

PLANNING FOR SMALL-SCALE CONTROLLED ENVIRONMENT AGRICULTURE



The information in this guide comes from interviews with First Nations communities and Indigenous organizations in B.C. that are operating or considering investing in a small-scale Controlled Environment Agriculture system, as well as from other technical experts in these systems. It was created with the intent of highlighting key considerations through the planning and decision-making process. If you are considering a Controlled Environment Agriculture system for your community or organization, we hope this will be helpful in deciding if this kind of crop production is a good fit.

WHAT IS SMALL-SCALE CONTROLLED ENVIRONMENT AGRICULTURE?

Controlled Environment Agriculture (CEA) is the production of food, medicine, or other crops inside a structure, where some or all aspects of the growing environment (light, heat, humidity, and ventilation) are controlled to support plant growth. While CEA operations can include greenhouse production or growing food indoors on a single shelf, this resource is focused on containerized CEA such as a reused shipping container or purpose-built container of a similar size. This technology has been commercially developed over the last decade and is still relatively unproven. As with any new technology, those investing currently face increased risks of downtime, high support costs, and obsolescence as systems improve.

WHAT CAN YOU GROW? BEST FOR GROWING LEAFY GREEN VEGETABLES

While researchers and manufacturers continue to work on developing technologies and systems for producing a variety of crops, including strawberries and other fruiting plants, as of 2024, commercially available container production is best suited for a small range of leafy green vegetables, due to factors like quick turnaround and a high production volume to space requirement. These crops also have a short shelf-life and when supply chains are long, the decline in quality is noticeable. The most suitable crops include lettuce, spinach, Asian greens, and some herbs, such as basil and cilantro. Some Indigenous growers are also working on producing culturally-important food or medicine plants that have become difficult to obtain.

INDIGENOUS COMMUNITIES' USE OF CEA UNITS: BEST AS PART OF A COMMUNITY FOOD PROGRAM

Across a range of ecological zones throughout Canada, some Indigenous communities have invested in producing vegetables in CEA units, with varying degrees of satisfaction. Communities using CEA for food production are likely to be rural or remote, and may not have reliable access to quality produce at a reasonable cost.

Commercially successful production may be possible with multiple containerized units under the right circumstances; however, making a profit is unlikely for small operators with current technology and costs of production. Producing crops with this kind of system is best suited as part of a focus on community food production, as one way to increase food security and food sovereignty by providing fresh, nutritious produce to community members. In comparison to less intensive production systems, such as a greenhouse, the cost of initial investment and ongoing operation of these units is relatively high. Communities may want to explore operational cost-recovery options such as in-community cost recovery through ongoing programs, or through commercial production. If cost-recovery is not desired, an ongoing subsidy will be required to cover costs. This document focuses on the potential for small-scale commercial sales as a mechanism to recover costs, while acknowledging this may not be the path of choice for some communities.

If grant funding does not cover the purchase and set-up, the investment is unlikely to pay off for your community. Any grant funding used for a CEA unit may come at the cost of other opportunities to build up other aspects of a community food system. Talk to the community, considering priorities and options carefully before deciding to purchase a unit.



OPPORTUNITIES AND CHALLENGES OF SMALL-SCALE CONTROLLED ENVIRONMENT AGRICULTURE

CEA units are often promoted as straightforward, turn-key operations that provide large yields of fresh produce continuously. In reality, these units are complex and yields can vary, particularly during the start-up phase. CEA units also require an appropriate site, reliable power and water, and most importantly, people with the right attitudes, skills, knowledge, and supports to operate them successfully.

OPPORTUNITIES

- Year-round, consistent crop production.
- Reduced reliance on shipped produce.
- Crops protected from weather related problems, including storms and excessive heat.
- Small physical footprint.
- Can be sited on land unsuitable for agriculture.
- Contribute to a more localized food system.
- Potential to support community health with fresh, nutritious produce.
- Crops may be higher quality than those available in area grocery stores.
- Potential for employment and training of community members.



CHALLENGES

- Need for consistent, skilled labour.
- High capital cost.
- High ongoing operational costs.
- Need for high amounts of electricity and backups for power outages.
- Need for clean and consistent source of water.
- Need to dispose of fertilizer/nutrient waste.
- Crops suitable for production are currently limited to leafy greens, which may not be aligned with community tastes and dietary preferences.
- Suitable crops are highly perishable, requiring cold storage/transportation and rapid distribution.
- Requires daily labour and a rigid schedule of sanitation and maintenance.
- Ongoing reliance on supplies (nutrient inputs, parts, etc.) and expertise shipped from outside the community.
- Problems with technology, disease, pests, power supply, or labour could cause complete crop loss.
- Success requires a high level of community support and engagement.
- Success requires effective leadership and project management, both during the implementation and for long-term viability.

BEFORE PURCHASING OR APPLYING FOR FUNDING TO PURCHASE CEA UNITS

Here are some things to consider before applying for available funding:

COMMUNITY SUPPORT AND ENGAGEMENT ARE KEY FOR PROJECT SUCCESS

- Has your community already planned to work on food security or sovereignty? How would this fit in?
- How suitable is this project for your community? Are there other options that would better meet community needs?
- Are there other community projects that will support success in this project? Spend time thinking about where and how things can work together.



NEXT STEPS:

- Look for funding to cover the costs of assessing the feasibility of a CEA unit.
- Talk to other Indigenous communities or organizations with experience operating a CEA unit. If you aren't sure who has one, ask CEA suppliers or the Ministry of Agriculture and Food to connect you with someone willing to talk.
- Think about who would operate a unit. This is skilled work that requires consistent availability. Labour is a major factor in success and the biggest operating expense. See the labour needs section below.

PLAN FOR POTENTIAL MARKETS AND REVENUE

Consider the kinds of produce that members of your community like to eat.

- Is there demand for lettuce, salad greens, or fresh herbs?
- How often, and in what quantity do people eat these foods?

Explore the potential for demand for leafy green vegetables from:

- Internal customers such as restaurants or catering businesses your organization owns, or community, school, or health facility food programs your organization delivers.
- Sales to community members.
- External customers such as restaurants or locally owned and specialty grocery stores.
- Sales to individual residents in nearby areas.
- Sales to nearby work sites or camps.



WITH EACH OF THESE POTENTIAL PURCHASERS, ASK:

- What kinds of leafy green produce would they want?
- Where do they currently buy this produce, and what price do they pay?
- What volume of produce would they want, and how often?
- Do commercial purchasers want crops of a specific size, visual quality, or packaged in a specific way?
- Do they require CanadaGAP food safety certification or something similar? See the Licensing and Regulatory Requirements section for more food safety considerations.

UNDERSTAND THE OPERATING COSTS

- Gather information on operating requirements from both potential suppliers and others operating similar systems, including labour, electricity, water, seeds, nutrients, packaging, and waste disposal.
- Plan for labour needs for every part of operations, including coordination, ordering supplies, propagation, harvest, packing, sales, marketing, maintenance, food safety and trackability systems, bookkeeping, and other administration.
 - What staff position would do each task? Plan to reduce the impact of turnover by ensuring staff can step in for each other.
 - How much time is needed each month for each task?
 - What would the labour cost be?
 - Would you need to hire contract trades companies for maintenance?



CONSIDER:

How would you transport crops to each market? Leafy greens have a relatively short shelf life and need to be maintained in a refrigerated cold chain for storage and distribution. Focusing on sales to the immediate community or offering a convenient pick-up point can reduce transportation costs.

UNDERSTAND TYPICAL PRODUCE YIELDS, AND PLAN TO BUILD CAPACITY AND MARKETS

Hydroponic produce is a premium product, with high costs of production. It may take time to develop recognition of this among your community or consumers, and you may have to build up to the wholesale or retail price you need to cover costs.

THINK ABOUT:

- How do the costs of operation, projected yields, and potential revenue compare?
- How will you cover operating costs in the early stages?

FIND A SUITABLE LOCATION FOR THE UNITS YOU ARE CONSIDERING

The cost of site preparation can be high. While these units are easily shipped and self-contained, they need an appropriate site and dropping them on an existing parking lot may not work. Consider costs of excavation, gravel, upgrading power transformers if needed, and getting power, water, and data connections installed.



PLANNING:

- Choose a location that increases efficiencies for operation and crop distribution, and avoid those that will create extra work or increase time required by operators.
- Talk to the community about the potential location. Are there other uses this land is being considered for?
- Are there regulatory requirements for using this land, such as zoning regulations or a process required by your Nation's land code?



PLANNING (cont):

- What is the process for gaining permission to put one or more units on the site?
- Are there reliable sources of power and water nearby? What are the costs of bringing these services in to the desired location? Hard wired internet may also be required for some units.
- Will you need to mitigate problems with the site, such as poor drainage? Are upgrades required to the vehicle access to the site?

OTHER INFRASTRUCTURE NEEDS FOR SUCCESS

There are a variety of licensing and regulatory requirements that may apply to any commercial production and sale of vegetables, including production and business licensing, purchaser requirements, and food safety regulations.

CONSIDER:

- Where will you wash and pack your crops?
- What are you planning for cold storage?
- How are you planning to distribute your crops?

LICENSING AND REGULATORY REQUIREMENTS

There are a variety of licensing and regulatory requirements that may apply to any commercial production and sale of vegetables, including production and business licensing, purchaser requirements, and food safety regulations.

PLANNING:

- The BC Vegetable Marketing Commission (BCVMC) regulates commercial vegetable production in the province, under the Natural Products Marketing Act and its Regulations. Those producing regulated vegetable crops for sale, including lettuce, should contact the BCVMC before starting production. Anyone who has produced gross value of \$5,000 or one tonne of regulated product in the previous 12 months is considered a commercial producer and requires a licence. Your production location, size, product line, production yields and sales channels will impact how regulations apply. For more information, contact the BCVMC at info@bcveg.com or 1-800-663-1461.
- Regional and First Nations Health Authorities licence food premises, including food stores.
- Local or regional governments of areas where you plan to sell your produce may require a business licence for operation.
- Retail and wholesale purchasers may require certification under the CanadaGAP certification food safety program for Good Agricultural Practices or something similar.
- Your farmers' market may require vendors to have MarketSafe certification.
- Both aeroponic and hydroponic production are prohibited under Canadian National Standard for organic food production, so certified organic production is not possible in most cases.



PLANNING FOR A SAFE AND EFFECTIVE HARVEST

Food safety begins with the production of food. If you're growing fresh vegetables for consumption, you should follow Good Agricultural Practices (GAPs) to minimize the risk of food borne illness. See the BC Good Agricultural Practices Guide for more information.

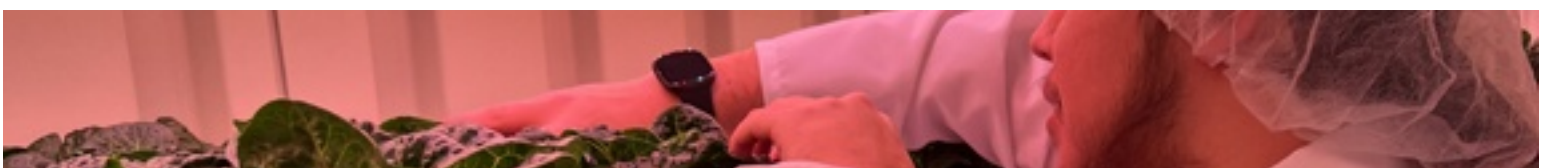
STANDARD OPERATING PROCEDURES (SOPS):

SOPs are step-by-step instruction guides for tasks performed in your farm, that in many cases can help support food safety through required recordkeeping, ensuring consistent production and harvest practices, allowing traceability of produce, and providing clear explanations of tasks. They also reduce the risk of disease or pest problems, facilitate training, and make the farm more efficient. You will need to obtain or develop SOPs for many areas of farm management, including biosecurity/farm access, cleaning and maintenance, production, harvest, post-harvest handling, storage, and distribution.

CHOOSING A SUPPLIER

There are several different companies that supply prebuilt or made-to-order units for containerized crop production. It's important to choose the right supplier for your investment. Here are some things to think about when making that decision:

- This is a significant investment of available resources. Don't be pressured into rushing the decision-making process. Consider and compare multiple suppliers before deciding on the right one.
- What kind of timeline are they proposing? Some suppliers will produce each unit to order, while others may have products on hand. While it can be tempting to move quickly, it may be more important to get the right product for your situation.
- Talk with suppliers about how their current order demand levels or the timing of your order will affect delivery time. Delivery may be delayed when ordering during high-demand periods. This may be hard to avoid if funding is available at specific times.
- What support does each supplier offer with and after purchase?
 - How and where will they train your staff on operating their product?
 - Does their training seem reasonable to build the skills needed for successful operation?
 - Can you continue to access training on an ongoing basis as your staff change?
 - What technical support is provided after the container is operational, and for how long?
 - What are the ongoing costs of supports or products provided?
 - How often will you need to order crop inputs such as nutrients? What will the shipping of these products cost?
 - Is there local or regional support available if repairs are necessary?



CHOOSING A SUPPLIER (cont.)



- Does operating the container require you to buy products or services from the supplier, or are system components, seeds, nutrients, and other supplies available from other sources?
 - Is there an ongoing subscription cost for software or other services?
 - Will choosing this supplier create a dependence on them for future maintenance and operation of the farm? What happens if they stop operating?
- Are their products custom-fabricated or built with reused shipping containers?
 - Systems using reused containers should cost less, but the condition of the container and risks of contamination from previous users are unknown.
- Are their products approved by the Canadian Standards Association (CSA)?
 - This can be important for the electrical permit needed to connect the unit to the power supply. If a unit is not CSA approved, the electrical inspector may require all wiring to be visible for their inspection.
 - How does the supplier support you to get required permits?
- Are their products designed with Canadian food safety and Hazard Analysis Critical Control Point (HACCP) development in mind?
 - Do they provide quality SOPs for some or all aspects of production, harvest and handling?
- What kind of growing system do their growing units use?
 - See the section on growing techniques for common systems.
 - Is it flexible enough to allow production of different produce, such as lettuce, Asian greens, microgreens, and herbs?
 - Does the water supply need to be filtered before entering their units?
 - What is this the right system for your situation?
- Are the yields they predict reasonable?
 - Do they include information on the expected size or weight of produce?
 - Are their stated yields backed up by documented research trials?
- The insulation rating of a growing unit could significantly impact energy costs or even feasibility during periods of extreme cold or heat. Is their product suited for your location?
 - What is the insulation rating?
 - Are the methods of heating and cooling the unit appropriate for your site?
- How many similar projects has the supplier completed?
 - Can they supply the contact information for references from Indigenous communities they have worked with?
 - A reputable supplier will have supportive customers. Call the references and ask about their experiences and any problems they had. Confirm the costs, potential yields, and any other information provided by the supplier with them.
- Review the proposed contract carefully.
 - Be wary of unclear contract language that may lead to disappointment and unrealized expectations.

GROWING TECHNIQUES

There are many growing techniques that can be used in a CEA system, but the most common in commercially available units are aeroponics and hydroponics. There are advantages and disadvantages to each type of system, but all require skilled operation and a high level of attention to detail for success.

AEROPONICS

Plants are suspended with roots exposed, and the roots are misted with a solution of nutrients on a controlled schedule.

- Pro: With aeroponics, plants may be grown in vertical towers, allowing a higher density of crops.
- Con: Aeroponic systems often lack flexibility for different kinds of crop production and are highly sensitive to crop damage if power is lost.

HYDROPONICS

The most common hydroponics systems are Deep-Water Culture (DWC) and Nutrient Film Technique (NFT).

DEEP-WATER CULTURE: Plants are suspended on rafts floating in tanks of aerated nutrient solution, and their roots remain submerged in the solution constantly.

- Pro: Provides more stability in the case of power loss, as roots are completely submerged in nutrient solution.
- Con: Requires more frequent maintenance and cleaning than Nutrient Film Technique.

NUTRIENT FILM TECHNIQUE: Plants are grown with their roots in an enclosed channel, and a thin film of nutrient solution is constantly flowing through the channel and over the roots.

- Pro: Requires less maintenance than Deep-Water Culture.
- Con: Power or pump failure can quickly lead to significant crop damage, as roots are exposed immediately.



LABOUR NEEDS



Who will be responsible for operating your container farm?

Labour was identified as the most important factor for successfully operating a container farm by all Indigenous operators and other technical experts that provided advice for this resource.

A container farm is a collection of complex tools that work together to allow for indoor crop production. All tools need to be used by a knowledgeable, skilled operator to be effective. Before they can succeed, operators need to learn about and have hands-on experience with the unit they are expected to operate and have supports in place if they have questions or problems arise. They also need to have the right attitude and appropriate supports. Like all agriculture, successful hydroponic production requires consistent, attentive, and daily management.

LABOUR TIPS

Find the right operator.

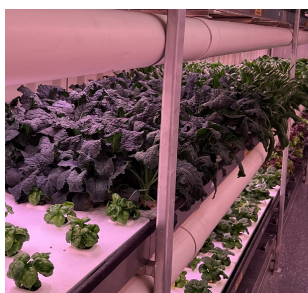
- The precision management needed for successful production works best with one skilled person responsible for production and supervising the rest of the team's work.
- Growers should have high level attention to detail and organizational skills and may need tolerance for long periods working alone. Training in horticulture is desirable.
- Budget at least 30 hours per week for production and management tasks inside one container. Attention is crucial for healthy crops, and the grower should spend time with them every day.
- Training community members who are less likely to move elsewhere for growing roles can reduce the need to recruit and train new growers.

Support the main operator with a team.

- Consider a small team with some workers focused on packing crops and delivering product, but with some training and duties inside the production unit to allow the main operator to take a day off while developing worker skills.
- You could pay packers by the volume of crops packed instead of an hourly wage. This provides incentive and can increase productivity significantly.
- Time for marketing, product transport, and administration also needs to be considered.
- Container farms need skilled and dedicated labour. Having volunteers work in these farms is not recommended due to the need for consistent procedures.

Make sure the right part of your organization is responsible for farm operations.

- Staff responsible need the ability to make financial and management decisions without waiting for processes such as band council meetings.
- Be prepared for events such as the sudden loss of an operator by cross-training others in your organization.



TIPS FOR SUCCESS

- ❑ Budget for an adjustment period while you adjust to production and learn how to address mistakes. You are likely to lose money in the early periods, and need to cover operating costs until consistent production improves. If you have not secured funding to cover this start-up period, your organization will need to subsidize these costs.
- ❑ Learning, understanding, and mastering the consistent operation of this technology will take training and a period of trial and error. Expect some problems with production during the first few years.
- ❑ Start slow: use a portion of the unit for initial production. This way, any problems with start-up have reduced impact, and workers can focus on learning to operate systems correctly with reduced complexity. Make sure you have production issues addressed before expanding the area used. Starting with smaller quantities also lets you build demand.
- ❑ Stick to a strict cycle schedule, even if it means harvesting and disposing of healthy crops that exceed current demand. If you leave crops growing in the container at harvest time, it can disrupt your planned production schedule and lead to problems further down the road.
- ❑ In your funding proposal, plan for time to secure and prepare your site, get your product delivered, hire and train staff, and get operations running before the funding has to be spent. Consider every potential risk or challenge, plan for the outcomes of worst-case scenarios to avoid surprises later.



SETUP AND OPERATIONAL COSTS

Estimated setup and ongoing operational costs can be highly variable. There is limited information available and any costs presented here are estimates. Each project will have unique challenges and costs.

Depending on materials used and systems included, commercial units could cost between \$200,000 and \$375,000, with container construction (used vs. purpose-built) being the main cost factor. Unit delivery, set-up, and operator training may be included, or could cost extra. Site preparation and utility set up could cost anywhere from \$10,000 - \$50,000 or more, depending on conditions. After the initial adjustment period, regular operational costs may be typically between \$4,500 and \$6,500 monthly, depending on costs of electricity, labour, packaging used, and other inputs.

SETUP | Use this table to estimate setup and operational costs as you are planning your project.

ITEM	ESTIMATED COST
Site preparation (gravel, excavation, etc.)	\$
Utility installation (power, water, data)	\$
Transformer upgrade if necessary	\$
Production unit	\$
Delivery	\$
Set-up	\$
Hiring	\$
Training	\$
Cold storage	\$
Distribution	\$
Other:	\$
TOTAL	\$

ONGOING | There will be a developmental period where costs will be the same or higher but income is limited as your team learns to operate effectively. This period could repeat with any employee turnover.

ITEM	ESTIMATED COST
Labour (including growing, harvesting, washing/packaging, distribution, marketing, administration)	\$
Utilities (power, water, internet)	\$
Growing materials (fertilizer, seeds, etc.)	\$
Packaging and sales materials	\$
Distribution	\$
Insurance	\$
Software upgrades/manufacturer support	\$
Maintenance	\$
Other:	\$
	\$
TOTAL	\$

We hope this resource has given you some things to think about as you consider investing in small-scale CEA production. For more support on this issue, contact the Ministry of Agriculture and Food's Indigenous Food Systems team - IndigenousFoodSystems@gov.bc.ca

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