Guidelines for Establishing a Northern Greenhouse Project

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Why a Greenhouse?

Although many good things are happening in the north, one area that continues to pose major challenges is the health of the northern population. Northern residents in general, and aboriginal ones in particular, have lower life expectancies than their southern counterparts, in some cases by 12 years. Obesity and diabetes are reaching epidemic proportions, resulting in lower quality of life, disability, and crippling health care costs.

There are a number of factors contributing to the poor health of many northern communities, but perhaps none more important than the accessibility and affordability of good quality food. Country food – traditional foods such as fish, moose, whale, seal, caribou and berries – is still the best source of healthy food for northern communities for both nutritional and cultural reasons. But the north is also a modern place, with urban areas and wage employment that doesn't allow for subsistence hunting as the sole source of nourishment. In addition, fresh fruits and vegetables make an excellent complement to traditional foods even where that source of food is sufficient.

Because of the high cost of importing food into the north, a consequence of the remoteness of many communities and sparseness of the population, many northerners have become reliant on packaged foods that are cheap to transport, last a long time, and are easy to prepare. Healthy options such as fruits and vegetables are often prohibitively expensive, and when available are often of poor quality.

A commercial or community greenhouse is not *the* solution to northern health and food security, but it is certainly *a* solution. A local greenhouse can contribute not only to improved health through better quality and nutritious foods, but also science

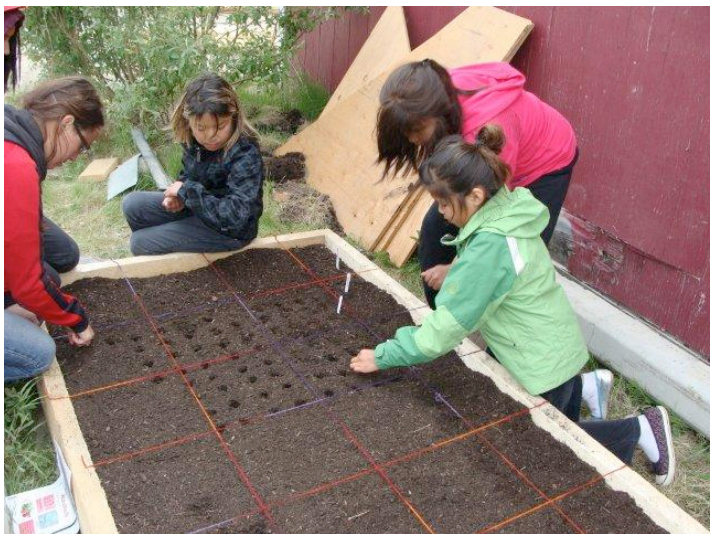
Benefits

- Improved health by consuming more fruits and vegetables
- Improve access to fresh foods
- Improved food security/autonomy over food sources
- Living science lab; great for school programs
- Opportunity for volunteerism, contributing to individual and community well-being
- Work and life skills through responsibility of growing and harvesting a crop
- Horticultural therapy through a positive green, light and humid space

Challenges

- Capital and operating costs
- Successful management of greenhouse
- Small markets for selling produce
- Preference for processed foods over fruits and vegetables

education, skills training and community pride and well-being.



Garden in Behchoko, NWT. Photo credit: Gene Hachey

This guide is meant to assist northern community leaders and stakeholders in determining if a greenhouse project would be a good idea for their community, and what kinds of issues and challenges need to be thought out in advance of taking on such a project. The guidelines will not answer every question that may arise, and specific circumstances in individual communities will need to be taken into account – although there are a few models of success, there is no one-size-fits-all solution for every northern community. But it can help provide the information needed to move a northern greenhouse from idea to reality. Some avenues for further support are listed at the back of the guidelines.

1. Main Options for Northern Greenhouses

While most communities would probably find a greenhouse project worthwhile, the cost of starting one can be a limiting factor for most communities. The good news is that gardening/greenhouse production is fully scalable up or down, and that modest projects that become successful can always be expanded.

On the spectrum of northern greenhouses, there are three main options: an individual garden plot/backyard greenhouse; a community-run greenhouse; and a commercial greenhouse.

Backyard Greenhouse

Greenhouse in Luselk'e, NWT Photo: Gene Hachey

The simplest and cheapest way to start a greenhouse is on an individual or small group basis. There are many backyard gardeners across northern Canada, growing small plots of tomatoes, cucumbers, peppers, beans, peas, lettuce and other vegetables for personal consumption. Gardening is a healthy activity for anyone, with psychological and physical as well as nutritional rewards. Communities may be

interested in promoting individual-level gardening by organizing gardening clubs, short courses on gardening, composting programs to improve soil quality, or by making space for a community or school garden. Small greenhouses, from locally constructed versions using clear plastic tarp to commercially fabricated greenhouses, can improve vegetable and fruit yields by extending the short growing season that exists in the north, especially by starting seedlings in the greenhouse in the early spring months. It can also greatly expand the types of fruits and vegetables that can be grown in northern climates. Similar to a greenhouse, and quite popular in the north, is a poly tunnel or high tunnel – a frame that uses polyethylene, a type of plastic, instead of glass, and uses no power. While it is not as sturdy or resistant to cold temperatures, it is cheaper to build and easier to transport. The cost for a small, backyard type greenhouse or poly tunnel is in the order of magnitude of a few hundred or a few thousand dollars.

Community Greenhouse

The next step up is to build a community-run greenhouse. This implies that there are public funds available for the operation and maintenance of the greenhouse, and that there will be volunteer labour available to run the greenhouse.

Wabowden Greenhouse. Photo Credit: Carol Sanofsky

Community greenhouses can vary in size and type. There are several in the north that are large polytunnels, such as the one in Wabowden, Manitoba; or refurbished arenas, such as the one in Inuvik, NWT. For those interested in building a greenhouse from scratch, one of the better technologies available is a passive solar greenhouse. A solar greenhouse uses light and heat in a similar way to other greenhouses, but retains the heat more efficiently through the use of concrete or other heat-capturing material in the north wall, water barrels, or other means to store heat during the day and release it in the night. A passive solar greenhouse, with limited added heat or lighting capabilities, will not be able to grow fruits and vegetables over a 12 month/year long cycle. However community greenhouses relying on volunteer labour have found that a winter break helps rejuvenate volunteers' ability and desire to participate in the spring and summer.

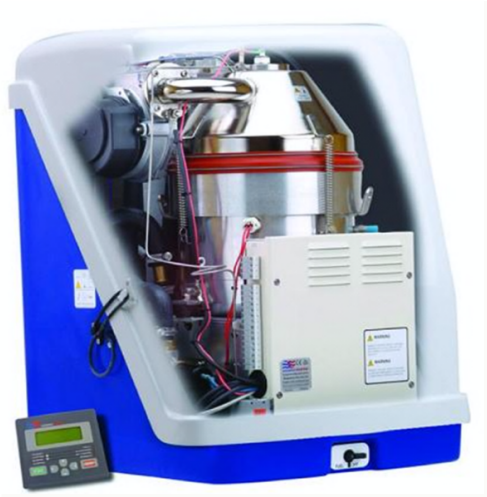
Some examples of passive solar greenhouses in northern and boreal climates. Photo credits: Tang Lee.

Some community greenhouses, such as the one in Iqaluit, rent out garden plots. Others grow food and flowers communally, using volunteer labour. One way to reward those who donate their time to a community greenhouse without private plots is to award coupons for produce or flowers in return for hours worked. However experience has shown that having some kind of paid, committed staff, is essential to the success of the greenhouse.

The cost of building a northern community greenhouse, depending on size, technology, location and objectives, would likely be in the order of magnitude of the tens of thousands of dollars. Some have estimated a seasonal passive solar greenhouse to cost in the range of $30-$40/square foot, and upwards of $75/square foot for a 4-season model, but this will depend on a number of factors and can increase with the remoteness of the community. A 1000-4000 square foot facility would be common for a community greenhouse.

Commercial Greenhouse

Finally, entrepreneurs in northern communities might want to consider establishing a greenhouse as a commercially viable business. Economic development corporations or existing grocers may be best suited to this kind of project.



WhisperGen PPS16 used at Yukon College Greenhouse

In the commercial greenhouse business, space=time=money. Therefore there are certain technologies, such as automation and high energy efficiency, that will need to be employed to reach a certain economy of scale. A commercial greenhouse will probably require a market (community size) of 5000+ people, and/or have contracts with nearby mine sites, hospitals, hotel/restaurants, food stores and other entities that could act as regular and substantial buyers of the grown produce.

A six month greenhouse operation may cut down on operating costs and capital investment, however it may be difficult to hire and train good workers for 6 months' work. Another option is to invest in a 12 month greenhouse operation. This has the bonus of providing fresh, healthy foods and employing staff year round. A 12-month greenhouse in the north will require significant supplemental heat and lighting. In the subarctic, for those communities who are not on the grid, advances in biomass heating are making this option much more economically feasible. This usually means either buying or producing wood chips or wood pellets and using that wood as a source of energy. Energy from wood pellets is more expensive than natural gas but much cheaper than heating oil or propane. In addition, Combined Heat and Power (CHP) technologies mean that both heat and electricity can be produced from wood pellets/chips.

An addition to heat, a 12 month greenhouse will need supplemental lighting. There have been advances in the use of LED lighting for greenhouse use. LEDs are low energy users and so help maintain low operating costs. Red LEDs offer the best light for growing, however are often blended with white lights for the benefit of the gardeners.

Red and blue LED lights at Cheno Hot Springs Greenhouse; Photo credit Meriam Karlsson.

The Cheno Hot Springs greenhouse in Alaska, which uses geothermal energy, offers a good example of a 12 month,

commercial greenhouse in a northern climate [http://www.chenahotsprings.com/].

The order of magnitude of a commercial greenhouse would normally be in the hundreds of thousands of dollars.

2. Training

Depending on the community, there may be limited horticulture/gardening experience available, and certainly operating a greenhouse will involve skills not previously acquired in most communities. Crops need consistent care and attention, such as seeding, transplanting, watering, fertilizing and pest management. There are significant management requirements, such as ordering and storing the proper supplies, managing the work schedule, and planning the harvest. In a commercial greenhouse, there is also the business side of tracking expenses and revenues, generating sales, and supplying customers. All told, there is a lot to do to successfully run a greenhouse. For communities with limited horticultural experience to draw from, it may make sense to start with a community garden or high tunnel project before expanding to a greenhouse; and to start with a seasonal community greenhouse before expanding to a commercial enterprise. That said, growing crops in a greenhouse is generally easier, and more productive, than outdoor gardening.

A few college and university distance education opportunities are available, such as the University of Saskatchewan's Prairie Horticulture Certificate, which has a greenhouse crop production stream. Greenhouse managers and employees should be trained before crop production begins.

Greenhouses in general will need expertise from plumbers, electricians and other specialized trades, and it is worth making a connection with the relevant tradespeople when beginning a greenhouse project. Greenhouses reliant on wood pellet boilers will also need to have someone with some mechanical or engineering expertise available to assist with its functioning.

3. Operating Expenses

A significant capital investment will be required to build a greenhouse, be it a modest community solar greenhouse or a technologically advanced commercial greenhouse. Sometimes government grants or private donations are available to offset the capital costs of a community project; however one must be mindful of the annual operating costs of running a greenhouse. For a community greenhouse to cover its costs, will it be selling fresh produce and flowers? Receiving a local or government subsidy for the medium-long term? Getting ongoing support from the local council, school board, health authority or others? It's important to figure out a strategic plan, of at least five years, for covering operating expenses once the greenhouse is built.

4. Technologies

Other than a small market and local food preferences, a main challenge to northern greenhouses, versus southern ones, is the short growing season, necessitating supplemental heat and light. A number of technological advances are making northern greenhouses more viable than in the past.

Glazings

Glazings are the transparent panels used in the walls and/or roof of the greenhouse. Single pane glass is not a particularly appropriate material in the north, with a low R (insulation) value of 0.9. Better materials exist, however final consideration should be based on a combination of cost; R-value; durability; and light transmission.

In the north, double glazing is important as it dramatically improves insulation, adding heat and humidity to the greenhouse and reducing energy costs. Polycarbonate and acrylic are two options. The Yukon College Cold Climate Innovation greenhouse uses Quad Pane 25mm polycarbonate glazing (R-4). It is more expensive to buy such materials on the front end, but saves energy costs and can improve crop performance over the long term. There should normally be no glazing on the north side in northern greenhouses.

Glazings that diffuse light are also considered to be beneficial, as they distribute light more evenly and create less stress on plants at full sun hours.

Energy Screens and Curtains

Similarly, energy screens or curtains can help maintain the heat that enters the greenhouse during the day throughout the night, preventing its escape or seepage.

Energy Screen; www.svenssonglobal.com

They might range from more transparent shades, that keep out excess sunlight, to more opaque curtains, which trap heat and provide further insulation. Energy screens can be installed to manually or automatically roll-up and down depending on the needs of the greenhouse. A similar technology that is still in the early stages of being developed is the use of liquid foam, to be applied at night in a foam cavity at the top of the greenhouse and removed in the morning.

LEDs

LEDs, or light-emitting diodes, can extend the growing season of northern greenhouses, even providing sufficient light for a 12 month growing schedule. Compared to past lighting systems, such as High Pressure Sodium (HPS) or Metal Halide (MH), they can be more energy efficient, provide a customized light spectrum, and radiate less heat. Although research is still in its early stages, red

Interlighting with red LEDs

LEDs appear to be the best for growing. Adding blue LEDs may enhance secondary metabolites. Some are also starting to use interlighting techniques which apply lighting almost directly to the crops. The technology in this field is changing quickly.

Design and Location

Greenhouse design in the north is very important. Orientation should be south-facing and should maximize light penetration for the latitude of the greenhouse. A south-facing slope is also beneficial. It also makes sense in a northern greenhouse to attach the north wall to another building, embed it in a hill or slope, or construct a thick concrete or wood wall to prevent heat loss.

Perhaps the most important consideration for finding a suitable location is access to fresh water. A municipal or band source is of course the easiest, especially if preferential rates can be negotiated. For non-aqueduct sites, there must be consideration for on site storage and resupply of water; storage and removal of waste water; and fertilization recirculation.

Your heating and energy source may also inform your best location. It may be possible to use the excess heat from a power generation facility; or adjoin a greenhouse to a school, grocer, community centre or healing centre. If the greenhouse will be supplemented by a garden, then soil quality in the adjoining area might factor in. If fresh produce and flowers will be sold at the door, then proximity to market (e.g. a relatively high traffic area) could be important.

As mentioned above, passive solar greenhouses make a lot of sense for seasonal, community greenhouses. For 12 month ventures, especially in areas with relatively poor light year round (e.g. from clouds), a growth chamber – an enclosed building that relies fully on artificial lighting and heat – may be the most cost effective.

Wood pellets

Biomass Energy

Advances in biomass as an energy source - in the subarctic, primarily from softwoods such as pine and spruce – can make greenhouses in the north more viable by reducing energy costs for heating and lighting. It is also transportable and storable, unlike other renewable

sources such as solar and wind, and environmentally sustainable. In the subarctic, biomass has the added bonus of being available locally.

Biomass energy production is not only good for the cost of operating a greenhouse; it can be highly useful in both reducing energy costs for subarctic communities that are not on the grid, as well as provide a new source of employment and revenue in forest communities. Advances in biomass energy production can help make northern communities not only more food secure but also more energy secure, adding local employment and revenue in the process.

There are a number of different ways to use wood pellets as energy, most of which are tried and tested technologies in northern Europe. They are scaleable up and down, coming in a large variety of 'sizes', such as 1 KW for a residential unit or small greenhouse; 5KW for a small commercial building or large greenhouse; 75KW for an apartment building; and 50MW for a district heating system. They are well automated and don't require much more effort to maintain than an oil-burning furnace.

The same economic development corporation that may be interested in a commercially viable greenhouse operation may also be interested in developing a biomass energy business, by making wood pellets from wood and wood waste and distributing them; and/or producing power themselves to supply to local homes, businesses, school and hospitals, or selling the power back to the grid.

Meadow Lake Tribal Council's large boiler demonstration project in Canoe Lake, SK. It heats four teacherages. The wood pellets are stored in the grey cylinders and automatically delivered to the boiler.

Although woody biomass is not a viable option for Arctic communities, advances in wind and micro-nuclear power may provide a more cost effective source of energy for that area in the coming years.

5. Crops

What fruits and vegetables should be grown in northern greenhouses? There are a number of factors to take into consideration: What is most likely to be eaten/sold? What works best with the light, temperature and humidity available? What is the most nutritious food? The answers of what kind of crop to grow will depend on your priorities.

In general, almost anything can be grown in a greenhouse if you can provide the right environment for the plant. Bananas are grown in greenhouses in Iceland, for example, however it is not a particularly efficient greenhouse crop. Tomatoes, cucumbers and peppers are popular crops in southern commercial greenhouses. Lettuce grows very quickly. Kids love strawberries. Potatoes, carrots, and onions can be stored for many months after harvest and form part of existing diets in many communities in the north. Beans and spinach are very nutritious. You may also want to experiment with growing traditional herbs and plants in your greenhouse. Many flowers also grow well in a greenhouse and make an excellent cash crop.

In short, what crops to grow will depend on the season, the market, and objectives ($, nutrition, ease of growing) of the greenhouse.

6. Community Benefits

There are many positive aspects to a greenhouse and many synergies that can be made, for example with school programs, rehabilitation/healing centres, and composting programs that reduce landfill waste and encourage sustainability. The health benefits of providing fresh food at a reasonable price is only one of a host of possible benefits from a community greenhouse.

A community greenhouse might want to involve science classes in its production. A greenhouse is a living biology lab. Soil nutrients, fertilizer, and water provide lessons in chemistry; greenhouse angle and light spectrum and diffusion quality apply to physics. Some plants grow quite quickly, such as beans and lettuce, providing quick gratification in terms of time from seeding to harvesting and making them well suited for a science module. Kids are also more likely to eat vegetables if they've been involved in, or just understand the process of, growing them.

There is also a "horticultural therapy" aspect to being in a nice, warm, humid, and green space with living things. Greenhouses are productive and lush places and can be very therapeutic.

Finally, working and volunteering in a greenhouse builds work and life skills, work ethic, self-confidence and a sense of responsibility, as plants need to be cared for and monitored carefully. There is also a tangible accomplishment at the end of the growing cycle when fruits and vegetables are harvested.

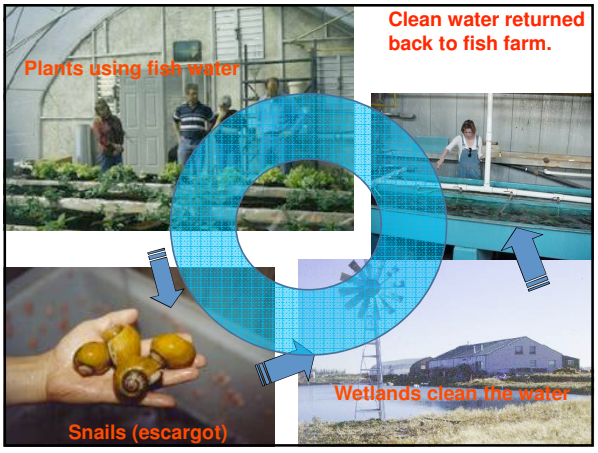
A commercial greenhouse, which may or may not opt to engage in community programs, still has the important social benefits of providing local employment and offering fresh fruits and vegetables at reasonable prices.

7. Other Options for Food Security and Revenue Generation

Greenhouse production is one option for addressing food security and providing local economic opportunities, but there are other options that are synergetic with a greenhouse project.

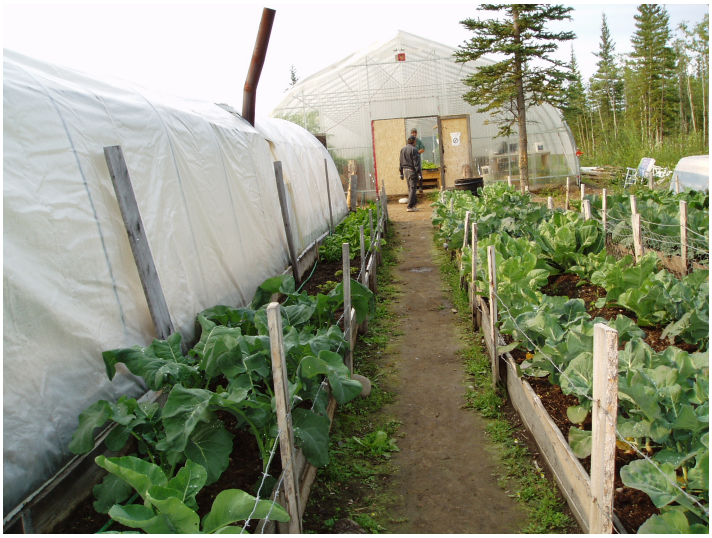
Aquaculture

If possible, it makes sense to incorporate an aquaculture, or fish farming, system adjacent to the greenhouse. An aquaculture system grows fish as well as plants, with the plants using and cleaning the waste produced by the fish, and the fish benefitting from the oxygen and nutrients passed on by the plants as well as the removal of ammonia in the water. There is considerable synergetic advantage between the two processes including CO2, humidity, heat, thermal mass and nutrients. Besides, fish has the best feed conversion rate and is also a healthy food with market potential.



Greenview Aquafarm in Alberta; image courtesy of Tang Lee.

Gardens



Little Salmon Carmacks Greenhouse in Yukon. Photo credit Dawn Charlie.

The best option is not to have either a greenhouse or a community garden, but to have both. Starting seedlings in a greenhouse can maximize the season that does exist for outdoor gardening in the north, while providing the same food security, health and work skills benefits as a greenhouse – and probably more exercise. Community gardens are also much less expensive to establish and operate than a greenhouse, especially if volunteer labour

is being used. Growing field crops under high tunnels is also a good option for extending the growing season and maximizing the harvest.

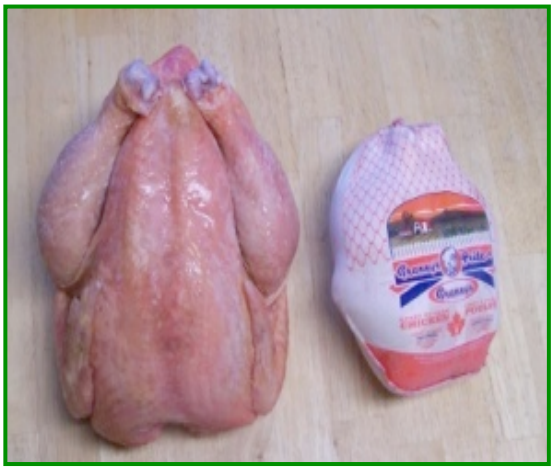
Communities may also want to consider community food storage sites and freezer programs to make garden and traditional harvests last into the winter and to provide a communal store of food.

Composting

Composting, or using old food scraps, coffee grinds, and other organic material as fertilizer and soil amendment, is an easy way to improve soil quality and enhance plant production while reducing the need to import expensive soil and fertilizer. This is particularly important in northern communities with poor soil conditions.

Composting provides the added benefit of diverting waste from local landfills and reducing municipal and band costs for garbage collection and disposal.

Material useful for composting. Photo credit Dawn Charlie.



Chicken grown in Wabowden (l), compared to grocery store chicken (r).
Photo credit Carol Sanoffsky

Chickens

Raising chickens – for both eggs and a source of meat – is another way to enhance local food security. Chickens are relatively easy to raise, however consideration must be given to feeding, cleaning after, and housing them. It may make sense in many northern locales to butcher chickens in the fall and start again with new chicks in the spring to avoid the costs of a heated chicken coop throughout the winter.

Plant Nursery

Forestry, mining, hydro, oil sands and other industrial and governmental actors are often mandated to reclaim and reforest areas after they've damaged them. A plant nursery business grows plants and trees for use in reforestation and reclamation. In addition to the commercial viability of this business, providing employment and revenue streams, using native plant species to reclaim an area is also an environmentally responsible and beneficial practice.

Seedlings at the Tipi Mountain Native Plants Nursery on St. Mary's Reserve, BC. Photo credit Michael Keefer

8. Other Advice

- Work to get community buy-in. Use community radio, local newspapers, community meetings, a website, Facebook page and/or email to build support and foster engagement.
- Be persistent and plan for the long term! Don't get discouraged when challenges inevitably arise.
- Be collaborative: work with schools, health authorities, elders, all levels of government, and join relevant associations and networks for support.

9. Questions to Ask Before Beginning

Community Engagement

- What is the community's short term / long term vision, and how does a greenhouse support that vision?
- How simple or sophisticated does the greenhouse operation need to be to meet the community's interest?
- Is the community interested in creating jobs and/or making profit, or does the community want a not-for profit business model where fresh food is provided, labour is volunteered and the produce is shared?
- What's the community's level of commitment i.e. time and money for taking on this venture?
- Is there community leadership with possible succession planning to ensure the long term viability of operations?

Market Demand

- What are the current foods consumed in the community?
- What is the size of the market?
- Are there food catering opportunities to local camps (e.g. mining, forestry), and how big does that service contract need to be for cost-effectiveness?

- What are the local diets and how does culture affect the introduction of new foods?
- What are the non-food services that a greenhouse could provide, (e.g. tree transplants for forestry and mining reclamation operations)?

Labour Supply

- What are the competencies and minimum education requirements in running a greenhouse operation?
- What are the short term and long term training requirements and associated costs to addressing the skills needed to operate the greenhouse?
- What is the cost of hiring the labour necessary to manage and operate the greenhouse?
- What level of volunteer labour is available, and how consistent/long-term is it likely to be?

Resources

- What is the source of water and its quantity and quality?
- What are the energy and power sources?
- What are the capital resources that could be tapped through building relationships and partnerships e.g. mining, forestry companies?
- What are the short term and long term training requirements and associated costs to addressing a skilled labour shortage?
- What are the resource management strategies for the energy feed stocks for woody biomass heating?

Technologies

- What are the agronomics for growing food and non-food commodities, including pest management, growth medium, light, temperature, humidity, air exchange, better adapted crop cultivars, etc.?
- What are appropriate varieties of warm and cool season vegetables and fruits that can be grown effectively in northern greenhouse operations?
- What are the most cost effective building materials to be used e.g. double walled poly, insulated shades, etc.?
- Which technologies are tried and true and can be operated and maintained by local staff? i.e. What are the most appropriate technologies given the existing labour supply to support it?
- What are the alternative energy/power technologies that can substitute for diesel and propane, e.g. biomass (wood, plant materials), biofuel (biodiesel, ethanol), biogas (bio-digestion from crops, manure, food by-products, landfill gas), solar, wind, thermal sinks, etc.?
- What are the proven best practice technologies in regards to energy efficient options for heating, cooling and lighting, e.g. Stirling engine, LED lights?

Economics

- Is there access to local, private or governmental funding to cover the capital investment as well as operating costs?
- What is the most likely business proposition(s) that best aligns with the community's vision and aspirations?
- Are there niche market opportunities to pursue?
- What are the economies of scale and size to capture, especially other uses of the heat source, e.g. through a district heating system using schools and other buildings?
- What are the government financial assistance programs that can be used to initiate and pay for start-up costs? (e.g. Aboriginal Affairs and Northern Development Canada - Eco-Energy Program, federal/provincial government Growing Forward programs, etc.)
- What level of support can Economic Development Corporations or industry provide?

10. Sources of Support and Information

Almost all provinces and territories have agricultural or greenhouse specialists and advisors whose mandate it is to provide information on starting gardens and greenhouses. Check your provincial or territorial website to get the contact in your region.

Universities and colleges across Canada may have research or educational programs that fit in well with a community greenhouse project, and are willing and eager to offer support and advice. Try contacting the agriculture, engineering, geography and other departments and colleges for assistance, or try the university or college's outreach director.

There are a number of northern, territorial, provincial and national associations and networks for gardening and greenhouse growers. There are also a number of active community greenhouses in the north; it's worth a phone call or a visit to see where others have had challenges and successes. Also browse through the list of conference participants, in appendix 3, for potential sources of assistance and information. Agriculture and Agri-Food Canada may also have technical support available for this type of project; call your regional outreach office for support [http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1181593230301&lang=eng].

Workshop Co-Chairs

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Dr. Karen Tanino

Professor of Plant Sciences, University of Saskatchewan, and Lead, University of the Arctic Thematic Network on Food Security

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Associations and Programs

Territorial Farmers Association

[http://www.farmnwt.com/]

Yukon Agricultural Association

[http://www.yukonag.ca/]

Manitoba Northern Healthy Foods Initiative

[http://www.gov.mb.ca/ana/nhfi.html]

Inuvik Greenhouse

[http://www.inuvikgreenhouse.com/]

Iqaluit Community Greenhouse Society

[http://iqaluitgreenhouse.com/]

Profiles of Food Security Activities in Inuit Communities

[http://archives.algomau.ca/drupal6/sites/archives.algomau.ca/files/2012-25_004_013.pdf]

Northern Food Network

[http://foodsecurecanada.org/webform/northern-food-network]

Government

Outreach Director Agriculture and Agri-Food Canada Local Outreach Office (Boreal Ecozone)
2103 - 11th Avenue Regina, Saskatchewan S4P 4L2 Canada
Telephone : 306-780-5153

Fax : 306-780-6778

Education and Training

Human Resources and Skills Development Canada:
Essential Skills: Greenhouse Managers and Operators

[http://www10.hrsdc.gc.ca/English/ShowProfile.aspx?v=410]

University of Saskatchewan Distance Certificate in Prairie Horticulture (including a greenhouse stream)

[http://ccde.usask.ca/phc]

Business Contacts

The following are known suppliers, designers, consultants and project managers of poly tunnels, greenhouses, and energy production. Their listing here is for information purposes and is not intended as an endorsement.

Murray Guy (greenhouse design)

Integrated Designs

[http://www.i-designs.ca/]

Charlie Seeberg (greenhouse design)

Precix Architectural Sciences

[http://precixar.com/]

Alia Lamaadar

Cleantech Community Gateway (green technology project management for remote communities)

[http://ctcg.org/]

Bill Swan (community greenhouse consultant)

Greenman Sustainable Solutions

[bill@greenmansustainable.ca]

Robin Darcy (project management)

Agriteam Canada

[http://www.agriteam.ca/en/]

Harry Edwards (poly/high tunnel supplier)

Haygrove Tunnels 717.606.8021

[http://www.haygrove.co.uk/polytunnels/farm-polytunnels/solo-series/?language=eng]

Jim Gallant (Small power plant design, construction and operation)

Remasco (519) 999-4678

[http://www.remasco.ca/]

These Guidelines are dedicated to the memory of Dawn Charlie of Little Salmon-Carmacks, Yukon.

Appendix 1: Northern Greenhouse Agenda

Northern Food Security: The Greenhouse Solution

November 7-8, 2012
Delta Room, Travelodge Hotel
Saskatoon Saskatchewan

WEDNESDAY, NOVEMBER 7
Socio-Economic Aspects of Sustainable Northern Greenhouses

Coffee and Muffins
8:15-9:00

Welcome
9:00-9:30

- Ken Coates, Co-Director, Research, ICNGD and Canada Research Chair in Regional Innovation
- Karen Tanino, Professor, Plant Sciences, U of S and Leader, UArctic Thematic Network on Food Security

Session 1: Outlining the Challenges
9:30-10:15

- Brian Hunt, Gov't of Manitoba, Winnipeg MB
  Northern Greenhouse Technologies and Outcomes: Lessons from Leaf Rapids, Manitoba
- Glen Sweetman, Government of Saskatchewan Ministry of Agriculture
  What You Need to Know Before You Build a Greenhouse

Coffee Break
10:15-10:30

Session 2: Community Perspectives
10:30-12:00

- Ellen Avard, ULaval/ Kujjuaq, QC
  The Kuujjuaq Greenhouse Project: Challenges and Perspectives
- Bill Swan and Dale Wilker, Groundswell Network Society
  The Invermere Community Greenhouse Initiative: What We've Learned
- Dawn Charlie, Carmacks Greenhouse, YK

An Adventure in First Nation Gardening and Greenhouse in the Far North

- Gene Hachey, Government of NWT
  The NWT Growing Forward Small Scale Foods Program

Lunch
12:00-1:00

Session 3: Food Insecurity, Northern Health, and Aboriginal Diets
1:00-2:15

- Gita Sharma, University of Alberta
  Developing Nutrition Intervention Programs in Isolated Communities: the Healthy Foods North Model
- Joe Munroe, Muskoday, SK
  Indigenous Food Systems
- Carol Sanoffsky, Bayline Regional Roundtable, Manitoba
  Traditional Foods & Medicinal Herbs

Coffee Break
2:15-2:30

Session 4: Training, Employment and Economic Development
2:30-4:00

- Larry Lenton, Agri-Food Canada, SK
  What are the Critical Success Factors in Operating an Economically Viable Northern Greenhouse? - The Federal Government Wants to Know!
- Tom Allen, U of S
  Economically Sustainable Production of Vegetables in the North: Is it Possible?
- Michael Keefer, Tipi Mountain Native Plants, St. Mary's Reserve, BC
  Trials and Tribulations in the Development of a Culturally and Economically Viable Native Plant Nursery Business
- Ben Voss, MLTC Resource Development Inc.
  Economic Development and Biomass: The Meadow Lake Bioenergy Centre

Reception
4:15-5:30
Appetizers and Cash Bar

THURSDAY, NOVEMBER 8
Technical Aspects of Northern Greenhouse Design

Coffee and Muffins
8:15-9:00

Session 5: Greenhouse Design
9:00-10:30

- Tang Lee, University of Calgary
  Aquaculture in Greenhouses for Synergetic Use with Vegetable Production
- Stephen Mooney, Yukon Research Centre
  Four Season Greenhouse- Designing for a Cold Climate
- Huiqing Guo, U of S
  Energy Efficient Greenhouses in Saskatchewan and Beyond
- Murray Guy, Integrated Designs, Saskatoon SK
  Is There a Business Case for a Passive Solar Greenhouse Industry in the North?

Coffee Break
10:30-10:45

Session 6: Growing Crops
10:45-12:15

- Xiuming Hao, Agri-Food Canada, Harrow, ON
  Potential Technologies for Northern Greenhouses
- Joey Villeneuve, ULaval, QC
  Northern Greenhouse Technology and Complete Growing Systems
- Mike Dixon, U Guelph
  Emerging Technologies for Food Production in Challenging Environments
- Meriam Karlsson, UAF, Fairbanks, Alaska
  Light and Lighting Options for Northern Greenhouses

Lunch
12:15-1:00

Session 7: Alternative Energy Options for Greenhouse Heating and Lighting
1:00-2:30

- David Arkell, 360Energy, ON
  The Journey to Energy Excellence for Northern Greenhouses
- Charlie Seeberg, Precix Advanced Cutting Technologies, Langley BC
  Extending the Growing Season of the Iqaluit Seasonal Greenhouse
- Darcy Kozoriz, SaskPower
  Supporting Local Energy Production: SaskPower's Net Metering and Small Producer's Programs
- Chris James, Saskatchewan Research Council
  Micro Combined Heat and Power (CHP) Technology

Coffee Break
2:30-2:45

Session 8: Moving Forward: Developing *Guidelines for Establishing a Northern Greenhouse Project* (Group Discussion and Breakout Session)
2:45- 4:00

- Moderated by Karen Tanino, Professor, Plant Sciences, U of S and Leader, UArctic Thematic Network on Food Security

End of Conference

Optional Workshop: Getting the Most Vegetable Production Out of Your Northern Growing Environment
4:30-6:00

- Led by Doug Waterer, Professor of Plant Sciences, U of S

Appendix Two Facilitated Break-Out Session

"Setting a Greenhouse Strategy for Northern Canada: Barriers/Solutions, Opportunities and Next Steps"

Wednesday and Thursday Nov. 7, 8	
Barriers and Solutions	**Opportunities**
1) Community buy-in • Defining a purpose for the greenhouse: community development or commercial business? What is the model? • Business model? Community-development model? • Systems-thinking---different approaches—data, social info. • Community-involvement, culture-specific, ownership by community. **2) Lack of trainers/leaders** • Skills, entrepreneurialism, other types of education, engagement • Lack of knowledge and training. • Funding/lending that is easily accessible/sustainable. • Industry is high-tech, high-investment and high-risk. • Lack of knowledge of growing, processing, storage. • Understanding the barriers (parents, mentors) • Imposing southern diet or traditional foods? • Disconnect between researchers and growers. Knowledge transfer gap. • Availability of education and training.	**1) Power generation (waste heat)** • Use of waste products—composting programs, partnerships with food industries for waste. • New sustainable technology is well accepted in the north. • Resources for new technologies • Carbon tax **2) Increase the nutrition and quality of the food.** • Nutrition in the north—e.g. Gita Sharma's program. • Reclaim diets of the past. • Community kitchens. • Need to expand seasonal eating. **3) Education of the communities in horticulture.** • Train-the-trainer. Accreditation, hands-on, training possibilities. • Training of the people in greenhouse management. • Options for distance learning. • Options for peer-to-peer learning. **4) Better consultation with communities, what they will bring to the project, their leaders and**

- Seeds that meet the right conditions for northern conditions—heritage seeds.
- Complexity and technical skills required in a greenhouse.
- Poor soils or lack thereof.

3) Energy, technology, light and heating.

- Access for materials to build greenhouses. High transport costs.
- Geographic, climatic/weather issues playing havoc with technology.
- Need for innovative low tech designs (e.g. Yukon producers request for a simple greenhouse).
- One design does not fit all---but is there a basic/common guideline?

4) Full cost accounting

- Greenhouses may cost money, but are a net gain to the system when considering health costs, food subsidy costs, value of science, training and education they provide, the costs of unhealthy communities
- Financing policy--- need for programs to provide capital.

how they will delegate responsibilities.

- Community involvement, bringing the community together

5) Build a network of researchers and growers, peer-to-peer, pan-Arctic.

- Data-bases.
- Indigenous food sovereignty groups in other countries.

6) Make $$

7) Plant breeding for the north.

- Native local plant species.
- Post-harvest storage and knowledge.

8) Knowledge sharing

- Micro-lending models.
- Need for a data-base for business plans, networking
- New business models where communities join forces for their mutual benefit.
- Financing programs to help with up-front capital costs, coop programs.
- Competitive financing on First Nations' banking

Appendix Three: Workshop Participants

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