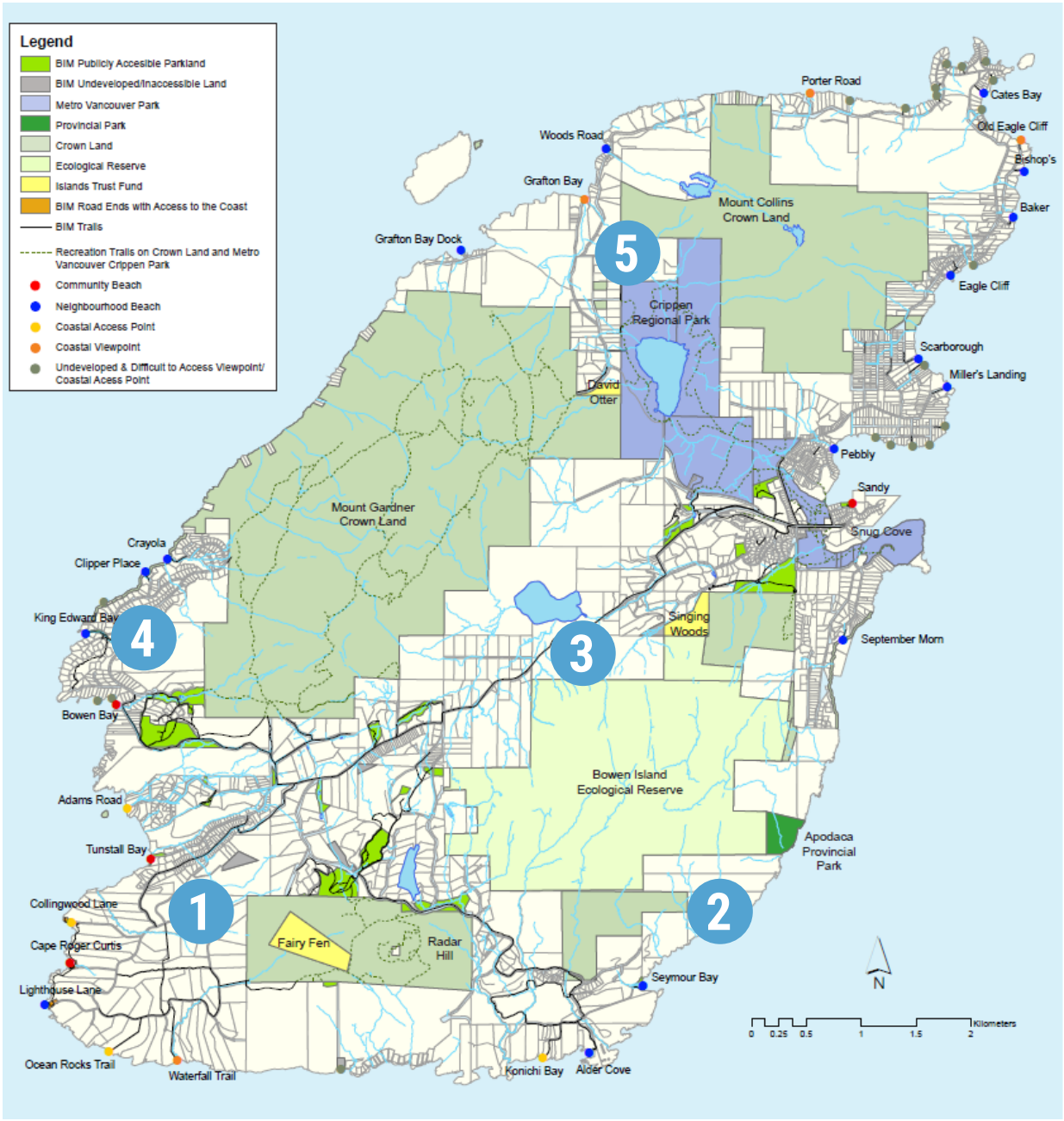
Grafton Agricultural Commons
Date of Site Visit: December 10, 2021
Attendees: Caroline Chiu, David Adams, Jackie Bradley, Micheal Robinson, Phil Gregory, and Wallapak Polasub

Arbutus Ridge
Date of Site Visit: February 3, 2022
Attendees: Allard Ockeleon, David Adams, Jackie Bradley, Jae Mather, Kelsey Watson, Paul Zysman, Phil Gregroy and Micheal Robinson

Xenia
Date of Site Visit: February 3, 2022
Attendees: Angelyn Toth, David Adams, Jackie Bradley, Jae Mather, Kelsey Watson, Paul Zysman, Phil Gregroy and Micheal Robinson

Figure 9 illustrates the locations of these five sites.

Figure 9: Locations of the five sites included in this research



1 The Cape, Lot 40

2 Bowen Wild

3 Grafton Agricultural Commons

4 Arbutus Ridge

5 Xenia

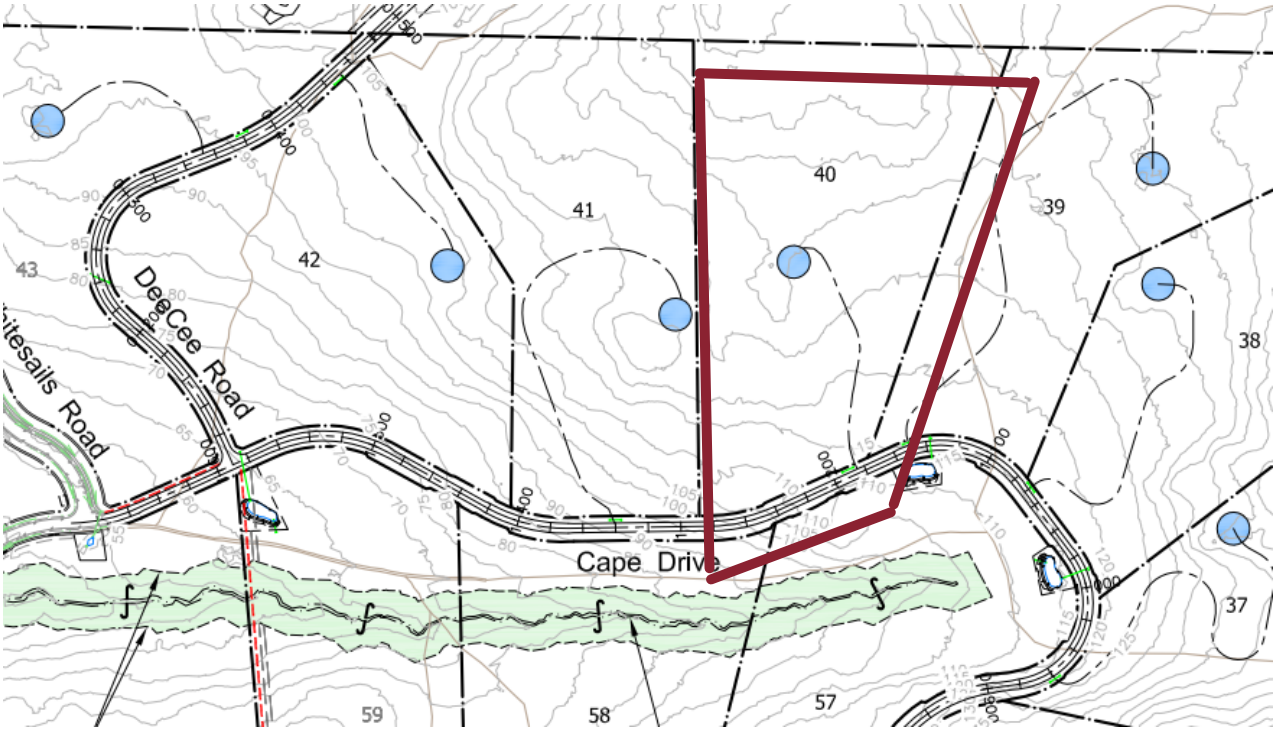
The Cape On Bowen - Lot 40

The History of The Cape On Bowen Island and Lot 40

The Cape On Bowen Island is a community development located on the Southeast Corner of Bowen Island. The Cape On Bowen is 618 acre site, made up of 10-acre lots, trails, and nature reserve. The cape serves as a good example of the typical characteristics found on much of Bowen Island.

Lot 40 is in the northeast corner of The Cape located close to the entrance of the development. The lot is bordered on two sides by lot 39 and 41. Lot 40 has only lightly been disturbed from its natural state, with a driveway, well, and a small building site having had been installed. Lot 41 currently operates under the name of "Island Discovery Learning Community". The main building on the site is within the visual field of the building site on Lot 40, directly down a short slope to the west.

Figure 10: The Cape On Bowen Lot 40 location and boundaries



Lot 40 - Soil Characteristics

The Cape sites both fall under the CC label as 7RT. This label means that the soils here are highly inappropriate for arable land or pasture and the limitation cannot be removed. **This is true of the majority of Bowen Island.**

Soil type: Cannell / Undifferentiated bedrock

1. Texture: Loam
2. Water holding capacity: Well drained
3. Nutrient holding capacity: Medium / low
4. pH: acidic

Crop Growth Implications

Areas with deep loam do exist within the 7RT label, but lot 40 has very limited loam present and currently none within any available space. The result of this is that any significant agriculture to take place would require the import or on-site creation of a functional soil ecosystem.

Lot 40 - Water

Drainage Requirements

Drainage on this site must be significantly managed to avoid runoff into a nearby riparian corridor containing Burke Creek. This corridor is 50 meters downhill from Lot 40 and 15-20 meters lower in elevation. The lack of significant soils, slope and rocky characteristic of the site make it highly likely to struggle with avoiding runoff and erosion.

Irrigation Requirements

Due to the characteristics of the climate, significant irrigation would be required during the bulk of the growing season. Early spring and late fall crop production needs might be met, but it is unrealistic to count on summer rainfall matching crop needs.

Main Water Source

A standard well is on-site with an average daily flow rate of 8.5Gpm. This is more than enough flow rate for a standard 30x100' high tunnel. British Columbia is currently undergoing changes to its groundwater regulations, this includes an application process for any non-domestic use. This could pose an extra hurdle for any production relying on groundwater access.

Figure 11: The Cape Lot 40 , looking south

SW Bowen Island Aquifer

The Aquifer located underneath The Cape and Lot 40 is currently listed under moderate productivity, moderate vulnerability, and high demand. Assuming water demand increases over time on southeast Bowen any significant agricultural enterprise should consider the viability of rainfall storage for a long-term sustainable water source.

Lot 40 - Topography

The site slopes steeply north up from the entrance to the property gaining 20 meters in elevation from road to proposed building site. This slope is split with steeper rocky escarpments on the west side of the property and a milder sloping driveway on the east. After approximately 120 meters the slopes levels off into a finer grade. Currently the site is almost entirely covered with second-growth Douglas Fir. This is characterized by dense stands of thin and tall trees, and limited undergrowth. Areas previously cleared have a mixture of tree seedlings, low shrub, bracken, and wild grasses.

Zoning

The zoning for lot 40 is currently RR 1. This Rural Residential Zone exists to facilitate rural and agricultural use of land within a rural setting. Agriculture and Horticulture are currently allowed within this zoning, as are accessory structures built to facilitate these land uses.

Figure 12: The Cape Lot 40, build site

Lot 40 - Site Visit Assessment

Site Perimeter

The perimeter of Lot 40 is not fenced in any capacity. There is a 7.5m setback of trees on the western side of the property where it is closely bordered by a residence/school. The eastern side of the property is currently bordered by an unoccupied lot.

Internal Site Access

A steep unpaved driveway leads onto the site and up to the flattened building site. Access to the driveway from the main road is three-quarters of the way up a hill, and a sharp turn. The road leading to the site is paved, and well maintained. Somewhat narrow, but not posing too significant of an access challenge. This driveway poses some potential challenges for access in the winter months.

Utility Access

Table 5: Utility Access for The Cape Lot 40

Service	Available	Required	Current Connection Type	Distance to Proper Service
Water (well)	Yes	Yes	8.5GPM wellhead on site	N/A
Electricity	No	Yes	N/A	Adjacent to Property
Sewer	No	Septic	N/A	N/A
Trucking Road	Yes	Yes	2-way traffic with shoulder	N/A

Management Considerations for Improving the Site

Light

Mid-day sun is very good, there is a large clearing running north-south down the property. Light access in the morning and afternoon is heavily restricted due to tree obstruction. The stand of trees on the east side of the lot could possible be removed with proper permits. The trees on the west side are in a right of way between lots 40 and 41. This provides a significant obstacle and would require the addition of supplementary lighting to any greenhouses placed on site.

Land

Lot 40 is heavily treed and rocky. Some room for landless agriculture does exist, but it would require significant earth moving and tree removal. Currently, tree removal does not directly align with the management goals of The Cape.

Overall Analysis and Recommendations

This site in its current form is not viable for a soil-based production system.

The site poses significant challenges with respect to open land, light access, lack of soil, runoff considerations, and tenure cost. While the possibility of significant site remediation does exist, the cost would be prohibitively expensive and unable to be recuperated on a reasonable timeline by any soil-based vegetable production systems.

This site is representative of much of the rocky, sloped, and forested plots of land available on Bowen Island. Considering the cost of tenure for properties on Bowen Island, most undeveloped forested lands should not be strongly considered for future use as agricultural production sites. There does exist the possibility of non-soil based systems, and supplementary supportive enterprises (such as abattoirs, processing facilities, distribution centres) but priority study of land for these alternative uses should be given to flat, cleared, and accessible lots.

Bowen Wild

History of Bowen Wild

Bowen Wild is a development project located in the southeast corner of Bowen Island. This 100 acre site is still very early in its development cycle, in what the owners are calling a discovery stage. They are currently exploring what possibilities exist for the site, and how the site might complement the surrounding community and island.

Bowen Wild - Soil Characteristics

The Bowen Wild site falls under the CC label 7RT. This label means that the soils here are highly inappropriate for arable land or pasture and the limitation cannot be removed. This is true of the majority of Bowen Island.

Soil type: Cannell / Undifferentiated bedrock

1. Texture: Loam
2. Water holding capacity: Well drained
3. Nutrient holding capacity: Medium / low
4. pH: acidic

Crop Growth Implication

Areas with deep loam do exist within the 7RT label, some potential for these loams exist on the site. An expansive site review could be undertaken to identify pockets of loam hidden within the rocky escarpments and if they were found, and determined to be of sufficient size, and cleared of existing vegetation, the potential for soil-based agriculture does exist. However, this sort of development strategy does not appear to ally itself with the goals of the current owners and it is our recommendation that existing loam on the site be left to serve its current ecosystem functions.

Figure 13: Bowen Wild Site location and watercourses

Bowen Wild - Water

Drainage Requirements

Drainage on this site must be significantly managed to avoid runoff into the sea and riparian corridors.

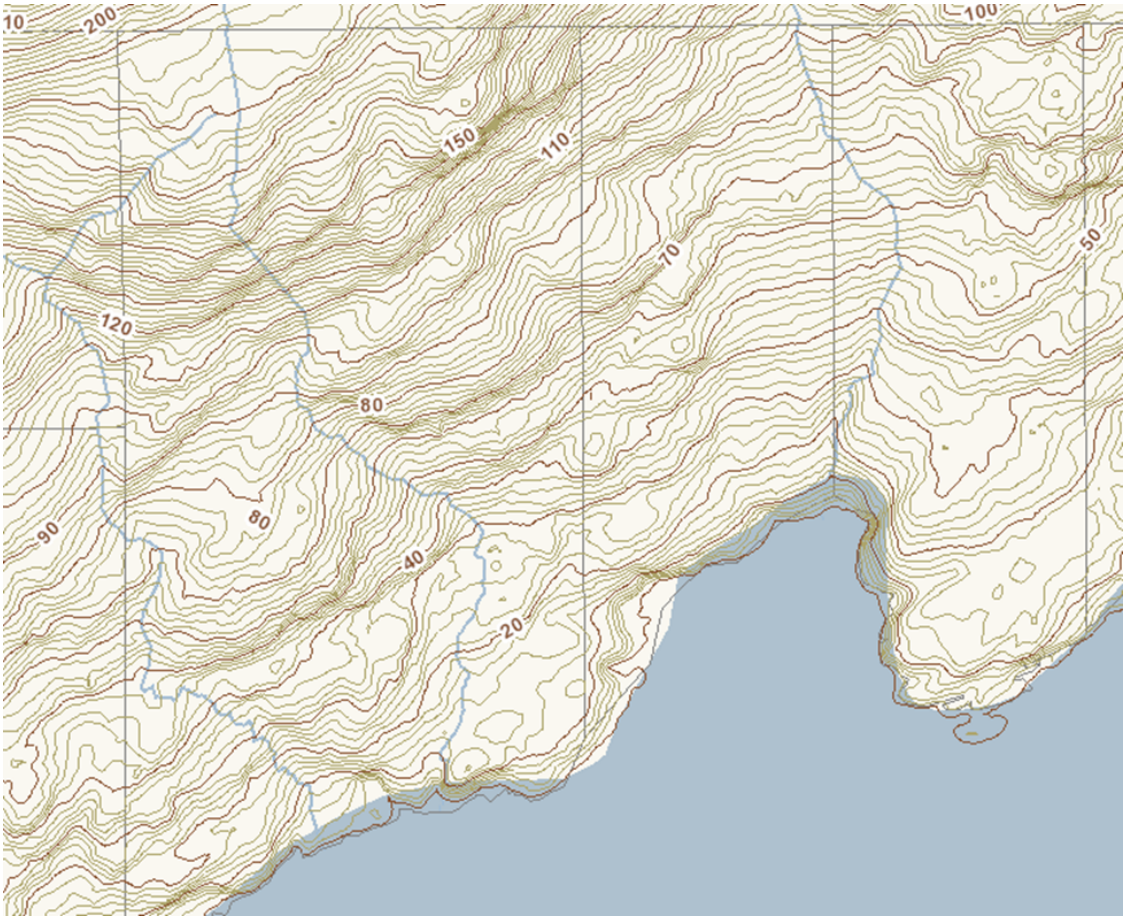
Irrigation Requirements

Due to the characteristics of the climate, significant irrigation would be required during the bulk of the growing season. Early spring and late fall crop production needs might be met, but it is unrealistic to count on summer rainfall matching crop needs.

Main Water Source

Water for the property currently located on-site is obtained through surface water runoff collection. In its current form, this meets the needs of a residential dwelling on site but would need to be significantly expanded to support an agricultural enterprise. Surface water collection is also being updated with the provincial new Water Sustainability Act on March 1, 2022. While domestic use is exempt, agricultural use of collected water will likely need a license.

Figure 14: Bowen Wild topography



Bowen Wild - Topography

The Bowen Wild site is a series of steep rocky escarpments leading down to the ocean shore. Flatter areas do exist, but they are limited in size and often with cliffs above and below. Three creeks cross through the property north to south, including Warwick Creek.

Vegetation

This site is currently covered by a mature coastal forest, housing a mixture of mature tree species including Arbutus, Douglas fir, Hemlock, and Red Cedar. Undergrowth is extensive and lush with salal, sword ferns, deer ferns and huckleberry.

Zoning

The zoning for lot 40 is currently RR 1. This Rural Residential Zone exists to facilitate rural and agricultural use of land within a rural setting. Agriculture and Horticulture are currently allowed within this zoning, as are accessory structures built to facilitate these land uses.

Bowen Wild - Site Visit Assessment

Site Perimeter

The perimeter Bowen Wild is not fenced in any capacity. The borders seem to be located within continuous mature forest.

Internal Site Access

Access to the site is via an extension of the Seymour Bay Drive Road. The road rapidly turns from paved to gravel and continues as a narrow and steep gravel driveway passing into the centre of the Bowen Wild property.

Utility Access

Table 6: Utility Access for Bowen Wild Site

Service	Available	Required	Current Connection Type	Distance to Proper Service
Water (well)	No	Yes	Runoff Collection	N/A
Electricity	No	Yes	N/A	N/A
Sewer	No	Septic	N/A	N/A
Trucking Road	No	Yes	2-way traffic with shoulder	1km

Management Considerations for Improving the Site

Light

The flat area near the shore, at the end of the driveway has very good southern exposure. If this area was to be cleared of trees and made available for production, there might not be a need for significant supplemental lighting.

Riparian Corridors/Marine Setback

The presence of three stream networks and a large amount of shoreline has led to a significant amount of the prime growing area falling into one of these two categories. Any agricultural production on the site would need to consider any impacts on these protection zones.

Figure 15: Bowen Wild vegetation

Internal Access

The current access to the Bowen Wild site would provide a significant challenge to any agricultural production at scale. The road would restrict access to larger vehicles such as larger delivery vehicles, and dump trucks. While it is possible to overcome this, it still poses a challenge and would serve to make the operation of an agricultural enterprise harder than with a better access road.

Overall Analysis and Recommendations

This site in its current form is not viable for a soil-based production system. The site poses significant challenges with respect to open land, light access, lack of soil, runoff considerations, utility, and water access. If the area was cleared, and space was made available near the shore, there is a potential for food production on the site.

Figure 16: Bowen Wild southern exposure

Based on how early in the development phase Bowen Wild is, it is our recommendation that the developers include in their long-term planning strategy a non-soil-based greenhouse. This could be used as a community amenity providing community members with fresh local food or used to support a small restaurant or Café on site. This greenhouse should be non-soil-based and have a water collection and recycling component involved. The developers mentioned the potential of a community hub at the entrance to the site. It is our recommendation that any agricultural production be integrated into this community hub during planning and construction to reduce the infrastructure cost.

While still in a speculative stage, the potential trail linking Bowen Wild with Snug Cove could provide greater access and linkage to local markets for any agricultural production.

Grafton Agricultural Commons

History of the Grafton Agricultural Commons

The Grafton Agricultural Commons (The Commons) is a 4-acre parcel of ALR land currently being managed by the Bowen Island 'FoodResilience' Society (BIFS). "The mission of BIFS is to build the skills, knowledge, networks, and structure needed to create a healthy, resilient, community-based food system on the island." BIFS took over the management of the Commons in May 2020. During that time, they have imported soil, built up raised beds, and begun feeding the surrounding community.

The site is currently included in a larger development project being undertaken by Primex Corporation and John Reid. The goal of the developers is to find a suitable community entity and transfer ownership of the Commons to them.

Figure 17: The Commons aerial view

Photo source: BIFS

The Commons - Soil Characteristics

The Commons falls under the CC label 4:4TA~3:3AT~3:5TPA and has been noted as containing class 123 soils. Class 1 to 3 is referred to as prime agricultural land with no to moderate limitations in use for crops.

Soil type: MURRAYVILLE

1. Texture: Loam
2. Water holding capacity: Imperfectly Drained
3. Nutrient holding capacity: Medium / High
4. pH: acidic

Crop Growth Implications

Without more significant soil testing on the site, there does not seem to be any significant limitations imposed on potential crop growth by the soils on site. Soil depth testing has been done in the primary garden areas and that too does not demonstrate any significant challenge to crop growth.

The Commons - Water

Drainage Requirements

The soils in the area around the commons are noted as having imperfect drainage.

Irrigation Requirements

Due to the characteristics of the climate, significant irrigation would be required during the bulk of the growing season. Early spring and late fall crop production needs might be met, but it is unrealistic to count on summer rainfall matching crop needs.

Main Water Source

The Commons has a high-productivity well on site. Adequate water is available year-round for vegetable production at the current scale. Close proximity to Grafton Lake should ensure the well remains a viable source of water for the site.

Figure 18: The Commons standing winter water

Photo source: BIFS

The Commons - Topography

The site sits at the base of a northwest facing slope. The current fenced-off growing area is reasonably flat with gently sloped edges, leading into the roadside to the northwest and creek to the east. The remainder of the site, currently (3) acres uncleared is more heavily sloped in the southeast corner. The northwest corner of the uncleared area borders on swampy in the winter, with significant water moving through the site.

Vegetation

Currently the site is divided into two main areas. The fenced growing area is reasonably clear of native vegetation, notwithstanding some cedar and fir trees near the parking lot. The remainder of the site is an aging Red Alder grove. Some Douglas fir exist intermingled within but the predominant species in the stand is the Red Alder. The understory is made up of a mix of native water tolerant plants such as sword fern, salmonberry, and skunk cabbage.

Zoning

The zoning for The Commons is ALR land.

The Commons Site Visit Assessment

Site Perimeter

The perimeter of The Commons is not fenced in any meaningful way. However, the area currently being used for food production and education purposes is deer fenced. Bordering the site is the Orchard Recovery Center, as well as forested area currently being developed. Water management up the slope by the developer should be noted as it will likely affect the wet area in the Alder grove.

Figure 19: The Commons potential greenhouse site

Photo source: BIFS

Internal Site Access

The fenced portion of The Commons is very accessible as it borders Grafton Rd. The site has a large driveway and small parking area. Double wide gates in the fencing allow for some vehicle access to the heart of the site.

Utility Access

Table 7: Utility Access for The Commons

Service	Available	Required	Current Connection Type	Distance to Proper Service
Water (well)	Yes	Yes	Yes	N/A
Electricity	Yes	Yes	Yes	Adjacent to Propery
Sewer	No	No	No	N/A
Trucking Road	Yes	Yes	2-way traffic with shoulder	N/A

Management Considerations for Improving the Site

Light

Light on the site can pose a challenge as the site's southern and eastern exposures have nearby stands of trees. This is exacerbated due to its low-lying location, especially in the winter when very little light is available. The possibility of tree removal by the owners has been mentioned and it would be our recommendation to remove some trees in order to facilitate improved year-round light access.

Land

The Commons has a long history of agricultural use, including the present food production by BIFS. Without more detailed analysis and soil sampling, the current regenerative production system being used seems to be a good fit for the site.

Overall Analysis and Recommendations

This site is viable for a soil-based production system. Due to the site's current successful management by BIFS, it is our recommendation that any installation of a greenhouse system be designed and installed to facilitate the success of the goals of BIFS at The Commons.

The Commons has a great potential to produce a significant amount of food for the Bowen Island community. The building up of soil health by BIFS is improving that capacity. If a food production-based model were made a priority for the site, it would be our recommendation that a more efficient set of growing practices be adopted. The reorganization of beds on-site and the introduction of a deep compost-based no-tillage system would be a good candidate as it aligns with the current regenerative practices of The Commons. Supported by a propagation greenhouse and a number of caterpillar tunnels this would allow for a significant extension of the growing season through improved heat capture and retention. As well these structures allow for the utilization of more vertical space through trellising and growth of high value high yielding crops.

Figure 20: The Commons access road

Photo source: BIFS

If the other three acres on site were to be cleared, there would open significantly more available land and increase light access on the site. A thorough understanding of how this would impact the water moving through the site to avoid erosion and contamination concerns, specifically of phosphorous into the nearby Grafton Lake should be a priority.

Arbutus Ridge

History of Arbutus Ridge

Arbutus Ridge is a 83-acre neighbourhood development on the West side of Bowen Island. Included within that development is a unique 10-acre parcel, which has been set aside for the creation of a community housing space for people with disabilities. The proposed vision for this space is a collection of cottages integrated into a working farm model. The farm would provide community space and give residents the opportunity to engage meaningfully with their community.

Figure 21: Arbutus Ridge Field, adjacent pond

Arbutus Ridge - Soil Characteristics

Arbutus Ridge, specifically the area outlined as the production field falls under the CC label as 7RT. This label means that the soils here are highly inappropriate for arable land or pasture and the limitation cannot be removed. This is true of the majority of Bowen Island.

Soil type: Cannell / Undifferentiated bedrock

1. Texture: Loam
2. Water holding capacity: Well drained
3. Nutrient holding capacity: Medium / low
4. pH: acidic

Crop Growth Implicaitions

Major challenges would exist if production on the site moved forward without significant soil remediation. Nutrient and water retention may prove challenging. The soils of the area identified as the production field looked to be low in organic matter, and quite rocky.

Arbutus Ridge - Water

Drainage Requirements

Drainage on the site will need to be managed in a way as to reduce the impact on the nearby stream but facilitate movement of standing water off of the site. A small pond was created, directly adjacent to the outlined growing area. Common Rush was observed growing throughout the production field. In conjunction, this indicates the potential of a very high water table perched on top of the bedrock. More testing will need to be done to confirm the exact details of this and its fluctuation throughout the growing season.

Irrigation Requirements

Due to the characteristics of the climate, significant irrigation would be required during the bulk of the growing season. Early spring and late fall crop production needs might be met, but it is unrealistic to count on summer rainfall matching crop needs.

Main Water Source

This site has two potential sources of water. Currently, it is being serviced by the municipal supply. The ability to drill wells is also an option if deemed necessary. Currently, no wells exist on this site, but nearby wells present a flow rate of 15 gallons per hour (gpm).

Arbutus Ridge - Topography

The site is a reasonably flat area, of approximately 1 acre. This is perched on a shelf of a predominately southeast-facing slope. Due west is a large rocky outcropping that stands over the production field.

Currently, the site is largely bare other than a mixture of low-lying and grassy species. This includes bracken, small tree seedlings, creeping blackberry, and common Rush. The area surrounding the clearing is second-growth Douglas Fir.

Figure 22: Arbutus Ridge field site

Zoning

This site meets zoning requirements, and an appropriate plan has been approved by the municipality, therefore posing no barrier to food production on site.

Arbutus Ridge - Site Visit Assessment

Site Perimeter

The perimeter of the site is not currently fenced. During the start-up phase of the site fencing to keep out pest species will be needed, but later assessments on the trade-off between community access and pest pressure might be needed.

Internal Site Access

Currently, significant access to the production field on-site is lacking. However, the site plan includes a 6.1 m wide gravel access road. This would provide more than enough access for any proposed production system.

Utility Access

Table 8: Utility Access for Arbutus Ridge Site

Service	Available	Required	Current Connection Type	Distance to Proper Service
Water (well)	Yes	Yes	Municipal	N/A
Electricity	Yes	Yes	N/A	Adjacent to Propery
Sewer	No	Septic	Sewer written into plan	N/A
Trucking Road	No	Yes	Written into plan	N/A

Management Considerations for Improving the Site

Light

Current light access to the site during the growing season is limited due to the surrounding forest. It would be our recommendation that mature trees all around the field be set back by at least another 25m, but more is always better. It is also our recommendation that trees in the southern exposure be thinned in some capacity.

Land

The Arbutus Ridge site does contain a rocky field of thin soil. We recommend that this soil be significantly remediated by the removal of large rocks and the incorporation of large volumes of imported organic matter.

Figure 23: Arbutus Ridge soil exposure

Overall Analysis and Recommendations

This site is viable for a soil-based production system. While the native soil is somewhat lacking, the vision for the site as put forward by the developers leads us to believe that a remediation is a viable option moving forward. It is our recommendation that a compost-based low tillage system mixed with raised bed production/therapy system be the direction moving forward.

The developers' plan situates the site as a community asset, with joint goals of both production and community amenity space. This plan allows for the creation of a community-owned farm, acting as the green space and community hub for the development. Examples of this model do exist, including locally, as reflected by the Southland Community in Tsawwassen.

Due to the small production space available, an emphasis should be placed on high turnover and high margin crops. Integration of a café or market stall within the community will provide an easy sales outlet for this type of system. On-site housing provided to any potential farmer further improves the outcomes of soil-based production at this site. We would recommend identifying a farmer early and including them in the design process.

Xenia

Located on the north end of the Island, Xenia is a 38-acre parcel of ALR land housing a sanctuary retreat. The site is made up of a mixture of open pasture, currently used for horses, and forested areas. The site gently slopes to the southeast with most of the pasture following a low point along this slope. The potential for soil-based agriculture exists on the site. The main agricultural challenges of the site include sunlight in the low-lying pasture areas, soil quality, access to water, and incorporation with the current business model.

The property owner indicated an interest in the inclusion of agricultural activities on the site. Specifically they suggested forest-based mushroom production. However, they do not have the capacity to undertake any agricultural initiative on their own. With the right person coming in to manage a new project, the property could contribute to Bowen Island's food security.

This site was not originally included in the plan of this report, an in-depth analysis of this site was therefore not conducted. However, an abridged analysis of the size is presented in Table 9.

Figure 24: Xenia general site characteristics

Site Assessment Summary Analysis

Table 9 presents a summary analysis of the five sites. This allows for quick assessments and comparisons between sites. Six key evaluation criteria include soil, water access, light, runoff concerns, space available, and land access. We used a ranking system between 1 – 5 for each criterion, with 1 being the lowest and 5 being the highest. The total score across all creteria is 30 points.

Table 9: Summary analysis for the five Bowen Island sites, assessing potential for food production

		Lot 40/ The Cape		Bowen Wild		Grafton Agricultural Commons		Arbutus Ridge		Xenia
Soil	1	No significant native soil on site	1	No significant native soil on site	4	Soil based agriculture currently present on site, soil being upgraded	3	Soil on site is thin and rocky	4	Soil on site exists, including longterm pasture
Water Access	4	Tested wellhead on site	1	Currently only collected gravity driven water	4.5	Wellhead on site and currently in use, flow rate unknown	5	Municipal Water in place with well potential	3.5	Well on site, flow rate unknown
Light	3-5	Good midday sun, bad morning and evening	3-5	Currently lacking significant light access, but site has potential if trees are removed	4	Good sun for majority of day, lacks significant winter light	3	Clearing needs thinning and tree removal to provide proper light	3-4.5	Depending on the location, light access changes drastically
Runoff Concerns	1	Significantly sloped and rocky nearby riparian corridors	2	Identified site is very close to shoreline, as well as nearby creek	3	Nearby ripirian corridor could be too close to farm site	3.5	Some considerations with nearby stream	4.5	Some water movement on site, but minimal in most potential growing areas
Space Currently Available	2.5	Small cleared building space on extension site	1	Limited cleared area for agriculture on site	4	Space is available and has been outlined by BIFS	3.5	Clearing is available, but need expansion to meet community goals	4	Space is available, but details would need to be confirmed
Land Access	2	Very expensive land	3-5	Developers interested, but still early in planning stages	4	Community group is very interested, but acts as third party	4	Farm is built into community plan, but acts as a third party	2-4	Owner is interested, but exists as third party
Total Score (max. 30)	**13.5-15.5**		**11-13**		**23.5**		**22**		**21-24.5**	

According to our analysis, two sites show promising short-term potential for soil-based food production: The Grafton Agricultural Commons (The Commons) and Arbutus Ridge. Both sites have adequate physiological characteristics which will allow soil-based agriculture to take place without requiring too much remediation. Water, and sunlight are available and land tenure has been secured. The Commons is currently being managed by the Bowen Island Food Resilience Society (BIFS), which represents a powerful community force striving to improve the lives of Bowenites. This level of ongoing community engagement and passion cannot be understated when discussing the viability of a given piece of land. Much like the Commons, the Arbutus Ridge site has a powerful driving force behind it. The vision and integration of the agricultural space with that of a housing system for adults with disabilities will serve to bring this project to fruition and ensure agriculture succeeds on the site.

The other two sites, The Cape and Bowen Wild, demonstrate some of the major land constraints on Bowen Island. Native soil is lacking in any significant way and any soil-based agricultural enterprise faces some major challenges. However, these sites do represent the potential for non-soil-based agriculture. We believe that for these two sites to play a key role in supporting Bowen Islands' food security aspirations, non-soil-based food production practices should be investigated. More importantly, the discussions on non-soil-based food production should be integrated early into their community development plans so that appropriate facilities and arrangements can be established strategically.

IV. Food Production Recommendations

In this chapter, we select two sites as examples to demonstrate how the sites could be adjusted to produce food to increase Bowen Island's food production capacity. The two sites that we selected are the Grafton Agricultural Commons (The Commons) and Arbutus Ridge Development (Arbutus Ridge). Our recommendations are based on the specifics of the individual sites, as well as best practices identified by producers across the region.

The goal of these recommendations is twofold. The first is to help the owners and users of the sites with their future planning efforts. The second is to provide suggestions that might alter the way other Bowen Island landowners view their own properties in relation to their potential agricultural capacities.

Final decision-making on recommendations made in this report is entirely up to the landowners and should be undertaken after increased levels of site assessments, market assessments, and business planning. The two chosen sites for this research project should reinforce the concept that, for places like Bowen Island, food security can come in the form of a network of small producers coming together to meet the needs of a community. In the face of disruptions to the global supply chain, and increasing climate uncertainties, small farms like the examples here demonstrate significant resiliency and promise for the future.

Recommendations for Grafton Agricultural Commons

Bowen Island FoodResilience Society's (BIFS) mission is to "build the skills, knowledge, networks, and structures needed to create a healthy, resilient, community-based food system that addresses the climate emergency and social justice issues". The Grafton Agricultural Commons (The Commons) is a key piece of achieving that mission. The Commons serves as the support and education of backyard growers, the support of existing and future farmers on Bowen Island, and the production of locally grown sustainable food on Bowen Island.

The Commons has a significant potential to do these things and our recommendation for the site is a transition to a more efficient set of growing practices. Alongside the transition of growing practices, we suggest the creation of a high tunnel on-site to support the education and growth of The Commons. We also suggest BIFS examines the possibility of The Commons serving as a marketing and community hub for the greater Bowen Island agricultural community. These changes will serve to lift The Commons up to a place of economic and long-term success. Alongside their own success, The Commons will integrate more meaningfully into the community and ensure its success as well.

Field Redesign

A major component of our vision of The Commons would be a redesign of the growing field. Currently the main growing field is laid out in a way that fails to maximize potential growing space. We suggest a transition to a standard square field shape, with a raised bed system. Expansion of the field slightly would allow for 2 sets of 20, 50' long beds, on a north-south orientation. On a 32" wide bed spacing with 24" pathways this would provide 5,333 sq ft of bed space on the site. While 24" pathways constitute less space efficiency, they leave a lot more working space for young and old volunteers.

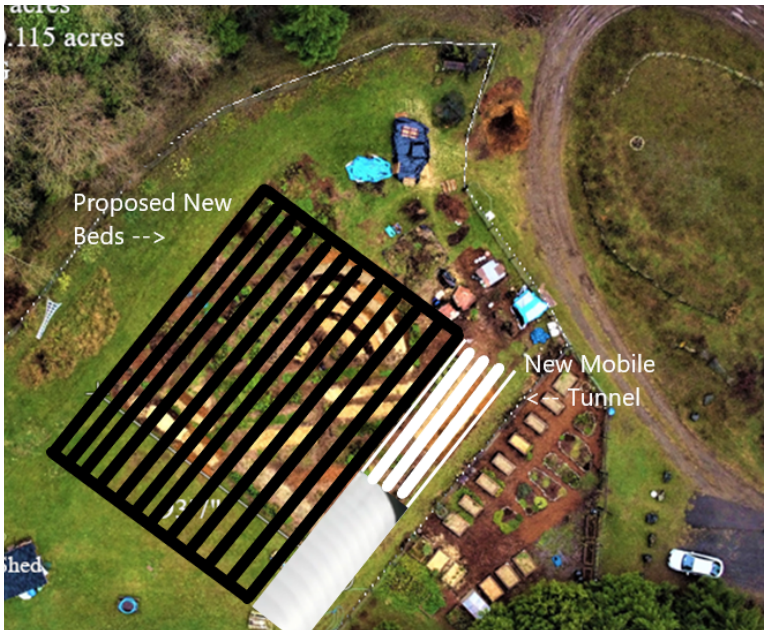
This change in bed shape would not only allow an increase in production but also an adoption of more efficient growing practices and technologies. To educate growers and future farmers on the island, the demonstration of efficient, economically viable, growing practices is of the utmost value.

Alongside the change of bed and field shape, we suggest the adoption of a compost-based no-till raised bed production system. This set of growing practices prioritizes soil health and maximizes carbon sequestration alongside an efficient production system. This system is demonstrated as viable on many scales from large farms such as *Local Harvest* in Chilliwack to the backyard market garden scale such as *Sattin Hill Farm* in North Carolina, USA.

Mobile High Tunnel

Our recommendation alongside the field redesign would be to purchase and install a mobile high tunnel. The adoption of a mobile high tunnel system would serve to meet several of BIFS needs without sacrificing efficiency or sustainability. A mid-sized (20x50') high tunnel that could transfer between two sets of beds would allow The Commons to have the same tunnel function for early season propagation, main season indoor crops, and overwinter brassicas. This extends the functionality of any high tunnel purchased over the course of a full growing season without the need for expensive and inefficient lighting systems. This type of mobile high tunnel functionally doubles or triples the covered area for a growing season. The tunnel can be moved on and off crops as they either need, or no longer need the added protection a high tunnel provides.

Figure 25: Proposed field redesign and mobile high tunnel



The image suggests an approximate scale of the proposed bed system and mobile high tunnel. In this image, the high tunnel is placed over the beds closest to the main road. Technically, the high tunnel can be placed over any beds. Therefore if there are concerns regarding the tunnel blocking the view of the farm, it can be moved toward the other end of the field.

Any final placement decisions would need to be made after site is fully measured and marked out.

The placement of the high tunnel is over top of the main field, providing the maximum amount of space for a two-plot mobile tunnel. Having a mobile tunnel over the field also addresses some common concerns about high tunnels including, disease management and salt buildup. With good planning The Commons can achieve a level of crop rotation, meaning that warm-season crops and winter crops can have a one-year break before needing to be grown in the same place. Similarly, by exposing different parts of the rotation to winter rains each year can remove the potential buildup of any negative salts, or fertility, inside the high tunnel.

The track systems are stable and do not increase a significant risk even in high wind, or snow load situations. The Kwantlen Polytechnic University's teaching and research farm at the Garden City Lands has several of these mobile high tunnels. Due to some concern for high winds, they went above and beyond the standard and installed ground anchors. The farm buried large highway lock blocks, and used those as anchor points, further increasing the system's stability.

Figure 26: Mobile high tunnel system at the Sustainable Agriculture and Food Systems farm at the Garden City lands, Richmond

Photo source: KPU

An example of the growing season would be as follows:

Spring: The high tunnel is located over Plot 1.
During the early growing season, the tunnel would function as a propagation house, with heated tables, providing the supplemental heat needed to start plants for the growing season. Some space would be available for early spring crops in the ground such as radish, spinach, or mustards.

Summer: The tunnel moves to Plot 2.
As the season warms up and the need for a propagation house diminishes. Plot 2 will be used for growing the warm season crops, tomatoes, cucumbers, and peppers. During the late summer, a winter crop of brassicas and salad greens will be sown into Plot 1.

Fall/Winter: the high tunnel moves back to Plot 1.
Warm-season crops are often finished for the year in late September or October. The tunnel will be moved back to Plot 1. There it will provide winter cover and supplemental heat for the brassicas and greens which were sown in Plot 1 during the late summer.

Figure 27 illustrates the locations of the tunnel in green over plots 1 and 2 throughout the year.

Figure 27: Example of mobile tunnel locations

	Spring	Summer	Fall/Winter
Plot 1	Propagation Space		Overwinter crops (eg brassica, greens)
Plot 2		warm season crops (eg tomato)	

Figure 28: A mobile tunnel in the spring time at the Sustainable Agriculture and Food Systems farm at the Garden City lands, Richmond

Lighting

We do not recommend supplemental lighting. We recommend a strategy that involves growing winter brassicas and then carrying them over through the winter. Significant light would be required to continue winter growth, which is in our estimation not viable at this scale or with potentially outlined setups. Using some average greenhouse calculations, the average cost per square meter of lighting for lettuce production, during the winter months, would be in the range of $6.25 – $7.10 at $187.5 per month on the low end. If lettuce was priced at 7.50 per lb, one would need to grow 25lb per meter per month. While this would provide salad greens for the community in the winter, this rate of production would be very challenging and likely would result in a financial deficit.

From a seed starting perspective, February is the earliest start of any vegetable seeds. If one were to start seeds this early, the amount of light they need would be minimal. If lights are needed for starting early seeds, our recommendation would be to pursue starting the seedlings indoors under lights and transitioning them into the high tunnel in March. For starting seedlings, we would suggest investing in the construction of DIY heated greenhouse tables (depending on scale a germination chamber). Heated propagation benches are cheap to create and can last many years when well taken care of. At the current scale of production at The Commons, this typically is all that would be needed and would remove the need for expensive heating infrastructure. If a mobile system is adopted this would further free up the need for any permanent in place heating infrastructure.

Marketing

To ensure the long-term viability of The Commons, our recommendation is to reorganize the sales strategy and the production around that strategy. Due to the high visibility location of The Commons, being on a major thoroughfare of the island, we suggest the creation and operation of a roadside stand. This stand would serve to draw people in providing potentially significant sales, as well as expose them to BIFS vision and programming.

Beyond selling produce, the potential also exists for cooperative marketing, providing other producers on the island a place to sell their products alongside those grown at The Commons. Another possibility would be the creation of a small weekly farmers' market on-site, providing even more space for other growers to increase their sales. This plan would meet many of the site's goals, increasing community participation, and forming something of a central hub around which the Bowen Island agricultural community could rally. Such a collaborative approach could potentially increase sales of other on-island producers – competition now turns to collaboration.

Another adjustment is on the types of crops and their volumes of production. Farms the size of The Commons have many advantages; high levels of management, soil health, dense plantings, equipment, and production systems designed for fast turnover crops. The success of enterprises at this scale relies on their ability to take advantage of these benefits and focus on crops that align with them. We do not believe growing field crops at any significant scale will lead to long-term economic viability at The Commons. The crops being grown at The Commons should have a few specific purposes. For example, select crops should ensure the economic success of the project. That could be through specific niche crops not currently being grown on the island, produced at a scale for specific customers. In another example, select crops should serve to meet the educational needs of The Commons. A growing calendar with yearly workshops should be developed so as to clearly integrate the teaching and growing aspects of the farm.

Recommendations for Arbutus Ridge

The Arbutus Ridge Development is in the process of creating a unique community living situation on Bowen Island. The goal of this subsection of the development is a cluster of cottage-style homes for seniors and adults with disabilities. Associated with the cottage community will be a small 1 to 2-acre therapy and production farm (Figure 29). The primary goal of the farm will be to provide members of the community with accessible, safe, work and play space, acting as a green space central to the community. The opportunity also exists for there to be a storefront or café located nearby to act as a direct market stream for the farm and provide further employment opportunities for residents.

Many other therapy farm models, such as *Providence Farm* or *A Farm Less Ordinary* have an emphasis on human-scale regenerative growing practices as the systems used to manage this type of agriculture is much more accessible to individuals with disabilities. As well these types of farms integrate well with communities providing a diversity of ingredients for things such as cooking classes or value-added businesses. This section provides some specific suggestions that we think will ensure the long-term success of any agricultural enterprise based on this site.

Figure 29: Arbutus Ridge development and proposed farm site

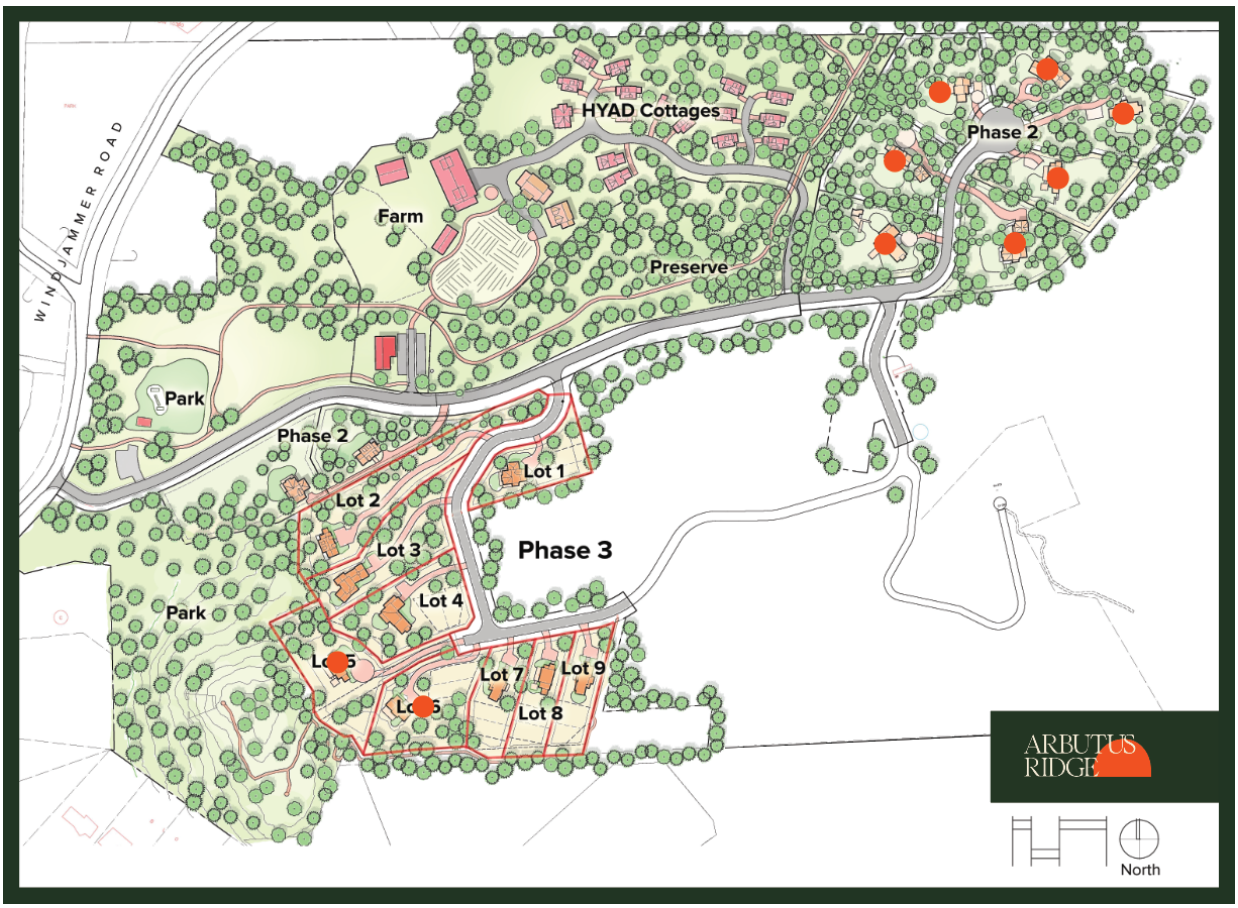


Photo source: Arbutus Ridge

Field Layout

Due to the unique constraints on the farm of acting as both a production and therapy site, we suggest splitting the farm acreage up into two zones, one being a production zone made up of permanent in-ground raised beds, and the other a community use space, made up of raised planter style wooden beds. The exact split would remain dependent on the developer, but we would suggest leaving at least ½ an acre of production in the plan. This half acreage should be able to provide at least the part-time employment of a farmer for the site.

While the bed numbers, size, and spacing would ideally be determined by the farmer running the site our suggestion would be to increase the pathway size slightly beyond typical. For example, Jean-Martin Fortier suggests a 32" wide bed with an 18" pathway, we would encourage a pathway closer to 24". This is entirely to support access for those with mobility challenges utilizing the space. Similarly breaking the beds up into 50' sections instead of a standard 100' can serve to reduce the monotony of working on any given task.

Soil

Natural Vegetation and site history lead us to believe the site will need significant remediation prior to any significant vegetable production. While ideally this would be achieved through cover cropping strategies, or the importation of local organic matter, it is unlikely this would match the proposed timeline for the site. As such we suggest that a compost soil mixture be imported and used to raise up the in-ground beds. An application of at least 2" would get things going and facilitate success in the first few years. Broad-spectrum soil testing should be undertaken and remediation based on the results of the soil tests should be a priority.

On Farm Housing/Farmer

To ensure the long-term success of the farm, we recommend finding and employing a farmer early in the development phase of this project. The more this person can be included in the planning process, the greater the buy-in from a future employee or business owner. In the last number of years, significant effort has been made in the province to support matching farmers and land. Much of this work is being done by Young Agrarians. It would be our recommendation to contact their land matching service and begin finding someone to manage the farm site.

A major challenge for any farm operation on Bowen Island will be housing. We would recommend including in the plan space for on-farm housing and include that in any employment contract. This will further support the success of long-term farm manager employment, a key component when starting a project like this that diverges from the needs of a typical farm enterprise.

Staffing for this project should start out small with just the initial farmer brought in during the planning phase. Depending on the level of infrastructure investment one full-time farmer may be able to manage this site with the help of the residents from the cottages. This would depend on how many labour-saving techniques are adopted and what level of marketing is undertaken. If most products are sold on-site this can reduce the need to hire part-time market staff. As well if significant ground cover and reusable landscape fabric weed barriers are used, many salad crops can be grown almost entirely without weeding needed. In organic production systems, labour tends to be the highest cost with the bulk of it being weeding labour.

Infrastructure

Included in the farm planning process should be some poly houses for the site. With increasing variability in weather patterns, farmers are more and more relying on these covered areas to extend their growing seasons. It would be our recommendation to include three structures in the initial plan. One standard high tunnel and one caterpillar tunnel.

High Tunnel

The high tunnel should be approximately 35x80'. This size structure is standard for many farms and provides ample space for both indoor production of warm season crops, such as tomatoes and cucumbers, as well as the room necessary to start transplants in the spring. Electricity, water, and some form of heating for the shoulder seasons would be a requirement for the high tunnel so placing the tunnel near those utilities would be important.

Figure 30: High tunnels at KPU Farm Schools

Spring seedlings

Tomato and lettuce plants

Caterpillar Tunnel

The Caterpillar tunnel, a seasonal hoop house, has in the last few years become a staple of any market gardener's toolkit. These simple structures maximize a farmer's ability to produce spring and fall greens, which integrates very well into a café's needs. The cost of these structures (as low as $3,000) means that they can be paid off within a single year's production. It would be our suggestion that at least one of these tunnels be purchased and placed on-site for the first year of production. Either two 50-foot tunnels or a larger 100' tunnel would make the most sense. The width depends on the company you purchase the tunnels from, but a typical width from either Dubois in Quebec or Farmers Friend in the US is 14 feet wide.

Figure 31: Caterpillar tunnels at KPU Farm Schools

Walk behind tractors (BCS) in front of caterpillar tunnel frames

Covering the caterpillar tunnel frame with plastic sheet

Another key infrastructure component to keep in mind during planning is a wash station or shed, and a cooler space. Without space to properly clean and store vegetable harvest excessive pressure is put onto the farmers and quality of life is threatened. Some existing diagrams of the proposed farm space include a barn, which would be an ideal location for this. Other option includes shipping container retrofits, such as one located on the Tsawwassen First Nation Farm School site.

Figure 32: Undercover areas for processing vegetables at KPU Farm Schools

Livestock

Many community-based farms have some form of livestock on site. We think this should be considered for this farm. While the site would not allow for any significant pasturing, there does exist room for a small chicken coop and run. A potential small flock of 25 birds would need a minimum indoor space of 5 square meters and an outdoor run of 7 square meters. A small flock of this size with proper maintenance would provide both a secondary income stream for the farmers, but also a very enriching work opportunity for the residents of the community. Working the barns, washing and packing eggs, and caring for the hens are all simple, but important tasks that can provide the important feeling of caring for another living creature.

Scale Appropriate Crops

With just a potential half acre of production on the site it will be important to plan accordingly. Farms of this size rely on maximizing production through the growth of fast-growing high turnover crops. Salad greens, radishes, turnips, summer squash, carrots, can all be highly profitable and quick crops to grow. These crops also align themselves well with the needs of a small market or cafe. The key to growing these crops effectively is to develop efficient systems that reduce weeding labour and facilitate quick turnover of the beds through things like flame weeding, power harrows, or tarping.

Many examples of this type of agriculture exist locally, such as *Zaklan Heritage Farm* and *The Plot Market Garden*. The long spring and fall seasons on Bowen facilitate and extended harvest window for many of these crops.

Summary

While similar in size, and both seeking to serve as community hubs, The Commons and Arbutus Ridge have unique characteristics that set them apart. The Commons has been in existence as an agricultural site for many years, and BIFS looks to use the site as a mechanism of driving food security on Bowen. The Arbutus Ridge Farm is brand new, and inward facing looking to take care of its own community first. Our recommendations should serve to inspire these, or other similar sites, and be taken as one of many potential options to start an agricultural enterprise. The vision and resources of the landowners should always take priority. Soil sampling, business planning and observations over the course of an entire season should be undertaken before breaking new ground. Bowen Island has many similar lots with small acreages waiting to join the network of food producers on the island. The recommendations given here are a good starting point when thinking about what these small acreages could look like.

At the Institute for Sustainable Food Systems we unequivocally believe that soil-based, regenerative agricultural systems are the way that our planet must move to feed itself now and in the future. As such our recommendations are shaped by that world view. Included in this umbrella of production practices are systems like organic, no till, no spray, and regenerative. The foundation of these systems is improving the quality of the land and environment the farming takes place, improving social outcomes in the community the farming happens, and providing economically viable work, as well as affordable food for the communities the farm interacts with.

V. Conclusion

Bowen Island faces many of the same challenges much of British Columbia faces, the predominant of which are the high cost of land and the limited availability of land with high agricultural value. This leads to significant problems when trying to find available land with high levels of agricultural suitability. Despite having a small Agricultural Land Reserve (ALR) area, the Agricultural Land Use Inventory database revealed that there are over 50 acres of ALR land that could be used for agricultural purposes. This amount if utilized is theoretically enough to produce 11 staple crops to feed the island's population for the next 10 years.

Food production; however, does not have to occur solely on ALR lands. Other lands outside of the ALR may have the potential for both soil-based and non-soil-based food production. In this study, we investigate five different sites on Bowen Island and selected two as examples to demonstrate what soil-based food production may look like on Bowen Island. The first is Grafton Agricultural Commons (The Commons, currently operated by the Bowen Island FoodResiliency Society, BIFS) located on ALR land. Another is Arbutus Ridge Development, located outside of the ALR.

The Commons is a small site with an agricultural past and is being run by BIFS as an education garden. One of this site's goals is winter production. We suggested a field redesign and an addition of a mobile high tunnel system. The Arbutus Ridge site is planned as a community-centered, mixed production farm. There we suggested following a successful small-scale system of raised beds and a caterpillar tunnel to extend the growing season and engage with community residents.

These two sites are great examples of one big challenge on Bowen which is plot size. Many plots both in and out of the ALR have been broken down into small parcels (often less than 10 acres). Because of this, unless significant land ownership changes happen, we envision the future of agriculture on Bowen Island as a mosaic of small producers. Small farms are diverse, and when intensively managed can be much more productive on a per acre basis than larger farms**.** As well the capital cost associated with starting these smaller farm businesses is much less of a burden for any given individual. To further alleviate the risk associated with starting a new agribusiness we suggest a set of shared infrastructure, both physical and intangible. Shared physical assets, such as propagation space, tractors, implements, and market equipment significantly reduce the need for upfront capital for the farmers and improves the efficiency of their businesses. Bowen Island being a small island reduces many of the hurdles associated with this level of shared infrastructure in other locations.

Shared marketing is another significant aspect of this vision. With marketing being managed cooperatively, this reduces the burden on each farm, while at the same time serving to meet the needs of larger institutional clients on the island. While something like a restaurant often needs more than one small farm can produce, if the farms pool their goods and market together, the marketing coop can meet the restaurant’s needs. Shared marketing would also reduce competition between farms and allow farms to focus on the crops they grow best. This shared marketing strategy will also allow for the creation of a Bowen Island brand, which will improve off-island sales, a key component of financial success as these farms first get off the ground.

Looking past vegetable production provincial programs such as Farmgate and Farmgate Plus licenses and BC's Food Hub Network could help address Bowen Island's need for an on-island abattoir and food processing facility (Sage, 2019). With the creation of a shared processing facility farmers, or a producer coop could capture even more of the food dollar with the creation of value-added goods such as pickles, or soup mixes. As well the creation of an on-island abattoir would serve to alleviate the biggest concern of most Bowen livestock producers, accessible slaughter.

Another added benefit of this model of cooperative small farms is that the shared infrastructure model provides significant value as the farms can function in a very modular way. As such different parts of the farm infrastructure could be moved between potential sites as tenure changed. A system like this leaves very little permanent on any given site, allowing for more success with shorter-term leases. This lowers the burden that high land costs currently pose.

It is possible to feed the world, nourish our communities, via the substantial regionalization of our food systems, and the aligning of them to the environmental and physical capacities of place. Indeed, this may very well be the key to feeding the world - that which the global-industrial system has unequivocally failed to do so. Regardless, the sustainability of our food system will substantially derive from its adaptability. Adaptability is derived from manifold variation (not from monolithic uniformity). And adaptive capacity confers resilience - the resilience of our food system or that of any other human enterprise. Nature, unequivocally, teaches this to us. Thus localization/regionalization of our food system(s) in any form, of any magnitude, contributes to community resilience and humanity's sustainability.

This study was undertaken by the Institute for Sustainable Food Systems and THRIVE Bowen, supported by a group of passionate individuals. It constitutes a small effort but a critical leap toward community food security and resilience; effort and action for all communities - large and small - to emulate. We hope that by increasing on island food production and capacity, Bowen Island will discover and reveal the community's economic and social capital development advantages of doing so. In this regard it is important to realize that small steps lead to bigger ones, small pieces add up. All are meaningful and important.

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APPENDIX 1

NON-SOIL-BASED FOOD PRODUCTION OPTIONS FOR BOWEN ISLAND

CARBON FREE GROUP
CONNECTED INNOVATION

Project Name: THRIVE non-soil-based food option

Task No / Proposal No.	Thrive
Status	Open
Client Contact Name	David Adams (davidjadams(at)shaw.ca)
Client Name	THRIVE BOWEN

Document Production / Approval Record

	Name	**Date**	**Position**
Prepared by	Jae Mather	31st March 2022	CEO
Final Submisson	Jae Mather	2nd June 2022	CEO

Document Revision Record

1	31st March 2022	Draft Issue
2	7th April 2022	Revised
3	2nd June 2022	Final Version Issued

Disclaimer

This report is indicative of potential costs, outputs, employment, production, risk, return on investment, and payback periods. It has been complied with the best available data at the time of the writing of this report. Further detailed technical and business analysis is recommended if interested in pursuing the options outlined in the report. Carbon Free Group does not accept any liability for any element of this report and is here to assist in helping to ensure that this alignment is true to and fit for purpose.

Declaration of interest: The Carbon Free Group's Rural Transition Alliance Programme is currently introducing the Growcer container farm solution into our projects in the UK and a business relationship is being established in that regard. There are no financial or other benefits to Carbon Free Group if any business were to take place with the THRIVE Bowen projects.

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INTRODUCTION AND BACKGROUND

PURPOSE

This report sets out to explore land-based, non-soil food production options that have the potential to be viable on Bowen Island for THRIVE. THRIVE's goal is to increase food resilience and food production systems on Bowen Island. THRIVE defines "community" as being "concentric circles of stakeholders within and beyond Bowen Island, based on levels of engagement with the project and its intentions. The innermost ring being the most engaged and the one that will become the cooperative/society/etc.

Currently, local food production is minimal and at best, only a few percentages of total food requirements are produced on the island for the island's residents.

Food production on Bowen Island is currently minimal due to several factors:

- Land prices and cost of living are very high on Bowen Island, this leads to several challenges:
  - Financial viability of food production
  - Food-based employment typically is not well paid
  - Accommodation costs are very high and challenging to find

- Agricultural land availability is minimal

- The outside growing season for most agricultural crops is approximately 222 days a year (just over seven months) and as such, there is a long period of time (almost 5 months) where food production is not very active. Greenhouses serve to increase the growing season, which helps to alleviate this challenge to a degree

- Small population on Bowen Island of approximately 4500

- Access to the large local marketplace in Vancouver

Non-soil-based food production, or Controlled Environment Agriculture (CEA), helps to increase food production and local climate resilience on Bowen Island in multiple ways:

- Managed and controlled environments that are not dependent on the growing season or external sunlight or temperature

- Very high levels of predictability:
  - Electricity consumption
  - Water consumption
  - Waste production
  - Produce/product production
  - Year-round employment that is often higher skilled and thus higher-paid
  - Cost control reliability

- Sustainability:
  - Climate change is set to continue and amplify extreme weather events (drought, smoke, heat waves, cold spells, wind, rainfall, and seasonal predictability), as such reducing the reliance on external weather conditions serves to increase resilience and decrease exposure
  - Local food reduces transport impacts and increases access to fresh produce/products year-round
  - Containerized and vertical farms typically reduce water requirements by 80-95% per kg of produce
  - Recirculating Aquaculture Systems (RAS) can produce organic fish that is free from heavy metals, pesticides, herbicides, microplastics, and significant reductions in antibiotics

- Predictability helps to ensure the commercial viability as performance is much more predictable than conventional farming
  - Business planning/modeling
  - Return on investment
  - Payback period
  - Invest ability

The report starts by describing the key main non-soil-based food production options that are the most viable for potential applications on Bowen Island. Viability is assessed based upon a combination of proven technical/output performance, mature supply chains, access to expertise risks assessment, and economics (costs, operations & maintenance, return on investment, and payback periods).

KPU is concurrently carrying out a soil-based food production assessment for Bowen Island that further serves to inform food production options for the island.

5 sites were evaluated on Bowen Island:

  - Arbutus Ridge
  - Xenia
  - Bowen Wild
  - Grafton Commons
  - The Cape

PROCESS

A wide variety of non-soil-based food productions options were evaluated for this report, listed below is a sample of some of the main providers and their solutions. Within this space there is a great deal of innovation occurring. This report has focused on those that have built a track record of financial viability (e.g. reasonable return on investment that provides robust and realistic returns for investors, reliable food production volumes, robust operational cost clarity, under 12 yr. paybacks) and quality elements (robust demonstrated designs in place in real work applications, multiple years of project applications, proof of performance, experience operating in similar markets for product sales, experience operating in similar regulatory and permitting environments, interest in working on Bowen projects, etc.). What follows is a summary of some of those solutions that, when evaluated with the available information, appear to offer the most promise for viability on Bowen Island from a technical, financial, and social perspective.

Decision-Making Framework Overview

Name	Type	Track Record	Projects Developed	*Interest in Working with Bowen	Cost-Effective	ROI	Experience working in a similar regulatory and permitting environment	Applicable on Bowen	
Growcer	Container Farm	4yrs	36+	Y	Y	Good	Y	Y	Featured in this report
Bright Greens	Container Farm	Y	1 very successful	N	Y	Good	Y	Y	Similar to Growcer
Terra Cube	Container Farm	?	?	N/A	?	?	?	?	Did not respond to requests for information
Crop Box	Container Farm	Y	Many	N	Y	Good	N	Y	USA based company that is similar to Growcer
Cubit Farm Systems	Container Farm	Y	Many	N/A	Y	Good	Y	N	Large-scale systems optimized for commercial production. They require 14 container farming units at minimum

Good Leaf Farms	Vertical Farm	11yrs	3	N	Y	Good	Y	Y	Large scale interested in urban applications
Nu Leaf Farms	Vertical Farm	Y	1	N/A	Y	Good	Y	Y	Large scale interest in urban applications
Living Earth Farms	Vertical Farm	Y	1	N/A	Y	Good	Y	Y	Large scale interest in urban applications
Habitats	RAS + Vertical Farm	4 yrs	1 very successful	Y	Y	Good	Y	Y	Featured in this report
Little Cedar Falls	RAS	9 yrs	1 very successful	N	Y	Good	Y	Y	Longest running RAS facility in NA
Grieg	RAS	Y	2	N	Y	Good	Y	Y	Campbell River and Gold River projects
For a comprehensive list of container farm systems and providers click here									
For an excellent article on Vertical Farming click here									

*Interest in working on Bowen. Yes (Y) is via direct communication and No (N) is based on direct communication or clear understanding from researching the company's business model and N/A is based upon a lack of response.

MAIN NON-SOIL-BASED FOOD PRODUCTION OPTIONS

1.Growcer Containerized Modular Farm

Source: Growcer

The Containerized Modular Farm is an industrial-grade hydroponic fresh leafy green production system housed inside a 40-by-10-foot insulated, prefabricated structurally insulated panel (SIP) container. Everything needed to grow fresh produce is contained within the module (LED lighting, hydroponics systems, pumps, fans, controls, and sensors) and the system provides flexibility in choosing locations and produce types (140+ options). It can be placed in almost any location as long as there is access to potable water (2000 liters / 440 Gallons a week) and electricity (60-65,000 kWh/yr.). The modules are arctic-grade (engineered to function to expected performance levels in arctic environments) and are professionally engineered to be industrial grade and rugged while being optimized for predictable, high yield, year-round production. Operation of the system requires no background in agriculture or a technical skillset (20-25hrs/week on average).

As outlined in the table above, after extensive research and evaluation of multiple container systems for potential application on Bowen Island, it is apparent that Growcer has successfully delivered over 30 projects (some with multiple containers) across Canada and built multiple business models with 140+ produce options. They also have built out a highly successful training system for operators and a 24/7 monitoring system that helps the operators to achieve optimal efficiency.

Why a Container Farm System

- Control for the optimum growing environment year-round, regardless of the climate and weather
- Modular model that is built off-site, delivered, and set up in 2 days. Multiple containers can be co-located (or even stacked or buried) to scale the operation
- Very high-density, regular produce production
- Minimal water requirements (2000 Litres/week)
- Flexible locations, sloped or rocky terrain is ok, soil and sun not required
- Exclude pests, pathogens, disease, heavy metals, microplastics, herbicides, and pesticides
- All 5 sites visited on Bowen Island look to be potentially suitable, provided electricity supply is available and water can be connected or delivered

Constraints/risks

- Planning permission
- Permitting
- Requires 25hrs week labor 52 weeks a year
- Market access
- Marketing

Requirements

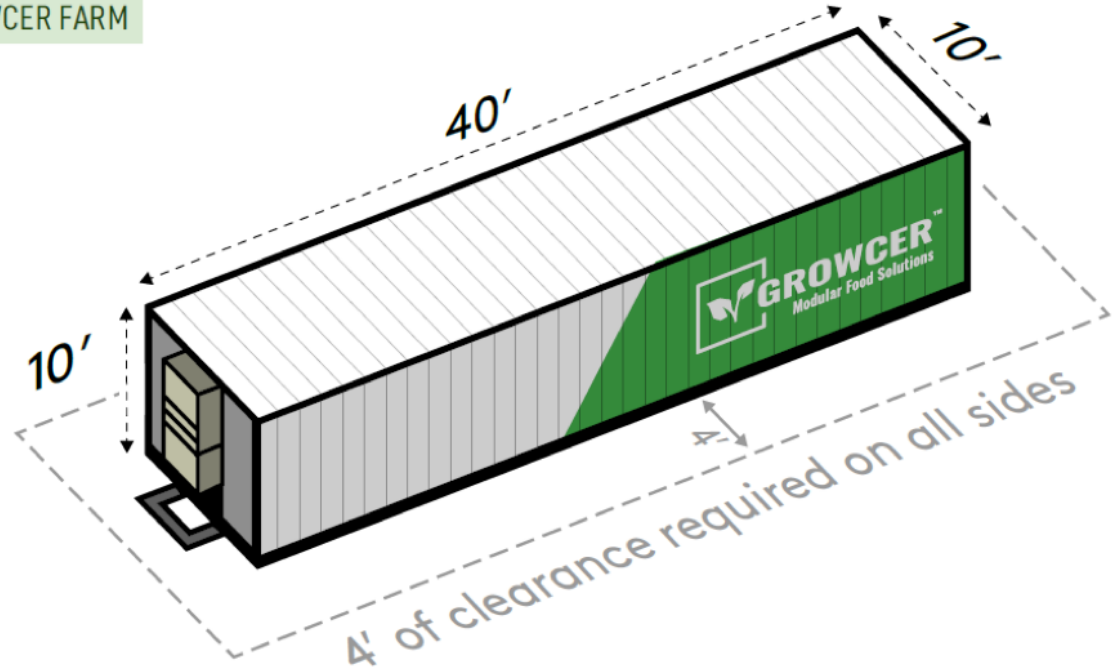
- 2000 liters of potable water supply per week. This would not necessarily need to be provided from mains supply as it could be tanker delivered to a multi-week storage tank (which would need to be costed into the system)
- Electricity supply of 60-65,000 kWh/yr. (see *Note below for Air Source Heat Pump alternative)
- 25hrs a week of labor per container
- Internet connection
- If multiple Growcer systems were to be installed on a single site or across multiple sites, then full-time employment would become possible, and a mixture of different products could be grown. This proposed version includes a mixture of living lettuce (90% of total yield) and herbs (basil and mint, 10% of total yield)
- Lease to own model possible

Sustainability Considerations

- Organic certification is currently not possible in Canada for hydroponically raised produce. There are a number of groups working to remedy this situation and it is anticipated that Canada will eventually adopt the organic certification methodology like many other countries already have for aquaponic raised produce
- The Growcer system is designed and operates along with organic produce principles. This makes the Growcer produce able to be certified organic once the regulatory frameworks are developed
- Fresh, hydroponically raised products are already realizing a 25% uplift in value in the Canadian markets
- Each container can grow the equivalent of approximately 1-0.75 acres of farmland and uses 90% less water
- Water is cleaned via UV treatment and filtration and is pathogen-free with zero discharge of wastewater
- The 92+% renewable electricity supplied by BC Hydro and the proximity to the Metro Vancouver market, make the Growcer produce very low carbon
- The absence of the need for herbicides, pesticides, heavy metals, and microplastics further supports the sustainability of the produce

See Appendix A for Growcer Site Preparation Guide and Appendix B Growcer Bowen Island Proposed System

GROWCER FARM



Estimated Financials

See Appendix C for Budgetary Pricing, Opex, Income and ROI of the proposed Growcer system. Pricing is for a 40-ft Modular Growing System to be delivered to Bowen Island by 3rd party logistics suppliers.

Budgetary Estimate Summary

System Construction, Parts and Labour	$133,750
Hydroponic Equipment	$88,490
Accessories and Optional Upgrades	$17,750
Consumables	$7,490
Shipping	$9,500
Services	$16,190
Travel & Accommodations for 2 Growcer Technicians Other	$4,000
Grand Total	**$277,170**

Site Preparation Estimate (External Contractor)

Item	Price
Steel Piles (Out of Growcer Scope - please confirm locally)	$11,200
Electrician (Out of Growcer Scope - please confirm locally) On-site project management, construction management, and other site prep (i.e. earth moving) Out of Growcer Scope - please confirm locally Sales and market development activities, and execution of merchandising plan (Out of Growcer Scope - please confirm locally)	$8,000
Plumbing (Out of Growcer Scope - please confirm locally) Attaching Modules together Crane Rental (Out of Growcer Scope - please confirm locally)	$5,000
Total Site Preparation (Estimate)	**$24,200**

Growing System	$249,490
Training and Install Support (with travel/lodging for Growcer Technicians)	$20,190
Growing Material	$7,490
Total Growcer Invoice	**$277,170**
Site Preparation Estimate (External Contractor)	$24,200
Total Project Cost	**$301,370**

Opex Annual Operating Costs

*Utilities (65,000 kWh/yr. electricity at $0.14/kWh)		$9,260
Growing materials & shipping		$7,490
Clamshell & bag packaging		$3,416
Labour (25hrs/w @ $25/hr)		$34,128
Remote monitoring services (Annual subscription)		$3,500
	Total	**$57,794**

*Note: Of the 60-65,000 kWh of annual electricity required, roughly 1/3 is for heating and another 1/3 for cooling with the remaining 1/3 for lighting, pumps, and other monitoring/control systems. We are confident that an air source heat pump can be used instead of the conventional air conditioning and heating system, and that 2/3 of the 39-43,000 kWh required for heating and cooling could be reduced by about 60%. As such an air-source heat pump helps to effectively cut the heating and cooling electricity costs by 60% (roughly reducing the annual electricity consumption by around 24,000-25,700 kWh which equates to around $3500/yr.). It is suggested that a smaller single-zone Daikin 3ton (36,000BTU) heat pump with 8KW backup electric heat ASHP would be a good solution. This could direct the airflow exactly where it is needed in the container and include enhanced air filtration. The cost for an Air Source Heat Pump alternative would still need to be determined but it is likely that the return on investment would be around 20% with a 5yr payback period. This option could also help if there was less electricity capacity available at a site as it would reduce the annual consumption of the Growcer to around 40,000 kWh instead of the standard 65,000 kWh.

Income Statement Snapshot

Inflation / CPI	**3%**				
Loss factor	15.0%	7.5%	5.0%	2.5%	2.5%
	Year 1	Year 2	Year 3	Year 4	Year 5
Gross Sales	$111,516.39	$114,861.88	$118,307.73	$121,856.97	$125,512.68
Less: Loss Factor	-$16,727.46	-$8,614.64	-$5,915.39	-$3,046.42	-$3,317.82
Net Sales	$94,788.93	$106,247.24	$112,392.35	$118,810.54	$122,374.86
Utilities	$9,260.30	$9,538.11	$9,824.25	$10,118.98	$10,422.55
Growing materials & shippings	$7,490.00	$7,490.00	$7,714.70	$7,946.14	$8,184.53
Clamshell & bag packaging	$4,983.28	$5,132.78	$5,286.77	$5,445.37	$5,608.73
Labour	$32,174.13	$33,139.35	$34,133.53	$35,157.54	$36,212.27
+ Overhead on labour	$5,100.24	$5,253.25	$5,410.85	$5,573.17	$5,740.37
Total Cost of Goods Sold	$59,007.96	$60,553.49	$62,370.10	$64,241.20	$66,168.44
Gross Profit	$35,780.97	$45,693.74	$50,022.25	$54,569.34	$56,206.42
SG&A					
Leasing payments (lease-to-own)	$0.00	$0.00	$0.00	$0.00	$0.00
Annual Subscription	$3,500.00	$3,500.00	$3,605.00	$3,713.15	$3,824.54
EBITDA	$32,280.97	$42,193.74	$46,417.25	$50,856.19	$52,381.88
Gross Margins	$0.32	$0.40	$0.42	$0.45	$0.45
Net Margins	$0.29	$0.37	$0.39	$0.42	$0.42
Payback					
Total Project Cost	-$301,370.00				
Free Cashflow (undiscounted)	$32,280.97	$42,193.74	$46,417.25	$50,856.19	$52,381.88
Total	-$269,089.03	$42,193.74	$46,417.25	$50,856.19	$52,381.88
Cumulative	-$269,089.03	-$226,895.28	-$180,478.04	-$129,621.85	-$77,239.97
Years	1	2	3	4	5
Payback in years	6.97				
IRR (20 YEARS) IRR (10 YEARS)	16.60% 12.50%				

Multiple business models have been developed and employed on the 36+ Growcer farms that are currently operating. The option presented in this report is the wholesale model.

Comparing Business Models

Business Model	Direct-to-consumer (DTC) Subscription	Wholesale	Hybrid	Impact
Ease of Implementation	Moderate	Simple/Good	Difficult	Simple/Good
Ease of Maintenance	Moderate	Simple/Good	Moderate	Simple/Good
Labour Commitment	Moderate	Simple/Good	Difficult	Simple/Good
Control Over Customer Experience	Simple/Good	Difficult	Moderate	Simple/Good
Profitability	Moderate	Difficult	Simple/Good	

Source: Growcer

2.Vertical Farm

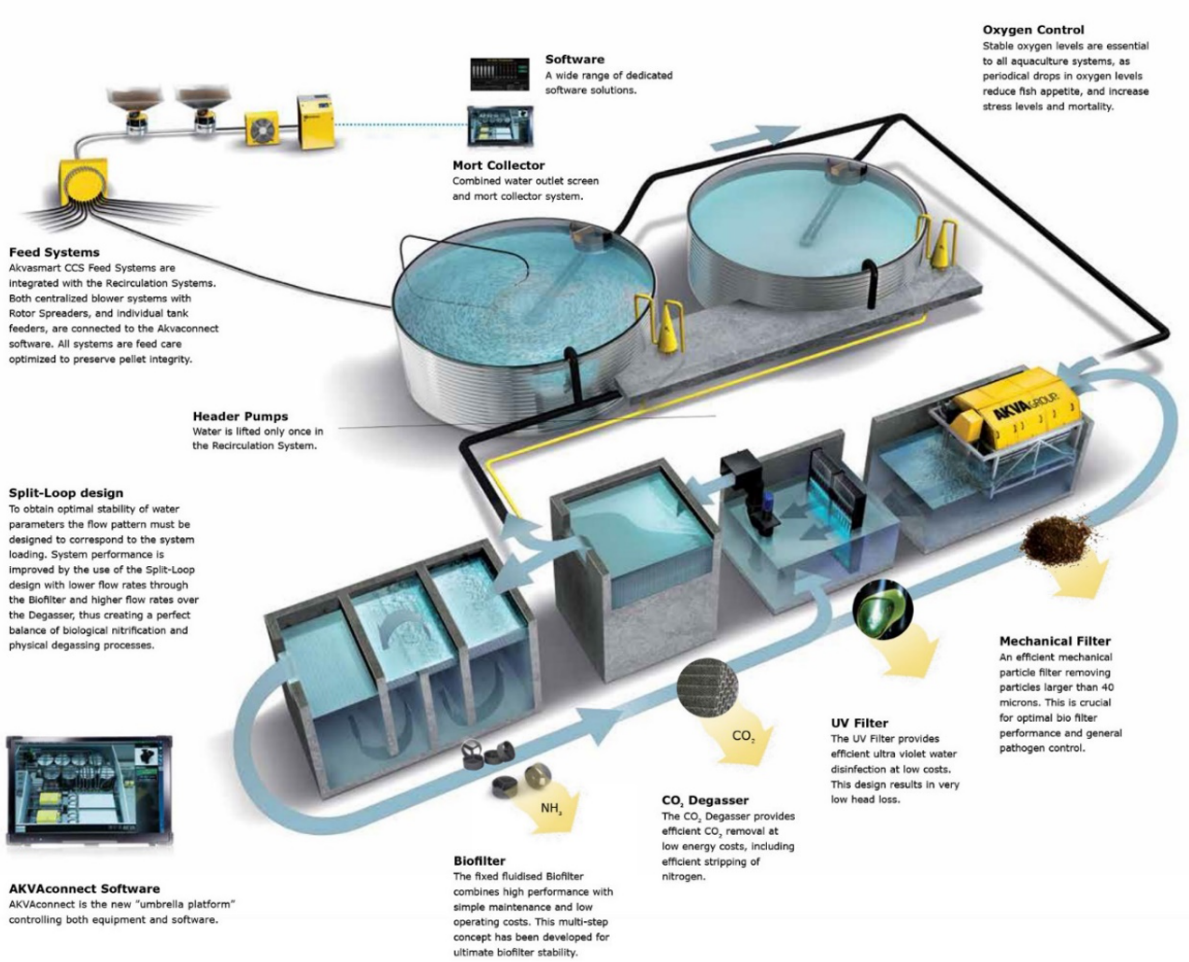
Source: Local Leaf Farms

Vertical farming is the practice of growing crops in vertically stacked layers. They incorporate controlled-environment agriculture, which aims to optimize plant growth, and soilless farming techniques such as hydroponics, aquaponics, and aeroponics. Common structures include warehouses, buildings, shipping containers, and tunnels.

Vertical farm providers are currently focused on large warehouse applications in urban environments, after speaking with numerous operators, it became clear that there was minimal interest in evaluating smaller scale vertical farms on Bowen Island and that the option outlined below (3) presents a more viable combined vertical farm with RAS system.

3. Recirculating Aquaculture Systems (RAS) with Vertical Farm Greenhouse

Source: Octaform



Source: AKVA Group

RAS is a high-density fish culture that is more intensive than other aquaculture production systems. Instead of growing fish outdoors in open ponds and raceways, this system typically rears fish in indoor/outdoor tanks under controlled environmental conditions. By recycling water back to fish culture tanks, recirculating systems filter and clean it. The technology is essentially
focused on the employment of mechanical and biological filters, and the process can be applied to any aquaculture species. Only new water is added to the tanks to compensate for splash out, evaporation, and waste material flushing.

Recirculating aquaculture systems (RAS) operate by filtering water from the fish (or shellfish) tanks so it can be reused within the tank. This dramatically reduces the amount of water and space required to intensively produce seafood products. The steps in RAS include solids removal, ammonia removal, Co2 removal, and oxygenation.

Open water systems are the typical fish farms that are contained in nets that float in the ocean and are anchored to the shore/seabed.

*2 Main Types of RAS:

- Partial (recycles 70%-90% of water flow = a full replacement of the entire water volume every 2-6 hrs)
- Full recirculating systems (recycles 97%-99.8% of the water flow = 20% of a full system volume exchange every 24hrs). This report is only focused on the Habitat full RAS system solution

Partial systems for on-land fish production require too much water to be viable in a place like Bowen Island. Open water fish farms present significant challenges when t comes to quality of fish, health and environmental impact and the BC regulatory space is steadily tightening up and even removing many elements of open water fish farms from the permitting regime. Full recirculating systems present the most compelling option due to the points laid out below.

Why Reuse & Recirculate Water?

- Control for the optimum growing environment in a world where climate change is increasingly disrupting food production
- One of the few food production options that would produce a significant % of actual food demands for Bowen Island's residents
- Very high-density, regular fish (high-value protein) production
- Reduce water requirements (99+%)
- Exclude pathogens, disease, heavy metals, microplastics
- Reduce effluent volume and treatment cost
- Reclaim nutrients for value enhancement (hydroponic co-location of the vertical farm)
- High-efficiency systems create a high return on investment, and thus financial viability, with a very large market in the local area (Bowen and Vancouver)

Constraints/risks

- #1 Water volume, consistency, and quality must be maintained at all times
- Wastewater discharge and other waste disposal
- Municipal support and permitting (e.g., water extraction license)
- High capital investment
- High operating and maintenance cost
- Requires an export market to supply fish/produce to be financially viable as the Bowen Island market is not large enough
- Dependent on consistent, high levels of efficiency and product delivery to facilitate the high capital and operational costs
- Can be subject to failures if not well managed/operated and maintained
- The system is a complex living machine that requires high skill levels are required to manage and operate the facility (a skilled team in a well-engineered system can use half the water of an average system)
- The industry has a history of failures, and therefore it is vital to work with the right team of designers and operators. This is specifically why Habitat is the suggested partner as they have a track record of delivery
- Public perception can be tainted by open water fish farms with all their environmental impacts
- 24/7 key workers are required for immediate responsiveness

Requirements

- Consistent water supply and quality (wells, water management, monitoring, sustainable extraction from aquifer)
- Electricity 24/7 backup generator required with at least a few days of fuel
- A reliable source of eggs/sprat to stock the system
- Sustainable feed supply (environmentally and supply volume)
- Chemicals/supplements
- Bulk Oxygen
- Distribution to market
- Wastewater discharge

Habitat RAS, Vertical Aquaculture Greenhouse System

Extensive research on RAS systems including, site visits, field studies, business analysis and the authors completion of The Conservation Fund, Freshwater Institute Recirculating Aquaculture Systems Course in Connecticut in October 2019 it became apparent that a well designed and managed RAS system presents a financially viable opportunity for sustainable food production that is compelling. Habitat had developed a combined RAS, vertical farm greenhouse solution that looks to be suited for application on Bowen Island. Habitat has now completed 4 years of Beta testing in their 4 metric tonne/yr. RAS, an organic marihuana facility in Chase, BC where they have raised capital to build out their model into an additional 150 metric tonne and a 1000 metric tonne salmon facility in BC.

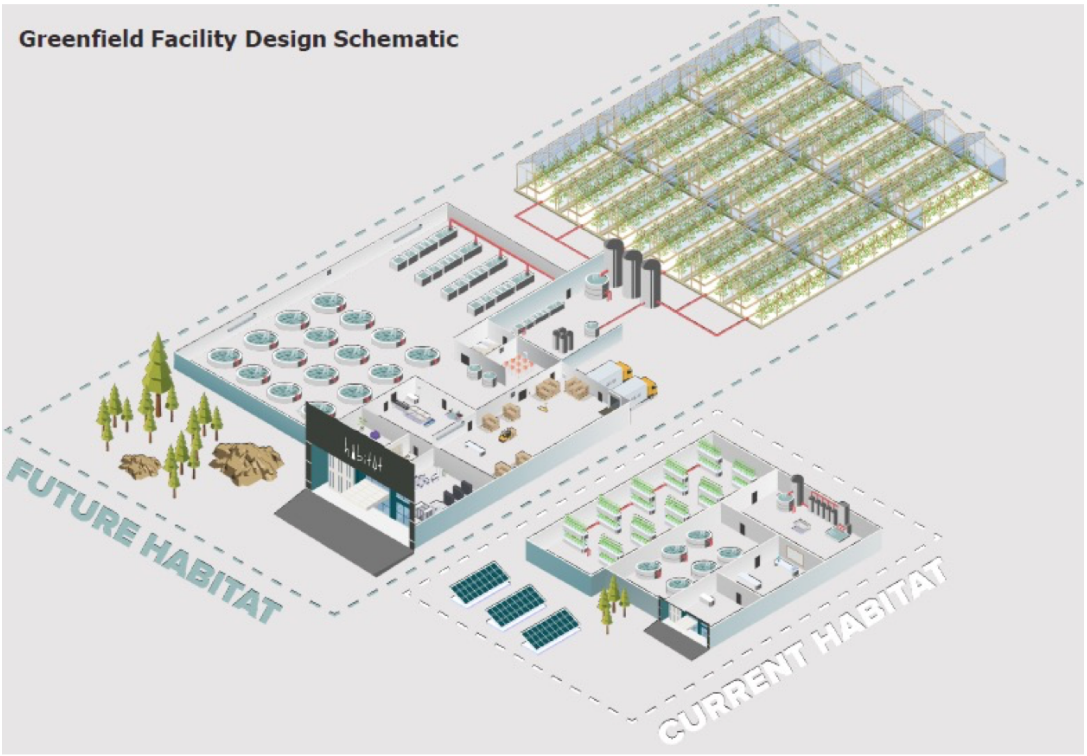
The 150 metric tonne/yr. system size is based on economies of scale, return on investment and scale of funds required, risk management, market capacity and price, and capability to scale expertise and management for optimal operation. The 150 metric tonne a year facility is optimally sized for financial viability and operational management. Smaller systems are possible, but the Habitat team has set this as the minimum size that they have an interest in designing, building, and operating.

Successful RAS systems require a combination of excellence in design, operations, management, marketing, BC regulatory compliance, training, and skills development.

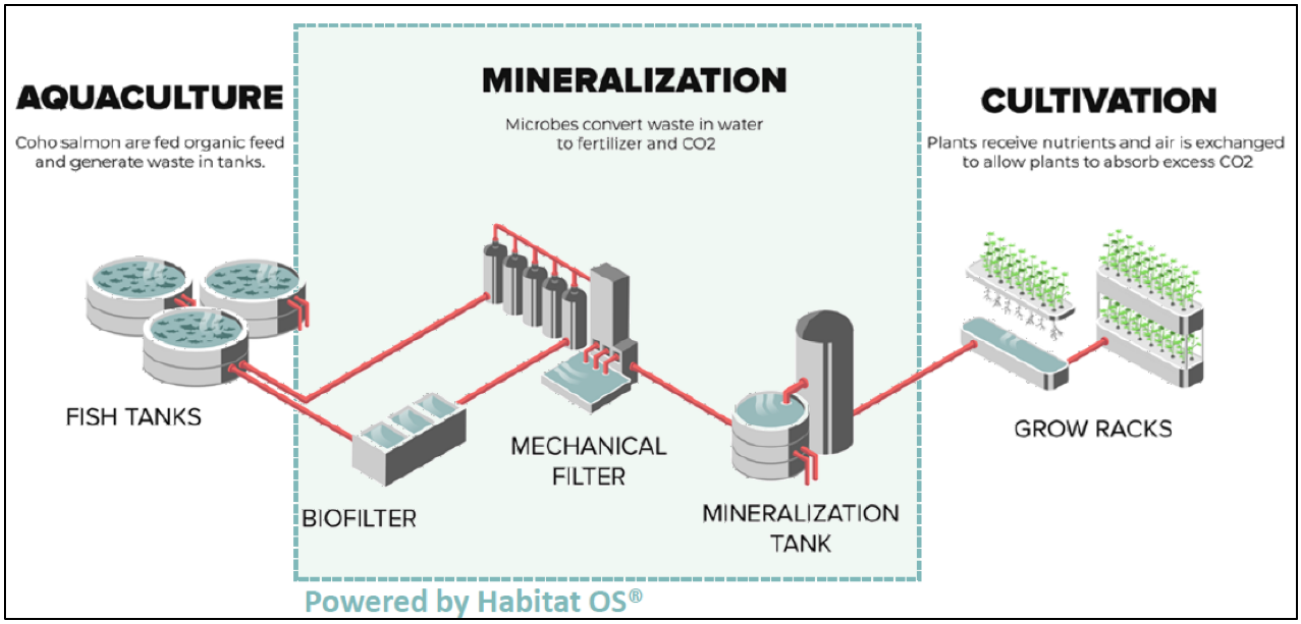
Source: Habitat

Habitat Proprietary Technology & Process

Habitat's proprietary knowledge is in connecting aquaculture waste streams to integrated greenhouse infrastructure inputs.



Source: Habitat



Source: Habitat

Sustainably grown organic sushi-quality, antibiotic-free Coho Salmon on a 15-month maturation period (vs.4-year wildlife cycle) through controlled photoperiods.

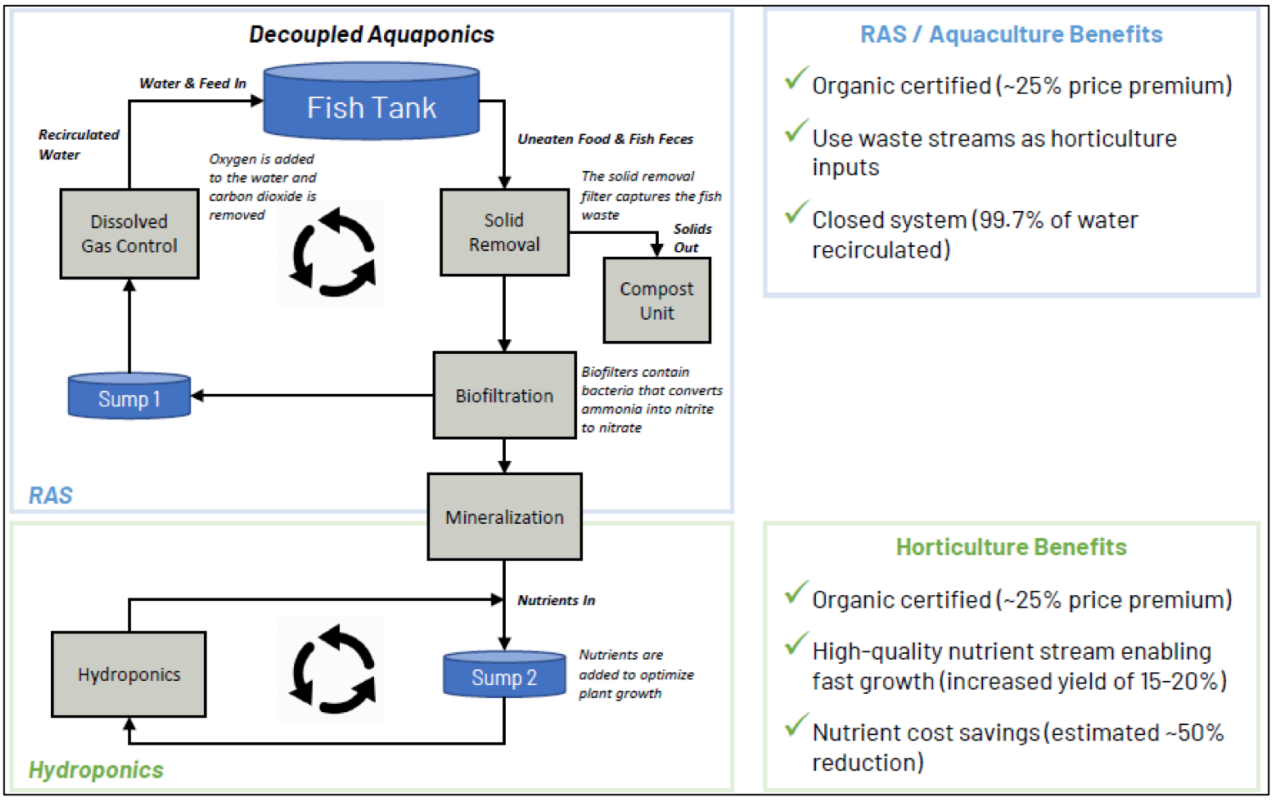
Repurposing waste through an innovative mineralization process to create organic fertilizer.

Growing crops (which will be certified organic when hydroponic produce is included within the certification process in Canada) within the closed-loop aquaponics system (99.7%water recycle ratio).

While the concept of aquaponics has long been understood, the ability to control the biological pathways between farm technologies in a commercial, scalable, and profitable approach has been challenging to commercialize.

Habitat has developed both sides of this equation offering seamless integration of its RAS farm to existing and future greenhouse infrastructure through the utilization of hydroponics

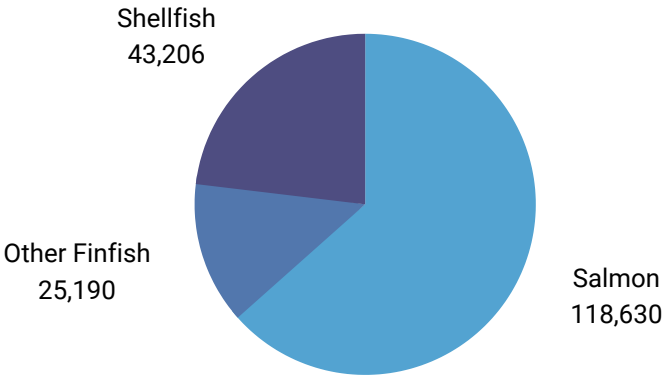
When compared to traditional greenhouse operations, Habitat's processes of combining RAS with hydroponics offer a horticulture solution that replaces the use of chemical fertilizers, and capital and resource-intensive potting soils.



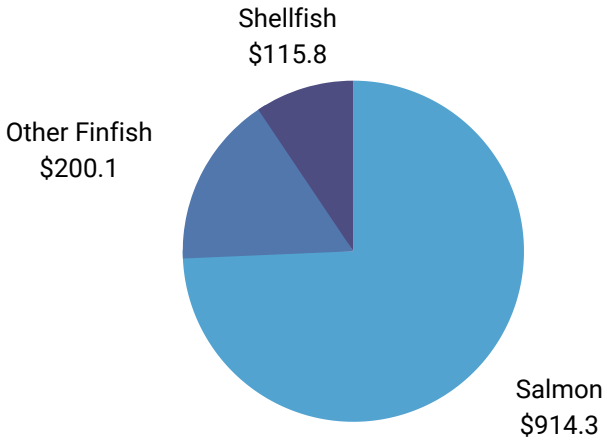
Source: Habitat

Canadian Market Sharepoint

2019 Canadian Aquaculture Production (MT)1



2019 Canadian Aquaculture Value ($M's)1



1.Fisheries and Oceans Canada: 2019 Aquaculture Production and Value
2.Calculated based on 2019 production and market value

Source: Fisheries and Oceans Canada: 2018 Aquaculture Production and Value

The proposed Habitat 150 metric tonne a year facility would supply about 0.12% of the 2019 Canada market share (as outlined above). If we estimate the demand for Salmon in Metro Vancouver as a percentage of Canada's population, we would be looking at about 6.5% (2021 population of Metro Vancouver = 2,463,000 of Canada's 38,000,000). This equates to approximately 7,710 metric tonnes a year of demand in Vancouver, and the 150-tonne facility would produce about 1.9% of the 2019 demand data above from Fisheries and Oceans Canada. Outlined below are the financial indicators and the potential of this solution.

The demand for fish in North America is expected to increase by 250% by 2035 (Source. The Conservation Fund Freshwater Institute, Water Recirculating Aquaculture Systems Course 2019).

Habitat has indicated that they are open to a Joint Venture or partial community-owned commercial enterprise. Habitat would need to design, build, and operate the system but they are open to upskilling the local operation and management in time and the possibility of becoming a franchise. It all comes down to financing for them as they would need to maintain a certain level of ownership and operational oversight in whatever model is chosen.

Suggested potential Habitat combined RAS and Aquaponic Vertical Farm Greenhouse production facility:

RAS Facility

- 15,000-20,000 sq/ft (1393-1858 m2) building depending on the processing facility options. A water-holding pond would be required to store well water and capture some surface water. The total area required approximately 3.5 acres (1.4 hectares)
- Closed system (99.7% of water recirculated)
- Water Requirements: 100 Litres a minute (26 GPM), this equates to 144 m3/d (or 38,040 GPD). Which equates to 52,560 m3/yr. (or 13,895,450 GPY). For comparison, an Olympic swimming pool contains 2,500 m3 of water (660,430 gallons)
- Organic Coho Salmon production 150 metric tonnes/yr. (MT)
- Fish weight is based on Head on Gutted (HOG) product
- Wholesale price is based on (HOG) $12/kg (60% higher than non-organic salmon), an average wholesale market price for organic Coho in Vancouver is $15/kg
- There is potential to add value to the fish by processing them further into 4oz raw portions ($35/kg) or cooked portions ($50/kg). Additional processing facilities and staff would be required, and the market would need further investigation
- Use waste streams from the RAS system as horticulture inputs into the greenhouse

Aquaponic Vertical Farm Greenhouse

- The 150 MT RAS would irrigate about 60,000 sq/ft (5,574 m2) of greenhouse or just about 1.5 acres (0.6 hectares)
- High-quality nutrient stream from RAS enabling fast growth (increased yield of 15-20%)
- Organic Tomato production of approximately 450+ metric tonnes/yr. The KPU report identified Bowen Islands' annual tomato consumption at roughly 80,000 lbs/y (36 mt/yr.) or 8%

Total system

- 5 acres of land (RAS and holding pond 3.5 acres, Vertical Farm Greenhouse 1.5 acres)
- Employment 7-10 full-time positions and 5-10 part-time. The jobs are made up of a mixture of highly skilled professionals (e.g., engineers, horticulturalists, RAS technicians) and laborers

Water supply

Everything to do with the viability of the RAS system flows from the water (pun intended). Reliable water availability and quality are essential for success. In essence, a RAS system is a living machine with vast complexities and integration between the parts. If an element goes out of synergy, the system can fail. Water is the lifeblood of the RAS, and its supplies can not be interrupted, or the balanced system will unravel. The entire system is also built around specific water quality and the treatment and cleaning systems also require a level of consistency and reliability. As such the RAS system would need to have its own committed water supply of an average of 100 litres/m, that is operated and managed by the facility.

New wells would need to be drilled and existing water drainage infrastructure may need to be upgraded for the project to be viable. A detailed aquifer and water infrastructure assessment would be required to ascertain the resources, costs, and impact on the viability of this solution.

This proposal included the costs for 2 new wells as this would enable a level of increased redundancy and potential for excess water to be supplied to the neighboring community. New wells have been estimated to cost $359,000/well which includes engineering, creating access, power supply, drilling, all mechanicals, chlorination treatment, telemetry/monitoring, controls, etc. Each well site requires careful planning so that sustainable yields are achieved within the recharge capacity of the aquifer.

The Arbutus Ridge site is the only visited location that currently presents a potential option for the RAS system. This is due to the landscape, a recently dug well with a reasonable flow rate and quality of water (for the residential aspect of the development), and the estimation that 2 additional wells would be dug on the farm element of the site with flow rates that are compatible with the RAS systems requirements. Additionally, 10 acres of land are already permitted for farming and up to 20,000 sq ft of structures. The proposed RAS and greenhouse system would require test wells to confirm the water requirements are able to be met and additional structures and water infrastructure and thus planning would be required.

Additional details about the existing water infrastructure at King Edward Bay can be found on pg. 16 https://bowenisland.civicweb.net/document/239285

Sustainability Considerations for the proposed RAS solution

- Sustainable Feedstock is an essential core element of all RAS systems if they are to be considered sustainable. Metro Vancouver is fortunate to have one of the most sustainable fish feedstock producers called Enterra, they produce aquaculture feed that is made with 100% Black Soldier Flies that are fed an approved plant-based diet that diverts pre-consumer waste from landfill
- BC Hydro's electricity supply is over 92% renewable and as such utilization of extensive electrification of the RAS and Greenhouse serves to significantly reduce carbon emissions from the operation
- Proximity to Metro Vancouver provides the added benefit of low food km, which when combined with the other sustainability factors, would serve to provide some of the freshest and lowest carbon organic salmon and tomatoes available in the region
- Lighting systems are provided by ultra-high efficiency LED lighting and heating/cooling would be provided by Air Source Heat Pumps for optimization of energy efficiency and cost-effectiveness
- The water supply for the facility would be provided via self-owned and operated wells with the 100 liter/min supply coming from an aquifer that is naturally replenishing and is not overburdened with unsustainable extraction
- The wastewater from the salmon production is cleaned and re-used in the greenhouse for optimization of Organic tomato production with the remaining wastewater already very clean and meeting/exceeding the municipal requirements for discharge into the municipal wastewater system
- It is anticipated that there will be excess well water that may be available to supply the local water system in King Edward Bay (tbc)
- Habitat is working in partnership with Adams Lake Indian Band and other Secwepemc leadership on a project proposal to rebuild the Upper Adam's Sqlelten7úẃl (Early Summer Sockeye salmon) stock to historical levels of 500,000 adult spawners per year
- Habitat is also in discussions with several other local first nations to utilize a similar program to reseed local salmon runs to overcome the historical damage inflicted by climate change, logging, open-ocean fish farms, and agricultural practices
- Habitat has entered a joint venture partnership with Ecodrum to take Habitat's proprietary process of turning the solid waste from its salmon farm into usable nitrate-based fertilizers. Habitat has been successfully doing this at its aquaponics pilot facility in Chase BC and is currently working with Ecodrum to engineer the process into a turnkey solution. As the demand grows for aquaculture to be more environmentally friendly and resource-efficient, solutions like Habitat's mineralization process can relieve inland aquaculture's biggest hurdle-what to do with all the solid waste?

Estimated Cost of RAS, Greenhouse, wells, and pond

Capex 20,000 sq/ft RAS building	Capex 60,000 sq/ft aquaponic vertical greenhouse	Contingency 7.5%	2 Wells and pond	Total Capex excluding land
$4,750,000	$2,500,000	$543,750	$720,000	$8,513,750

Estimated Fish and Tomato Production

Organic Coho Salmon Production per year (kg)	Organic Tomato production per year (kg)
150,000	453,600

Estimated Operational Expense (Opex)

Opex RAS (O&M, staff, etc.) per year	Opex Greenhouse per year	Total Opex per year
$1,275,000	$792,893	$2,067,893

Estimated Income, Profit, ROI and Payback Period

Annual Organic Coho Salmon Income	Annual Organic Tomato income ($5 kg)	Annual income	Total Opex per year	Annual Profit	ROI	Payback Period
$1,800,000	$2,268,000	$4,068,000	$2,067,893	$2,000,107	23.5%	4.3

Estimated Capex with land, Income, Profit, ROI, and Payback Period

Estimated Land Cost	Total Capex including land	Annual Profit	ROI	Payback Period
$1,600,000	$10,113,750	$2,000,107	19.8%	5.1

THRIVE Bowen Island evaluated sites with high-level conclusions:

- Arbutus Ridge Containerized Farm and RAS system
- Xenia Containerized Farm provided electricity and water are available
- Bowen Wild Containerized Farm provided electricity and water are available
- Grafton Commons Containerized Farm provided electricity and water are available
- The Cape Containerized Farm provided electricity and water are available

NEXT STEPS

If outlined solutions are of interest, speak with the solutions provider about the specifics of locations and potential partners (community, land, and financial) and ownership models.

For the RAS system, a detailed study of the water supply potential, system design, and financial models would be required. The costs for these elements will need to be determined.

Professional support for planning permission approval would also be required.

OWNERSHIP MODELS

The Growcer container farm system is happy to support the evaluation of projects with a multitude of ownership models. They currently have 30 applications across Canada of various sizes that range from commercial for-profit versions to not-for-profit and hybrid models. They also have a lease to own or outright purchase financing model.

Habitat is ramping up the application of their RAS, Greenhouse model and is currently looking for sites for application. They are open to joint ventures, partial community ownership, share offerings, and even an eventual franchise model (once operational knowledge and skills are in place).

Signed for and on behalf of the Carbon Free Group

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7th April 2022

APPENDIX 2

CONVERSATIONS WITH PROVIDERS OF GROWING SYSTEMS

Conversations with Providers of Growing Systems

Agriplay (Calgary, vertical):

- This vertical farming technology is currently "in-development" and operates much the same way that other vertical farms currently do: in HUGE office towers/industrial buildings. However, the goal of this company is to figure out how to bring the technology down to a much smaller scale, with minimal needs beyond the technology itself, so that it can be useful in all kinds of settings to increase food resilience. This level of sophistication is expected within a couple of years as the original technology is being launched to the public from a Calgary office tower this September.
- While the system relies on AI learning (which adjusts the system towards optimal conditions depending on what crop you are growing) the idea is that this system can be set up locally by just about anyone… and in any building that would be habitable for humans
- The growing system is aeroponic, which uses the least amount of water of all growing systems, and it is wall-based (the original model was built using growing towers)
- One grow unit (54-68 plants) loses less than a gallon a day to feeding and evaporation. Right now much of that water is re-captured in dehumidifiers.

Cold Acre Farms (Whitehorse, modular):

- This company was formerly partnered with Cropbox, however, ultimately decided the Cropbox system was too problematic to sell. (They ran a crop box for a year and half and had to make so many changes they decided it wasn't a good product. They started building their own custom systems depending on the needs of buyers.)
- They say the containerized model is perfect for a population of 4,000 people.
- Because of ridiculously high planning standards in Whitehorse, they build each system to a standard whereby they could be used as living spaces. Models are 6, 12, and 16ft long, fully customizable (can also be built as community freezers or processing space, and can have arctic greenhouses attached). Heat exchangers push heat from the container into the greenhouse which has insulated floors and walls, south facing windows)
- Price range - model 12: $170k; model 16: $190…
- Interior - hydroponic, Arctic Greenhouse can have a soil portion.
- This company is running their own farm and will support buyers until they hit 80% of production capacity. "Out of a model 12, we're pulling 250 lbs of greens per week." Herbs drop the number down - basil, mint and thyme it's going to be 40 lbs a week (they are lighter plants)
- Community engagement: there is typically one angry farmer per year. Everybody else is so excited. The part we've been excited about is tours with school kids. Surprising amount of kids ask about volunteer opportunities, teachers keen
- They donate 100% of unused greens to the food bank -tax credit.
- They have worked with non-profits and indigenous communities in NWT, Yukon, BC.
- These models are not feasible with private enterprise looking for a 4-year ROI.
- There are a lot out there with unrealistic numbers about how much you can grow. "Had we been told the truth, we would have done it anyway we just would have prepared differently."
- Job satisfaction at these farms is pretty high. This makes it a desirable place to work. There are a lot of wage subsidies because it fits in with a "green" space.
- They offer free grant writing and consulting services.

Fork Farms/Flex Farm (Wisconsin, tower system):

- This is a panelized, vertical system that could be used within someone's home, or "daisy chained together" into a larger system.
- Had a long chat with the salesperson for this provider and was able to view her system in the background.
- One Flex Farm panel can grow 20lbs of leafy greens every 28 day growing cycle.
- The system itself costs roughly $5,000 USD.
- Keeping the system going (with supplies) costs roughly $480 USD per year.
- Electricity costs are an estimated $17 per month.
- The main waste product coming from this system is called Rockwool, which is the growing medium. It is non-compostable.
- The wastewater can be dumped into a garden (this usually happens when the system is deep cleaned, it is recommended that this happens every three months).
- The salesperson had 23 different crops growing in her system at one time.
- The plants grown in a Flex farm can be transplanted as seedlings into an outdoor garden.
- This company was VERY clean to connect and provide further information, including connections with other customers who are using product, and business planning (they say some of their clients have used these systems to set up local co-ops)
- These systems are also being used by schools and community programs, and come with learning plans.

Freight Farms (Boston, container):

Freight Farms has been in the containerized/ vertical farm business over 12 years (longer than almost all other providers).

FF are in 34 countries, including Canada (Toronto area, northern Alberta, Vancouver Island, and Vancouver).

- Their system appears to be ~50-60K less to purchase and install, including shipping to Bowen Island, than Growcer's.
- A capital payback period could be 2-3 years, depending upon the type of products sold.
- There are no regulatory issues being from outside Canada. The only tax we would pay is GST with the total custom brokerage fees through Cavalry Logistics being $150.
- The farm has been designed so that one can do everything from seed to harvest to packaging inside the unit.
- In terms of Admin space, it will depend upon the needs for your particular project; but assume that purchasing an empty container (either a 20 footer or 40 footer would be good for an office space).
- For each farm, one will need a plot of land that is 50 feet long by 10 feet wide. One can find detailed site requirements here: Site & delivery guide.
- **What sort of servicing is required (Water, electrical, sewer/septic.)?**
    - These details can be found in the site guide linked above, but for quick reference: the farm comes standard with a 150-amp, 240V split-phase electrical connection and will need to be connected to electricity by a licensed electrician.
    - One wants to be within 50 feet of a water source.
- Freight Farms does not need any drainage for sewage; there would just be waste water from when one turnover one's tanks every ~4 weeks. Most of their customers dispose of their waste water onto their lawn, or other plants if possible when they do tank cleaning (usually 50 gallons, or less of water) as it is just clean water with trace nutrients.

One of our customers plants flower beds around her farm and uses the wastewater to water the gardens. As an added perk, the company that owns the building where her farm is located, gave her a discount off the rent for handling the upkeep.

However, it can depend on where your farm(s) are located and what specific regulations one's site may have regarding waste water. If BI Municipality brings it up, it may be good to ask them if they currently restrict use of MiracleGro, or other plant fertilizers because the answer will very likely be no (at least no one in the US regulates it). Then you can easily reinforce there's no regulatory concerns.

- Additional Freight Farm resources:
- **How To Think About The Greenery S As A Business:** overarching outline of the primary business considerations for operating a Greenery S: customer segments, building your brand, revenue and COGS analyses by sales channel, and more.
- **Freight Farms Opportunity Deck:** overarching presentation that dives into potential customer segments, business considerations, sample questions for customer discovery, recommended crops, comprehensive crop varieties and more
- **Greenery S Tech Summit:** check out this video to hear directly from our Founder/COO, CTO and Lead Industrial Designer as they unveil all of the features and enhancements that went into designing our brand-new Greenery S farm and updated state-of-the-art Farmhand software
- **Greenery S Product Booklet:** full technical specs and enhancements on our brand-new, state of the art container farm: the Greenery S
- **Farmhand Software Demo:** watch as our head of Product, Erich, takes you through a detailed demo of our updated and enhanced Farmhand 2.0 Software
- **What Does It Take To Operate The Greenery?**- this short video highlights a typical week of work inside the farm(only about 15-20 hours of total labor)
- **Greenery Crop List:** detailed guide of the different crop varieties that can be grown in the farm
- **Freight Farms Case Studies Page**
- **Business Planning Tool:** this is where you can get the best sense of your potential profit margins, operating costs and yield potentials for a wide variety of crops. It's an interactive tool that allows you to plug in all of the relevant information for your business model.

NuLeaf Farms (Calgary, vertical):

- NuLeaf has provided confidential information as to their operations and business planning. They have said it is not for public consumption.
- They have an offering that sounds incredibly promising with a capital layout of $500K to $3M, depending upon the size of facility.
- Capital payback could be less than three years, depending upon what was grown. For example, with their $3M facility, NuLeaf said they grew and sold 9M worth of starter plants, of which $7M was gross profit.

PR Aqua (Nanaimo, RAS):

- PR Aqua is a Recirculating Aquaculture System (RAS) designer, including of the prototype of the Habitat RAS, profiled in Jae Mather's report.
- PR Aqua would be available in 12 to 24 months to partner with THRIVE Bowen, if we decided to go the route of a RAS.

Their sales rep provided quite sobering commentary on RAS, including that he has seen "more RAS endeavours crash and burn than succeed." The systems are notoriously fickle, are a significant financial outlay ($10M+), and demand sophisticated expertise and dedication. One power outage can wipe out an entire stock of fish due to lack of oxygenation.

Despite many benefits to a community to a RAS, he also said that he would be more likely to invest in a casino than a RAS. When given the capital investment of upwards of $10M, it seems like an unrealistic solution for Bowen in the short-term, though one never knows.

Tower Garden (Colorado, tower):

- Tower Garden is a vertical, aeroponic growing system that allows one to grow up to 20 vegetables, herbs, fruits and flowers in less than three square feet—indoors or out.
- **See Appendix 4 – Tower Garden Growing Resource Guide.**
- How is their electrical/power consumption? How noisy are they? Are there any annoying hums?
    - Both the pump and the LED lights are low draw.
    - Pump: This pump is rated at 0.25 amps, 24 watts @ 120 VAC/60 Hz. Assuming you run your pump 12 hours a day (that's 15-minutes on, 15-minutes off, all day and night) and your power company charges you 12 cents per kilowatt hour, that would come out to roughly $1.05 per month, $12.62 per year (USD).
    - LED Lights: The TG LED Grow Lights Kit is rated at 1 amp, 125 watts, 120 VAC/60 Hz. Assuming you run your grow lights for the recommended minimum 14 hours per day and your power company charges you 12 cents per kilowatt hour, the cost to run those lights would come out to roughly $6.39 per month, or $76.70 per year (USD).
    - There are not any annoying hums from the pump, however, there is water trickling when the water kicks on approximately 15 mins every 15-20 mins. Watering and light usage are set via timers. I think most people find the water sound soothing, but some might not. The lights are rather bright. I had my Tower in the family/TV room and often ran the lights at times when I wasn't in there. Personal preference.
    - The estimate on water consumption is that each plant will consume 1 gallon/3.78 liters for its entire ~30 day lifecycle. This will be less for the smaller petite greens plant ports on the tower.
- In terms of the costs, it would be good to know what it costs to be continuously growing through this system AFTER the point of purchase?
    - That depends on what you are growing and how long you are leaving things in the towers. Most products turn in 30-45 days but there are crops (e.g. basil) that you can cut multiple times without replacing the plant ports. In general though each tower comes with enough nutrients, pH balancing and testing to last you for 6 months to 1 year. Seedling supplies are good for 4 months or so.
- Here is a link to the Tower Garden Home page for specs and information on supplemental products (e.g. nutrients, pH balancing, rock wool clips).
- There is another version of the Tower Garden called the Tower Garden Flex which is a little less expensive, but has few plant ports and it doesn't have wheels (can purchase separately). Benefit is that it does allow for vine crop production by adding a tomato cage. It would end up being more expensive than the Home version by about CAD$80. I didn't mention it earlier, but here is a link (would need lights). I don't think that your recipients would be growing vine crops indoors with artificial lighting. It is possible, but challenging for the beginner.
- Here is a link to info regarding using the tower garden systems within schools. Also, here are some additional educator resources.

APPENDIX 3

THRIVE APP/PLATFORM FOR SUPPLY-DEMAND INTELLIGENCE IN COMMUNITY FOOD PRODUCTION

THRIVE App/Platform for Supply-Demand Intelligence in Community Food Production

1. Problem Definition

Food resiliency and security can be unattainable simply due to lack of information between supply and demand capacities, even when the capacity clearly exists in terms of resources, funding, and technology. A key challenge for food production is knowing the ongoing demand for one's offering; and more importantly (beyond one-time surveys) having a system which can keep exchanging information between the supply and demand sides to power market executions and to allow both sides to plan (production and consumption) symbiotically.

In the case of Bowen Island, the reports commissioned by THRIVE Bowen are clear: the Island has more than enough soil-based agricultural capacity for its population; and also that non-soil agricultural options available to it today could offer viable additional options.

What is not clear are the consumption preferences and desires of the population, and how these could be coordinated with the current and future supply-side combinations. More specifically:

1. Supply-side actors (producers such as farmers, gardeners, etc) do not have an accurate insight into the demand-side: what would people buy and at what price.
2. Demand-side actors (consumers) have no channel to aggregate information on their willingness to support local food production, e.g., how much they are willing to pay to local options compared to off-island prices, or to motivate suppliers to introduce a new product/service.

2. An App Platform Solution

Demand-analysis platforms allow community stakeholders to coordinate demand and supply information using modern algorithms and mobile/web app technologies. They have a proven track record in the past two decades across many domains. Beyond connecting supply and demand for individual transactions, the anonymous aggregate information in the platform can be valuable for planning on a community level, not just for food resiliency but for other related economic needs.

THRIVE has engaged with SocialCogs, we are a technology provider who specializes in community networks of supply-demand relationships. SocialCogs is a Canadian non-profit and offers its technology open-source.

SociaCogs's technology, or a comparable alternative of another provider, could be customized more broadly for Bowen Island, or for THRIVE stakeholders more narrowly, providing all participants user apps and the backend platform to run the marketplace algorithms.

The platform could also be used by off-island suppliers and/or consumers, which can help Bowen supplier and/or consumers be sustainable when island demand and/or supply is not enough, respectively.

If built using open-source technology, the benefits could span beyond Bowen Island, because the app and platform code would be made to other communities globally who have similar objectives, such as our food resiliency mission.

3. Functionalities Provided

The sections below summarize the functionality based on user types. THRIVE Bowen would fall under the multiple "producer" categories. However, the marketplace is envisioned to include other producers such as local farms or neighbourhood/personal gardens.

Consumers

People or businesses looking for food products can

1. Come with a pre-existing need, and post it in a way that stimulates local producers to
2. answer it
3. Browse existing offers by local producers to discover something new of interest

Food Producers with Existing Products that Need Placement

People or businesses interested in selling food products can:

1. Come with a pre-existing offer, and post it to a locally engaged community
2. Browse the needs of the community for more accurate business planning

Potential Producers

People or businesses who are interested in creating new food products but who need funding can browse demand information from the community and discover something new they could offer.

Investors

If allowed, investors can be given access to some of the information if they can address a gap in the local food economy.

4. SocialCogs Fintech

SocialCogs uses a novel financial technology (fintech) whereby a supporter of an economic activity or outcome (e.g. growing a certain crop) can support it financially without having to commit to consuming a specific amount or any at all (i.e., unlike a CSA box).

The supporter creates or buys optionality (e.g. before the farming season) which allows them to decide at any time later on if and how much they want to consume themselves. Whatever portion of their optionality is not consumed by themselves, it gives them a cash benefit when others purchase the products. See Figure 1 for mock-ups of mobile app screens where a supporter sets up such financial optionality.

Aside from buying optionality with money, SocialCogs's fintech can allow those with demand for food products to acquire them without money (or at a discount) by offering their own services or products to the marketplace, all while complying with tax laws. This platform capability is not from 'bartering' because the exchange does not have to happen directly between the food product supplier (A) and beneficiary (B), but can involve any number of intermediaries so that A exchanges with a C, who exchanges with a D, etc. until some Z exchanges with B.

These combinations are computed in real-time, and the users do not have to worry about the backend complexity. Explained briefly like this, the solution may seem similar to what has been known as multi-party coordinated barter; but the proposed solution is quite different because it uses more advanced fintech only available in the past decade and currently used mostly between banks.

Figure 2 shows mock-ups of mobile app screens where supporters can organize their monetary and non-monetary support. Figure 3 shows a summary diagram of the functionalities that could be provided by the app platform.

SocialCogs's fintech makes the app platform a tool for local community economic development across multiple domains. In the case of Bowen Island, it would have the ability to scale to a tool for more general community economic development across all economic sectors relating to the island. The same type of market interconnectivity and intelligence it can offer for the food domain, it can also offer for any economic domain of community interest, such as arts, hospitality, etc.

If THRIVE chooses a more legacy marketplace fintech instead of SocialCogs, the functionalities would be a simplified version without the optionality function and without non-monetary supporters; but the general idea would remain the same as described in Section 3 above.

5. Development & Support Costs

In the case with SocialCogs, there would be no license fees. The software development to customize the open-source code could either be done by SocialCogs for a non-recurring cost, or they can help THRIVE and local partners form our own technical and support team. The latter option could share technical resources with another organization, or poll resources across multiple communities that may end up using the app platform. With wider adoption, we could apply for support from various government levels. THRIVE will investigate various funding models for the above scenarios.

Aside from a formal team structure, another option is to do something such as the Millers Landing Buying Group on Bowen Island: they develop and support their own supply-demand software platform through community self-organizing. With adoption across multiple communities, the platform could become self-sustainable and community-organized like many successful open-source solutions, in terms of maintenance, upgrades, and support.

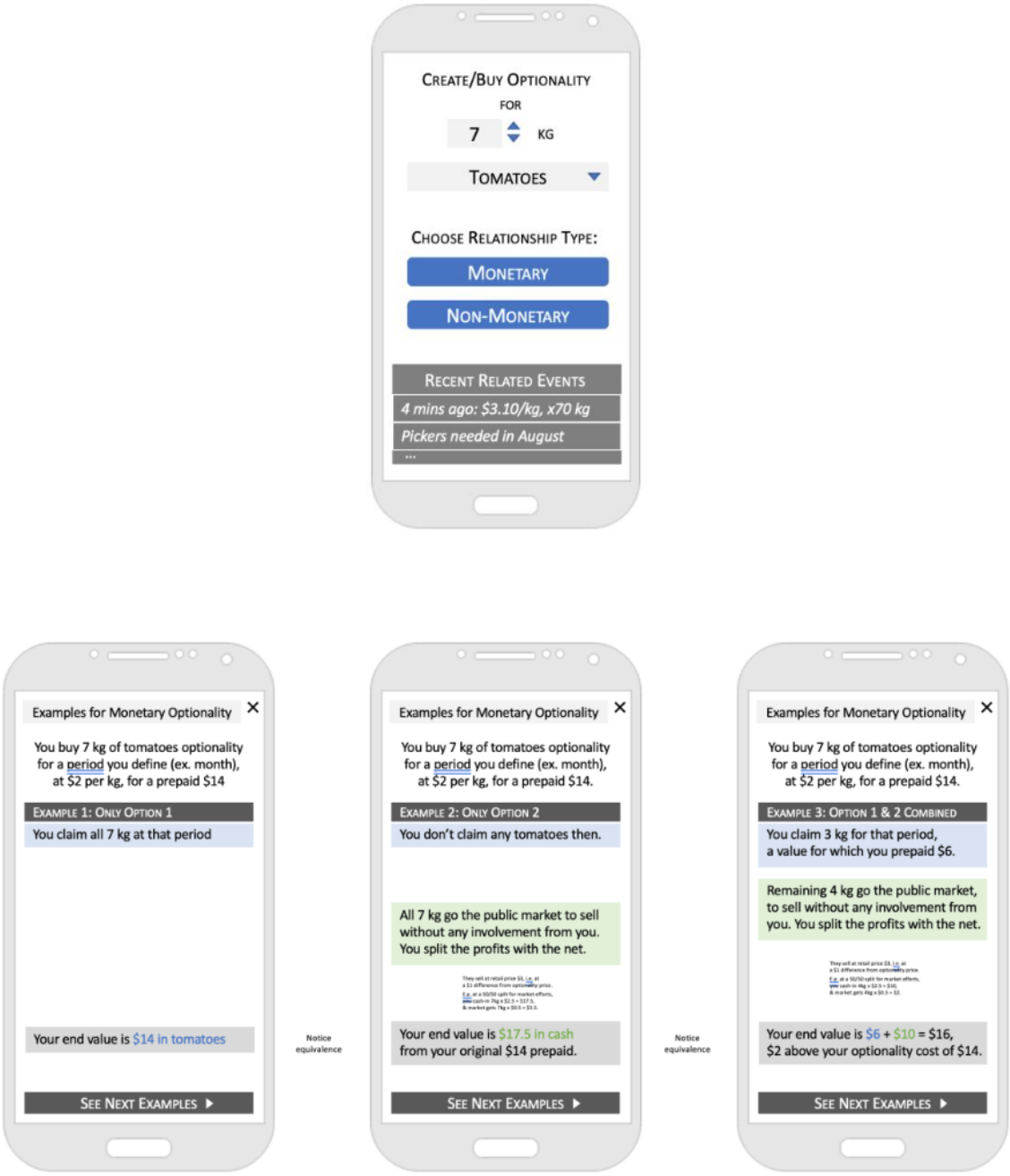
CREATE/BUY OPTIONALITY
FOR
7
KG
TOMATOES
CHOOSE RELATIONSHIP TYPE:
MONETARY
NON-MONETARY
RECENT RELATED EVENTS
4 mins ago: $3.10/kg, x70 kg
Pickers needed in August
Examples for Monetary Optionality
You buy 7 kg of tomatoes optionality for a period you define (ex. month), at $2 per kg, for a prepaid $14
EXAMPLE 1: ONLY OPTION 1
You claim all 7 kg at that period
Your end value is $14 in tomatoes
SEE NEXT EXAMPLES
Notice equivalence
Examples for Monetary Optionality
You buy 7 kg of tomatoes optionality for a period you define (ex. month), at $2 per kg, for a prepaid $14.
EXAMPLE 2: ONLY OPTION 2
You don't claim any tomatoes then.
All 7 kg go the public market to sell without any involvement from you. You split the profits with the net.
Your end value is $17.5 in cash from your original $14 prepaid.
SEE NEXT EXAMPLES
Notice equivalence
Examples for Monetary Optionality
You buy 7 kg of tomatoes optionality for a period you define (ex. month), at $2 per kg, for a prepaid $14.
EXAMPLE 3: OPTION 1 & 2 COMBINED
You claim 3 kg for that period, a value for which you prepaid $6.
Remaining 4 kg go the public market, to sell without any involvement from you. You split the profits with the net.
Your end value is $6 + $10 = $16, $2 above your optionality cost of $14.
SEE NEXT EXAMPLES

Figure 1.

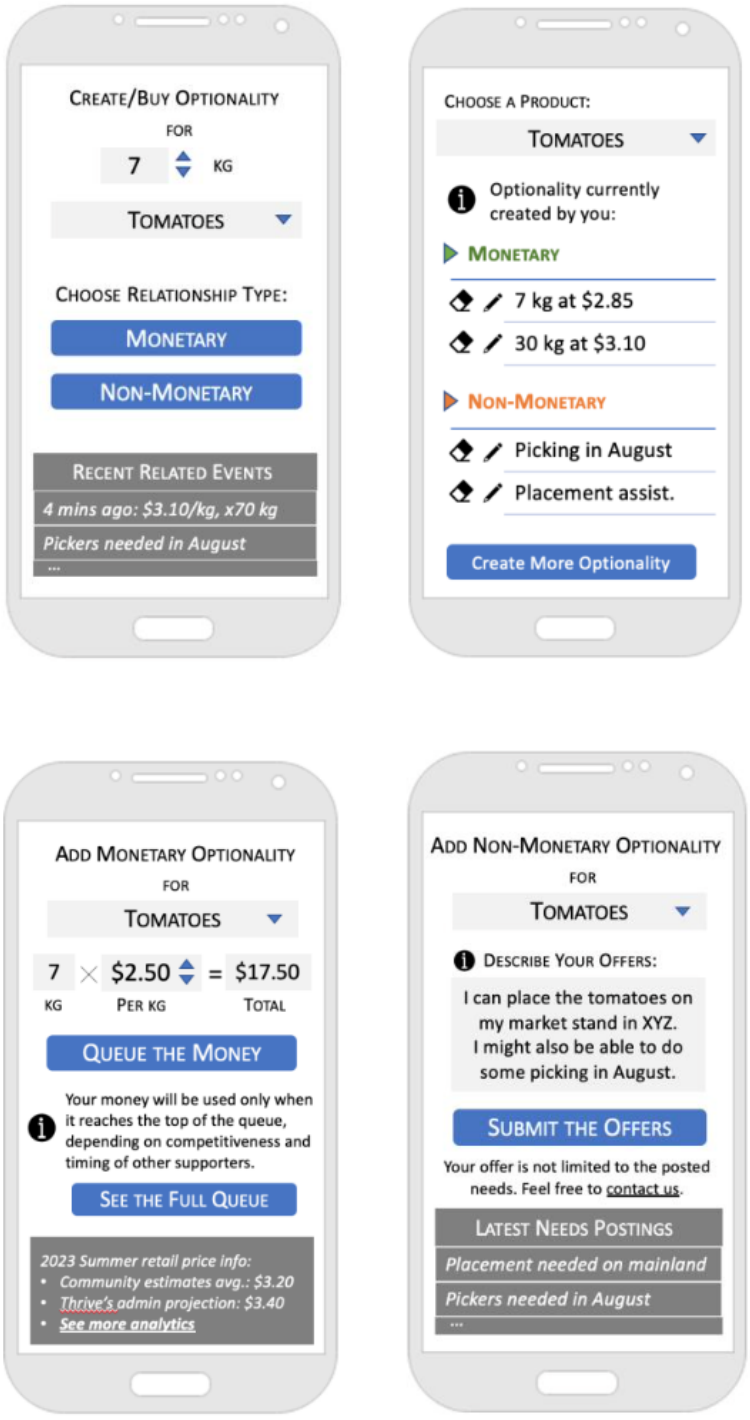
CREATE/BUY OPTIONALITY
FOR
7
KG
TOMATOES
CHOOSE RELATIONSHIP TYPE:
MONETARY
NON-MONETARY
RECENT RELATED EVENTS
4 mins ago: $3.10/kg, x70 kg
Pickers needed in August
...
CHOOSE A PRODUCT:
TOMATOES
Optionality currently created by you:
MONETARY
7 kg at $2.85
30 kg at $3.10
NON-MONETARY
Picking in August
Placement assist.
Create More Optionality
ADD MONETARY OPTIONALITY
FOR
TOMATOES
7
KG
$2.50
PER KG
=
$17.50
TOTAL
QUEUE THE MONEY
Your money will be used only when it reaches the top of the queue, depending on competitiveness and timing of other supporters.
SEE THE FULL QUEUE
2023 Summer retail price info:
Community estimates avg.: $3.20
Thrive's admin projection: $3.40
See more analytics
ADD NON-MONETARY OPTIONALITY
FOR
TOMATOES
DESCRIBE YOUR OFFERS:
I can place the tomatoes on my market stand in XYZ. I might also be able to do some picking in August.
SUBMIT THE OFFERS
Your offer is not limited to the posted needs. Feel free to contact us.
LATEST NEEDS POSTINGS
Placement needed on mainland
Pickers needed in August
...

Figure 2.

Figure 3.

F6. How does the app platform complement the findings of the other THRIVE Bowen reports?

The KPU finding regarding ALR land

The finding points to the major underutilized supply-side potential, which a new marketplace and funding platform can mobilize using modern marketplace technology.

The tower system and any proposal to promote community engagement et al through the integration of towers into the lives of residents, schools, businesses, restaurants, etc?

If the produce from the towers does not go to a marketplace, and is instead for the owner's consumption, the app would be used only for selling/placing the towers, i.e. the tower becomes the product with THRIVE as the supplier, engaging supporters (investors/buyers).

Otherwise, the app could be used for the produce itself, similar to the use with other growing systems below. Perhaps due to the extreme distributed nature of these tower systems, it could match ultra-local trades, e.g. getting something from a neighbour's tower.

Larger systems: Containerized systems, NuLeaf Farms systems, Recirculating Agriculture System (RAS).

With these systems the produce needs to be distributed through one or more marketplaces. The app platform is what would power those marketplaces, offering the functionalities described in Section 3.

Needed community engagement and education around food security/ resiliency/ sovereignty?

The fintech behind our app platform is built specifically to facilitate community relationships from a deep-network perspective where the systems compute how one relationship (A-B) cascades with others (B-C, C-D, etc. -> A-B-C-D-...) across the community network.

This offers considerably more intelligence than looking at a relationship only as a direct line between two parties. This means the platform can surface the possible paths (combinatorics) to local self-sufficiency, even if partial and improving.

In other words, it helps the local supply and demand actors, as well as community stakeholders, arrange themselves in economic flows that support local resiliency and sovereignty. All the actors get more information that is typically available in flat marketplaces, and a richer engagement.

7. How could the app tie into current and future food production beyond THRIVE?

Local farms

Local farms can become suppliers at an equivalent level as the THRIVE growing system, and benefit from the same demand information, consumer and investment forces in the new marketplace. The app platform would create a novel information space where multiple suppliers for a more general economic objective can connect with the related stakeholders.

The farmers' market

The app platform can become a digital extension of the Saturday farmers' market that can operate 24x7. It would not replace the physical market, as pick-up, drop-offs, and meet-and- greet would still primarily happen there.

Restaurants

The app platform can allow Bowen (and maybe Vancouver) restaurants to offer "locally grown" labelled creations. It could also offer Bowen and off-Island restaurants a more expedited and predictable supply of certain ingredients.

Local individual/resident producers, growers, gardens, etc

The distribution and sales functions are often the most underdeveloped for such growers. The app could allow them to tap in easily into the unified marketplace and functionalities. They can see unique growing opportunities, where they can place excess, and engage in selling, with less administrative overhead.

Victory Gardens 2.0 (networks of neighborhood/individual gardens et al.)

One key challenge with the "victory gardens" concept is between a garden growing enough diversity on one hand, and on the other hand coordinating with other gardens on who will grow what and how much. This is precisely the unified information space that the app platform can provide between individual or collective growers, without anyone doing central planning but by networking the distributed market relationships.

APPENDIX 4

GROWING RESOURCE GUIDE

The Many *Benefits* of Tower Garden

Why should you use Tower Garden rather than another growing method, and not just plant a few seeds in the dirt? Why even garden at all when you can buy produce from the grocery store or farmer's market?

The advantages of Tower Garden can be summarized in three words: *healthier, easier,* and *smarter.*

Here some of the benefits of gardening with Tower Garden:

Bountiful Harvests:

- Grows plants 3x faster than traditional gardening
- Increases yields by an average of 30%

Convenience:

- No digging
- No weeding
- Cuts down on grocery bills (pays for itself in about 6-12 months)

Food, Nutrition & Learning:

- Clean food
- Control over your food
- Nutrient dense
- Colorful produce
- Tastier & better smelling
- Nurtures healthy habits
- Educational resource tool

Sustainability:

- **Minimal water usage.**
  Uses as little as 2% of water as traditional gardening.
- **Leaves a smaller CO_2 footprint.**
  Reduce your carbon footprint by eliminating supermarket transit and storage.
- **Uses only 10% of the land of traditional farming.**
  The vertical design uses 90% less land normally required to grow produce.
- **Recycles 100% of nutrients and water.**
  Tower Garden uses a closed-system technology to recycle 100% of its nutrients and water.
- **Reduces need for pesticides and herbicides.**
  The pH-balanced ionic minerals and plant nutrients in the Mineral Blends produce strong, healthy plants that can better protect themselves from plant pests and disease—without pesticides.

General Tower Garden Guidelines: How (and when) to *Harvest*

Gathering *gorgeous* Greens

Most greens—such as lettuce, kale, collards and others—allow for two harvesting methods, so you may always have fresh ingredients on hand for salads and other healthy dishes.

1. **Whole plant.** Remove the entire plant and net pot from your Tower Garden or cut all the leaves off at 1-1.5 inches from the base of the plant.
2. **Cut harvest.** This technique keeps the plant alive and encourages continued production. When there are plenty of mature leaves present:
   - Harvest only a few leaves at a time, from the bottom of the plant upward.
   - Allow 2-3 leaves to remain so the plant may keep growing.
   - Repeat every 2-3 days until the plant bolts or begins flowering.
   - After bolting, replace the plant with a fresh seedling.

Picking *perfect* Produce

While tomatoes, squash, peppers and other fruit-bearing plants may be quite different, a few harvesting best practices apply to all. Do the following to improve your chances of record yields:

- Harvest frequently to promote continued flowering and production.
- When harvesting, use a clean knife or shears to avoid injuring the plant.

Harvesting *healthy* Herbs

It seems a little counter intuitive, but typically the more herbs you harvest, the more you will grow. And there's no such thing as too many herbs! Here are a few guidelines to remember when harvesting herbs:

- Harvest frequently to encourage healthy, bushy growth.
- Harvest no more than 1/3 of the plant at a time.
- Once the plant bolts (or starts to flower), replace it with a fresh seedling.

Saving Seeds

Harvesting seeds from your plants may not be something you've considered. But it's a great way to keep growing your favorite crops for free! The following seed-saving steps will apply to most plants.

- After flowering or fruiting, collect seeds from open-pollinated plant varieties.
- Wash and dry seeds.
- Store seeds in an airtight container, and place somewhere cool, dry and dark

How To *Plan* Your Tower Garden

Welcome to Tower Garden! We're so glad you're a part of our growing community and are here to help you have the best growing experience with Tower Garden, whether you have a green thumb or not! We've got you covered when it comes to planning your garden, so get ready to get planning and planting!

1. Find the Ideal Location

With a 3 sq. ft. footprint, Tower Garden fits almost anywhere. In addition to space, be sure to consider these factors when choosing a location for your Tower:

Light
Most plants need 6–8 hours of full sun or, 14–16 hours under Grow Lights indoors. Check seed packet labels for plant-specific light requirements. If you grow outside in a location with intense summer heat, keep in mind your plants may appreciate a little afternoon shade.

Water
Since Tower Garden uses a water + nutrients solution, a nearby source for clean water is critical. It's best to not use softened, heavily chlorinated or very hard water.

> ***Tower Tip:*** *To remove chlorine, fill a bucket with water and leave it out in full sun for 48 hours. Alternatively, add the water to your Tower Garden and run it for 48 hours before adding plants.*

Electricity
You'll need electricity to run the pump (and lights if you're growing indoors).

2. Pick Plants

Food preferences
What produce will you actually use? To answer this, consider what you use currently or what you typically bring home from the supermarket.

If you're new to gardening, stick with plants that are easy to grow on your first go-around like:

- **Leafy Greens:** lettuces, arugula, chard, kale
- **Herbs:** Basil, Cilantro, Dill, Mint, Parsley

Plant Arrangement and Quantity
Have your list of plants? The next step is to determine how many of each you need, and how you should arrange them. Here's a handy guide:

Ideal Planting Locations:

- **Top:** Small plants like lettuces, herbs, strawberries, chard, celery
- **Middle:** Medium Plants like peppers, eggplant, beans, kale, collards, sugar snap peas
- **Bottom:** Large plants like tomatoes, cucumber, zucchini, all squash (no more than 4 large or vine plants per Tower Garden is recommended)

For the average family, here is a guide to the number of each type of vegetable seedling we suggest planting (but of course it's up to you based on your preferences):

O= Outdoor I= Indoor

- **Herbs:** 1 of each (O, I)
- **Lettuces:** 5-10 (O, I)
- **Bell Peppers:** 1-2 (O)
- **Butternut Squash:** 1 (O)
- **Eggplant:** 1 (O)
- **Green Beans:** 4+ (O)
- **Spaghetti Squash:** 1 (O)
- **Sugar Snap Peas:** 4+ (O)
- **Summer Squash:** 1 (O)
- **Tomatoes:** 1 (O)
- **Zucchini:** 1 (O)

3. Supplies

Your Tower Garden kit comes with everything you need to get started. If you're starting a new garden or a new harvest in your existing garden, make sure you have these items ready to go before you plant:

- **Seeds or Seedlings**
- **Mineral Blend**
- **Net Pots**
- **Rockwool Cubes**

Depending on what and where you're planting, here are some additional accessories to consider that can be found on towergarden.com:

- **Support Cage (for vine growing plants)**
- **Weather Protection Blanket**
- **LED Grow Lights**

Maintaining & *Cleaning* Your Tower Garden

Daily:

- ☐ Check your plants. Look for any discolored leaves or pests.
- ☐ Check water level.
  - Keep enough nutrient solution in your reservoir so that the pump stays completely submerged at all times.
  - Add nutrients to the water every time you fill your reservoir tank. You can mix water and the Mineral Blend in a bucket prior to adding it to the reservoir (20ml each of Mineral Blend A and Mineral Blend B for each gallon of water).

Weekly:

- ☐ Prune large and faster growing plants like lettuces, baby greens, herbs, tomatoes, etc. These plants must be pruned and harvested regularly to avoid encroaching on nearby plants.
- ☐ Check the pH weekly and after refilling the reservoir, follow the instructions to adjust your pH level. Yellowing leaves are an indication that your pH may have drifted out of the recommended range.
- ☐ Keep roots away from the pump. You can trim the roots that may be dangling in the reservoir.

Monthly:

- ☐ Keep the shower cap holes clean and free from debris. You can use a toothpick to clean the holes if they get blocked up.
- ☐ Clean the pump by unplugging it, pulling it pump up through the access port and removing the pump cover. Clean with water to remove debris.

Semiannually:

- ☐ After disassembling, clean the tower sections, shower cap and lid, and the pump with warm soapy water and a sponge.

Cleanup and Storage

1. Remove the plants from the Tower Garden by pulling the net pots from the planting ports.
2. Disassemble the Tower grow pots, starting at the top. Do not remove the bottom section from the reservoir lid.
3. Compost or discard plant material. Clean and save net pots for future use. If net pots are damaged, you can order new ones at towergarden.com.
4. Unscrew the blue swivel hose from the reservoir lid and pump. Rinse pump with clean water before storage.
5. After cleaning the Tower grow pots, you can store the parts of the Tower Garden in the reservoir until you are ready to grow again.

TOWER GARDEN

What to *Grow* in a Tower Garden

All produce on a Tower Garden can be grown indoors (with LED Grow Lights) or outdoors (based on the season), but here is a list that will help guide your growing journey by plant for the best growing experience.

Indoor

Arugula • Basil • Beans • Bok Choy • Cabbage • Chives • Cilantro • Cress • Celery • Collards • Dill • Endive • Kale • Leeks • Lettuce • Mint • Mizuna • Mu Oregano • Mustard • Pak choi (and other Asian greens) • Parsley • Peas • Radicchio • Sage • Sorrel • Spinach • Swiss chard • Thyme • Mustard greens

Outdoor

Basil • Beans • Broccoli • Brussels Sprouts • Cabbage • Cauliflower • Collards • Cucumber • Eggplant • Endive • Kale • Kohlrabi • Lavender • Leeks • Lettuce • Mizuna • Mustard • Parsley • Peas • Radicchio • Spinach • Swiss Chard

Both

Collards • Endive • Kale • Kohlrabi • Leeks • Lettuce • Mustard • Parsley • Lavender • Arugula • Bok Choy • Cabbage • Chives • Cilantro • Dill • Swiss Chard • Mint • Muzina • Mu Oregano • Pak Choi (and other Asian greens) • Sage • Sorrel • Thyme

TOWER GARDEN

How To Grow Strong, Healthy *Seedlings*

The key to a healthy garden starts with strong seedlings. Whether you start your garden from seed, or purchase seedlings from a seedling provider, the overall success of your garden will depend on the quality and health of the seedlings used when starting the garden. If you use weak seedlings, you'll probably end up with slow-growing, unproductive plants that invite pests and other problems.

In this guide, you'll learn seven techniques that professional growers use to cultivate hearty seedlings that become fruitful plants.

Benefits of Starting from Seeds

Why would you grow your own seedlings rather than buy them from a professional grower? There are a few advantages:

- **You save money.** A single seedling will typically cost you about the same amount as a full packet of seeds. So for a couple of dollars, you could either get one plant or — if you choose seeds — potentially dozens.
- **You have more options.** Seedling providers offer an array of plants. But you'll find that many varieties — and often the most interesting ones — come only in seed form.

Bonus benefit: If you're gardening with kids, starting from seed serves as a fun, educational experience. What better way to learn about a plant's life cycle than to watch it from the very beginning?

7 Steps of Growing Spectacular Seedlings

With so many advantages, you may be wondering, "Why doesn't everyone start from seed?" Well, frankly, it's slower and a little more challenging. This guide will help you master the process. Let's dig in.

1 Decide the best time to plant your seeds.

As with most gardening activities, seedling success has a lot to do with timing. Start your plants too early, and an unexpected frost might kill them. Start them too late, and they may not have enough time to mature.

Fortunately, seeds often come with planting schedules stamped on their packet. But if yours don't, there are also planting calendars you can reference.

2 Gather all the supplies you'll need.

Cultivating healthy seedlings requires only a few things. First and foremost, you'll need the seeds.

You can order high-quality seeds online or from seed catalogs. Local garden shops and seed swaps are also great sources. (A key benefit of buying online is that you can often see product reviews from other gardeners, which may give you an idea of what to expect.)

Wherever you get them, you'll want to use relatively fresh seeds. After a year or two, most seeds don't germinate as well, especially if they haven't been stored in a cool, dark place.

Besides seeds, it's helpful to have:

- A seedling tray (a food storage container or glass baking dish will also do)
- Rockwool cubes and vermiculite
- Grow lights (fluorescent shop lights are an inexpensive, but effective option)
- A small fan
- An outlet timer

Tower Tip: *The Tower Garden Seedling Starter Kit comes with a seedling tray, plus rockwool cubes, vermiculite, and seeds.*

If you've used any of your seed starting supplies before, make sure to clean everything well. You don't want to expose your seedlings to disease before you even transplant!

3 Plant your seeds.

Many gardeners find that soaking seeds overnight in a shallow bowl of water improves and speeds germination rates. And this seems to work for most plants. (That being said, don't worry about soaking smaller seeds, such as those for lettuce and greens — they're too easy to lose, and they usually sprout well anyway.)

Before you plant your seeds, thoroughly soak your rockwool cubes for half an hour or so. Then plant the appropriate number of seeds based on crop type:

- **For lettuces and greens,** plant 6–12 seeds per cube.
- **For herbs,** plant up to 6 seeds per cube.
- **For vegetables with larger seeds** (e.g., tomatoes, cucumbers, peppers, beans), plant 1–2 seeds per cube.
- **For other types of seeds,** refer to the instructions on the seed packet.

Once you've planted the seeds, fill each rockwool cube seed hole with dry, coarse-grade vermiculite. (For smaller seeds, fill the hole only half-full.) This will ensure seeds have enough moisture to germinate.

> ***Tower Tip:*** *Not all seeds must be sprouted before being transplanted. Some you can seed directly into your Tower Garden. These include plants that grow very quickly after germinating, such as beans, cucumber, and squash.*

4 Provide the ideal conditions for germination.

Before your seeds sprout, temperature is a critical factor. Most leafy greens and herbs will germinate well in the 55–75˚F/13-24˚C range. But fruiting crops usually prefer the upper end of that range. If your propagation area is cooler than that, a heating mat may help.

Following successful germination, you'll want to turn off the heating mat.

5 Keep your seedlings healthy.

It probably goes without saying that your plants need water. But how much? How often? Essentially, you want your rockwool cubes to stay moist but not oversaturated. Adding about a quarter inch of fresh water (replacing any existing water) to the seedling tray daily should do the trick.

As soon as you see something green peeking out of your seeds, you should give them lots of light. Keep in mind, despite what you might have heard, light from a window — even a big, southern-facing one — likely won't be enough, especially in the winter.

If it's too cold to move your plants outside in the sun, placing a Tower Garden grow light just inches away from your young plants will work well. Seedlings will typically grow best with 14–16 hours of daily grow light exposure. (This is where an outlet timer comes in handy.)

Seeds contain all the nutrients they need for their first few weeks, but after they run out of their reserves, they'll need to be fed. So once you see true leaves — the leaves that come after the first pair of cotyledon leaves that were formed inside the seed — you can start adding a capful of Mineral Blend A and Mineral Blend B every other day to supplement your plants' diet.

6 Make your seedlings strong.

To get your seedlings ready for the great outdoors (assuming you're not planning to keep them inside), you need to toughen them up a little.

How? Routinely "pet" your new seedlings and/or set a fan to gently blow on them. This will make your plants stockier, which will help them better resist real wind and other outdoor elements. It also promotes air circulation around your plants, preventing plant diseases.

By the time your seedlings have a few pairs of leaves, weeding out the competition — that is to say, thinning some of your seedlings with a sharp pair of shears to leave only one plant per rockwool cube — can be wise.

The plants that benefit from thinning typically fall into the heartier, fruiting crop category (e.g., tomatoes, squash, peppers). For most herbs and greens, on the other hand, you can usually grow multiples per rockwool cube.

7 Transplant!

When your seedlings are about three inches tall and have roots protruding from the bottom of the rockwool cubes, it's time to transplant.

If you started your seedlings indoors, it's a good idea to harden them off before placing them in an outdoor Tower. Do this by placing them outside in partial shade for a few days before adding them to the Tower.

> ***Tower Tip:*** *Hardening off prevents shock, which can delay your plants' development.*

Finally, plug your new, happy, hardened seedlings into your Tower Garden and watch their growth explode!

Common Seedling Problems (and Solutions)

You should be closely monitoring your seedlings from the time that you plant the seeds. Here are a few common problems to watch for:

- **Seeds won't sprout.** How old are your seeds? (The fresher, the better.) Keep in mind that certain seeds may take up to two weeks to sprout. Also, see step four to verify you've created the ideal sprouting conditions.
- **Seedlings grow tall and thin.** Leggy growth likely means your plants aren't getting enough light. Confirm that they're either under grow lights for 14–16 hours per day or outside in the direct sun for 6–8 hours daily.
- **Slow growth and/or pale-yellow leaves.** Have you been feeding your seedlings? This could be a symptom of inadequate nutrition.

Troubleshooting: Common Tower Garden *Challenges* (and How to Avoid Them)

Maintenance Mistakes:

Water leaks around growing ports or section seams.
Let's begin with one of the easier problems to fix (or avoid altogether).

- To function properly, Tower Garden must be on a level surface. If your Tower Garden is leaking, make sure it's level.
- If you verify it is level, but it still leaks, you may need to simply push the grow pots together more tightly.
- If water is coming from the pump cord hole, tie a loose knot in the cord and place inside the reservoir to catch drips.

The pump suddenly stops pumping.

- Make sure the pump is plugged in properly.
- Check roots halfway through the growing season. If your pump stops working plant roots may have jammed it.
- To fix this:
  - Unplug the pump.
  - Pull the pump up through the access port.
  - Remove the pump filter cover.
  - Flush the filter with water to remove any debris.
- Trim roots that grow down into the reservoir to prevent clogging the pump.
- Trim roots up to half their length (this will not harm plants).

pH constantly drifts out of the recommended range.
Tower Garden grows plants with only minerals, oxygen and water, no soil. So, the quality of the water in your Tower Garden is very important.

Using heavy chlorinated, hard or softened water will most likely cause problems. Fluctuating pH is just one.

What to do if your pH is not balanced:

- **For hard water,** fill your Tower Garden using an RV water filter.
- **For softened water** (i.e., water from a home softener system), fill your Tower Garden using a reverse osmosis filter system or buy distilled water.
- **For heavily chlorinated water,** leave the water out in the sun for 48 hours. Alternatively, run the water through your empty Tower Garden for a day or two.

Algae growth on rockwool.
Algae growth is relatively common if it appears at the base of your plants on the rockwool. This is typically harmless to plants and not actually a problem.

Pests infest your indoor Tower Garden.
Your Tower Garden can be grown indoors or outdoors, but be aware that bringing a Tower inside from outside could come with unwanted pests. If you experience pests:

- Without natural predators indoors, pests multiply very rapidly and can become very troublesome, very quickly.
- Even if plants appear to be healthy and show no visible signs of problems, you should still think twice about bringing them inside. Aphids, small caterpillars and the eggs of certain pests can hide on the underside of leaves.
- Reducing the risk of an indoor infestation is accomplishable: start all your indoor plants fresh, and regularly check your plants for signs of trouble. The earlier you catch a pest problem, the easier it will be to control.

Plant Problems:

Seeds won't germinate.
Sprouting seeds can be a little tricky. There are a number of reasons seeds may not germinate. The three of the most common are:

- **Poor seed quality.** For best results, start with the best seeds. While the seeds that ship with Tower Garden are of top-notch quality,if you're buying new seeds, make sure to source them from a reputable provider.
- **Old or expired seeds.** Some seeds have shorter shelf lives than others. So, when in doubt, try using new seeds.
- **Temperature.** Like plants, most seeds have temperature preferences. Generally, the seeds of warm season crops germinate best in warmer environments, while those of cool season crops prefer cooler ones. In fact, some gardeners refrigerate spinach seeds—which are notoriously stubborn—to encourage germination. (If you try that, just be sure to move the seeds out of the fridge as soon as they sprout.) For seeds of warm season crops, consider using a heating pad.

If you address these factors and still have problems, here are some more tricks to try:

- **Soak your seeds.** Initially soaking seeds overnight often speeds germination, as it helps moisture break through a seed's outer coating.
- **Germinate using the "baggie" method.** The process is simple: distribute seeds on a dampened paper towel placed in an open sandwich bag. (This creates a sort of miniature greenhouse.) Check the bag every few days—moistening the paper towel as needed— and, as soon as the seeds germinate, transplant them to rockwool cubes.

Seedlings wilt after transplanting.
Though wilting can be a symptom of various problems, one cause concerns Mineral Blend concentration. Keep these points in mind:

- When you're starting a fresh Tower Garden (i.e., one full of small seedlings), you should fill it with a half-strength nutrient solution. That ratio is: 10mL of Mineral Blend A + 10mL of Mineral Blend B per gallon of water.
- If you're using full-strength nutrients and your seedlings are wilting, try diluting the solution. Your plants should perk up.
- After you've been growing for a week or so, you can increase the solution to full-strength.
- Another time you should be using half-strength nutrients is in hot weather. Heat evaporates the water more quickly, resulting in a more concentrated solution.

Plants grow slowly.
As soon as your seeds sprout, they need light. Without it, they'll grow lanky and weak, That means they won't have the resources they need to develop strong root structures. As a result, when you put them in your Tower Garden, your seedlings will likely struggle to grow (if they even survive).

So, for healthy, happy seedlings, give them light. And once they're about three inches tall and have roots protruding from the rockwool, you can transplant.

But the need for light doesn't cease post-planting, of course. Outdoors, most plants require at least 6–8 hours of sun. Indoors, they'll need 14-16 hours of artificial light. Many people assume light from a south-facing window is all indoor plants need for proper development, but the light that filters through window panes is rarely enough.

To ensure your indoor garden grows to its full potential, use LED Grow Lights.

Tomatoes (or other plants) take over.
Given free reign, certain vining plants, like tomatoes, will probably overwhelm the world. They're voracious growers, sending out vines, tendrils and roots to help them ever expand.

This characteristic makes them pretty easy to grow. Unfortunately, it also makes them bad neighbors. It can get crowded. And when plants grow together so thickly like that, they create the ideal conditions for leaf fungus diseases.

To prevent all of the above, just do a little pruning here and a little harvesting there. This will help keep your plants' growth in check (with the added benefit of making them healthier and more productive).

Plants don't produce.
With declining pollinator populations, many gardeners are finding they must "be the bee" to ensure a consistently hearty harvest.

If you're growing indoors or if you don't see many bees or other pollinators around your garden, you'll probably want to consider hand-pollinating your plants.

Crops taste bitter (or turn black and die).
There's a time for everything, but it's not always time for everything. When it comes to outdoor growing, certain seasons are perfect for growing certain crops. Others? Not so much.

Lettuce is refreshing and delicious in the fall and spring. But try growing it in late July, and—depending on your growing zone—it will likely bolt.

Likewise, if you try to grow tomatoes in November, they may not even make it past the seedling stage. And as soon as a little frost hits, they won't make it.

So be strategic about what plants you decide to grow each season.

Best *Herbs* to Grow in Tower Garden

Most herbs grow well indoors, but the following 15 in particular really thrive and require little attention. In addition to tasting great, many of these herbs will infuse your air with spirit-lifting aromas and your body with health-boosting nutrients.

Note: *Tower Garden allows you to grow up to 20 plants at once. So you can grow every plant on this list — and then some.*

Basil

Commonly used to make pesto, basil's sweet and spicy flavor complements a range of dishes, from Italian pastas to Thai curries. This herb also reduces inflammation and supports the digestive system.

Chamomile

When brewed as a tea, chamomile has a calming effect and can even diminish feelings of depression and anxiety. It also helps settle upset stomachs!

Chives

Related to onions and garlic, chives add a delicate onion-like flavor to everything from omelets to potato salad. And since it's most delicious when used fresh, it's a great herb to grow yourself.

Cilantro

Cilantro tends to have a polarizing effect. But for the fans, this herb is a delicious addition to spicy foods. (Think salsas and stir-fries.) It may also help inhibit blood vessel damage and support digestive health.

Dill

With a buttery flavor, dill elevates fish and egg dishes. Is it good for you? Well, let's just say its antioxidant count rivals superfoods, such as kale and pomegranates. The herb also supports digestive health.

Lavender

Lavender has calming properties and is good for your skin. It's often used to make teas and essential oils, but you can add the herb to salads and other dishes, too.

Lemongrass

Offering digestive tract support and anti-inflammatory benefits, you can use lemongrass to make a restorative tea or a satisfying soup.

Marjoram

A close cousin of oregano, marjoram is typically used to add light, zesty flavors to meat or potato dishes. It also offers digestive and antiseptic benefits.

Mint

Peppermint, spearmint, lemon balm, catnip — virtually all plants in the mint family flourish indoors. Whether you use it to brew tea or top off that cocktail, mint adds an unmistakable flair. And regularly consuming mint may guard against age-related diseases (as well as bad breath).

Oregano

Reportedly good for keeping your cholesterol in check, this herb is a staple in pasta sauces and as a pizza topping.

Parsley

More than garnish, parsley can add flavor to a variety of dishes from salads to pastas to soups. It's also a strong antioxidant.

Rosemary

With a minty, pine-like aroma, rosemary adds depth to chicken, bread, and potatoes. Steep it in hot water for a healing tea that eases inflammation and promotes brain function.

Sage

Though it's most famous in holiday dishes, sage can be used for so much more. Try adding it to potatoes or quinoa to enjoy its throat, skin, and hair health benefits.

Stevia

The healthy alternative to sugar, stevia is a surprisingly sweet herb that pairs well with beverages, fruit, and many other foods.

Thyme

Add this potent herb to vegetable and grain dishes, and you'll never want to go without it again! Containing antibacterial properties, thyme is useful for treating winter colds.

Harvesting *Herbs* with Tower Garden

Nothing quite beats the aroma and taste of fresh herbs picked straight from your own garden. The perfect addition to everything from soups to stews, fresh herbs are packed with flavor and nutrients like calcium, iron, and antioxidants. While harvesting herbs is fairly straightforward, it's important to get the timing right. If left too long, herbs will start to flower and take on a bitter taste.

To ensure your crops retain all of their amazing flavors and nutrients, follow these harvesting best practices for 5 popular herbs that can be grown with Tower Garden:

Basil

- Frequent picking (up to twice per week).
- Pick roughly 6-8 leaves.
- Pinch or cut stem tips above where plant branches.
- If production slows, harvest the entire plant by cutting stems at its base.

Dill

- Harvest frequently to encourage healthy, bushy growth.
- Harvest no more than 1/3 of the plant at a time.
- Once the plant bolts, replace it with a fresh seedling.
- If you grow dill outside, consider letting it flower. Bees and other pollinators love it!

Chives

- Harvest at 6 inches tall
- Use a sterilized pair of scissors to cut the plant's outside leaves two inches above the base of the plant.
- Harvesting half at one time will result in the same clump of chives producing multiple yields throughout the growing season.
- Cut chive plants regularly to encourage new bulblets to develop and prevent leaves from becoming tough and flowers from forming.
- Chives dry and freeze well.
- Experience full flavor and optimal nutritional eating fresh.

Cilantro

- Snip the bottommost leaves at the base of their stems.
- Remember to never take more than a third of a plant at once.
- To save coriander seeds, cut them from the plant and place them in a paper bag until they fully dry and fall off the stems.
- Cilantro leaves lose most of their flavor when dried. So for tastiest results, use them fresh or freeze for later.
- And if you're cooking with cilantro, add it last to preserve the herb's bright flavor.

Parsley

- Parsley can take up to 90 days before it's harvest ready.
- Harvesting approximately one-third of a parsley plant at once will keep it healthy and productive. Snip off the stalks close to the base, beginning from the outside. (If just the tops are cut off and the leaf stalks remain, the plant will be less productive.)
- You should pick parsley throughout the growing season to ensure a continual harvest and prevent a leggy plant structure. It's also wise to trim unhealthy leaf stalks at the base of the plant and discard them.

Harvesting *Greens* with Tower Garden

Did you know that most produce loses 30% of its nutrients within just three days of harvest? And in some cases, the nutrient loss is much worse. Spinach, for example, loses 90% of its vitamin C content only 24 hours after being picked! By eating a plant that you harvested from your garden the very same day, you're ensuring peak *freshness*, *flavor*, and *nutrition*.

To ensure your crops retain all of the amazing health benefits and flavor profiles, follow these harvesting best practices for 8 popular greens that can be grown with Tower Garden:

Amaranth

- Amaranth greens are usually ready for harvest 3-4 weeks after planting.
- Simply cut the bottommost, older leaves first, taking care to not damage the stems of the inner leaves.
- If you allow at least 2/3 of the foliage to remain, the plant will produce additional yields — as frequent, moderate harvesting encourages new growth.

Baby Greens

- After you transplant your baby greens, your Tower Garden will do most of the work. And in two or three weeks, your crops will be ready to pick.
- Many people harvest baby greens as soon as the first true leaves (i.e., those that come after the cotyledon leaves that form inside the seed) appear. The drawback to this approach, however, is that you get only one harvest from each seed.
- If you let your baby greens grow a little longer — to the point of qualifying as petite or baby greens — you can actually harvest repeatedly from the same plants for weeks by taking only the older leaves and allowing the new growing tips to remain.

Broccoli

- After 80–100 days, your broccoli heads should be ready to harvest. But you can harvest leaves long before that time.
- Broccoli leaves are not only edible, but also highly nourishing and as versatile as broccoli heads. To harvest broccoli leaves, simply cut them from the plant, always allowing a few to remain and keep growing.
- When your broccoli plant produces heads that are firm and tight, harvest them quickly — before they flower — considering the following:
    - You should cut heads (along with about six inches of stem) at a slant to keep water from pooling in the main stalk and causing rot.
    - After the primary head is harvested, you can continue to harvest side shoots for several weeks.
    - If you don't enjoy your homegrown harvest right away, you can blanch and freeze your broccoli to preserve it.

Brussels Sprouts

- After about 90 days, you should start to notice little buds growing along your plant's main stalk above the base of each leaf.
- Once they reach about 1–2 inches in diameter, harvest these by twisting until they snap off of the stalk.
- You can also remove them with a sharp knife.
- Cutting away leaves around the sprouts may make this process a little easier.

Kale

- Kale is one the fastest growing plants in your Tower Garden, and depending on the variety and growing conditions, may be ready to harvest in as little as one month.
- Pick or cut the bottommost kale leaves first, allowing at least three or four leaves to remain and keep growing.
- Frequent harvesting will foster new growth.

Lettuce

- About 45 days after starting seeds — or whenever there are several mature leaves present — you may start harvesting your lettuce.
- There are two ways to harvest:
  - Periodically pick individual leaves, which allows the plant to continue to produce.
    - For the leaf harvest method, start from the bottom of the plant and pinch off or cut only a few leaves from each lettuce plant. Always allow two to three leaves to remain so the plant has enough energy to keep growing.
    - You can harvest like this every week until the plant shows signs of bolting. (In spring and fall, you can usually harvest for more than a month before bolting begins. In summer, this harvesting period will likely be a bit shorter.)
  - Harvest the entire plant once it grows to a full head. If you'd rather use the whole head harvest technique, simply cut or remove the entire plant once the lettuce head reaches the size you desire.

Spinach

- You can harvest spinach (starting with the outer leaves first) as soon as the leaves are big enough to eat.
- Harvest often to encourage continued production, prevent disease, and extend your plant's life cycle. If you notice signs of bolting (e.g., sudden vertical growth), harvest the entire plant to prevent the remaining leaves from becoming bitter.

Swiss Chard

- Swiss chard is sweetest and most tender during the cooler temperatures of spring and fall. And yields are most flavorful once the plant is 50 to 60 days old.
- Harvest leaves when they are four inches long by cutting leaf stalks near the base. (Be careful not to cut the stems of the inner leaves, as this will stunt additional growth.)
- Start with the mature leaves, picking three to five at a time. And don't be shy about harvesting often, as this will stimulate the production of new leaves.

Harvesting *Fruiting* Plants with Tower Garden

To get the most out of your fruiting plants, like eggplant and tomatoes, it's important to harvest them at the right stage of maturity. This will ensure optimum *flavor*, *quality*, and *nutritional* value. The trouble is, knowing the signs of maturity and harvesting methods for each crop can be a challenge, even for more experienced gardeners. Not to worry, Tower Garden is here to help.

To ensure your fruiting plants are harvested at the right time and maintain all of their great flavors, follow these harvesting best practices for 8 popular fruiting crops that can be grown with Tower Garden:

Cucumbers

- Cucumbers will start producing fruit around 50 days after germination.
- Harvesting will produce one to four pounds of cucumbers a week for up to 10 weeks, with proper care.
- Most cucumber varieties are mature at eight inches in length, but can be picked at any size, as long as they don't get overripe (i.e., smooth, bloated, and yellow).
- Harvest by cutting the stem above the fruit — twisting the fruit from the vine may damage the plant.
- Check at least twice a week, and harvest frequently to encourage additional fruit to develop.

Eggplant

- Eggplant may be ready to harvest as soon as one month after transplanting seedlings.
- Harvest eggplant fruit when it is about half a foot long.
- Cut just above its cap with a knife or shears to avoid injuring the rest of the plant.
- Eggplant does not store as well as other produce. Cook immediately for the best flavor.
- Avoid leaving mature eggplant fruit on the vine for very long. Once they grow too large, the fruit will become pithy and may taste bitter.
- As a visual cue, fruit that has lost its glossy sheen or lightened in color is probably past its prime. If this happens, remove the mature eggplants from the vine so that other fruit may develop.

Green Beans

- Green beans will be ready to harvest about a month to six weeks after transplanting seedlings.
- To harvest, snap or cut the beans from the stem, taking care to not damage the plant. For best taste, harvest before the beans show excessive swelling.
- Your first harvest might be just a few pods, but as the crop matures, harvests will be more plentiful. Regular harvesting will promote the production of new pods.
- When the plant's most mature leaves turn yellow or brown, your green beans will likely stop producing within a few weeks.

Peas

- You should expect to be harvesting your sweet green peas around 65 to 75 days after germination. Depending on the variety, peas may indicate that they are harvest-ready in other ways:
  - Pick English peas when they're firm but still succulent.
  - Pick snap peas when the pods are crisp and round.
  - Pick snow peas before the swelling seeds within the pod become too evident.
- Pea pods are firmly attached to the vine. To harvest, hold the vine in one hand and twist the pod off the vine with the other. This will protect the vine from injury. You should harvest your peas often to promote continued flowering and production.

Peppers

- Peppers are ready to harvest about 65 to 85 days after transplanting seedlings. Most change color from green to red, yellow, purple, or orange when they're ripe.
- As the color of the fruit changes, so does the flavor. But peppers don't continue to ripen once you remove them from the plant. So, you should leave them attached until they're as ripe as you want them.
- It's perfectly fine to harvest peppers before they reach full maturity — the immature fruit of some varieties are more flavorful. (Jalapeños, for example, are commonly harvested when green, even though they aren't fully ripe until they turn red.)
- To harvest, use a knife or shears to make a cut above the cap of the pepper, leaving a portion of the stem attached.

Strawberries

- Everbearing strawberries planted in the spring should start producing fruit by early summer. And once berries are red, they're ripe and ready to eat!
- To harvest strawberries, cut the stem just above the fruit. (Don't pull the berries, as this may damage the plant.)
- You should enjoy your harvests as soon as possible because the natural sugar in strawberries converts to starch soon after the fruit is picked.

Squash

- Most summer squash varieties will be ready to harvest about 60 days after planting.
- To harvest, simply cut fruits from the vine once they are 6–8 inches long. If you wait much longer, they will become less tender and flavorful.
- In the winter, when the rind of a fruit is hard enough to resist being punctured with a fingernail, it's ready to harvest.

Tomatoes

- Tomatoes will always mature in the order that the tomatoes appear on the truss (i.e., the fruit closest to the branch stem will mature first).
- The time it takes for a tomato plant to produce fruit depends on an array of factors, such as the plant variety, weather, pollination, and more.
- But once you *do* see fruit, your first clue that a tomato is ripe and ready to pick is its color: It should be a deep red (or yellow or purple, depending on the variety).
- Your second clue is the fruit's hardness. The riper a tomato gets, the softer it will become. A perfectly ripe tomato has some give but is not mushy.
- A ripe tomato should easily "pop" off the truss when it's ready to harvest. But if you like, you can harvest the entire truss by cutting the stem attaching it to the main branch.