Stretching your fruit and vegetable growing season – Webinar Series

Controlled Environment Agriculture with tunnels, hoop houses and minimally heated greenhouses

December 8, 2021

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Content of presentation

Update on the NBDAAF's CEA Action Plan

Overview of CEA Consultation Project

What you should know about season extenders:

- **Mini (low) tunnels**
- **Caterpillar high tunnels**
- **Multi-bay high tunnels**
- **Hoop houses**
- **Minimally heated greenhouses**
- **Practical information**

Upcoming Webinars

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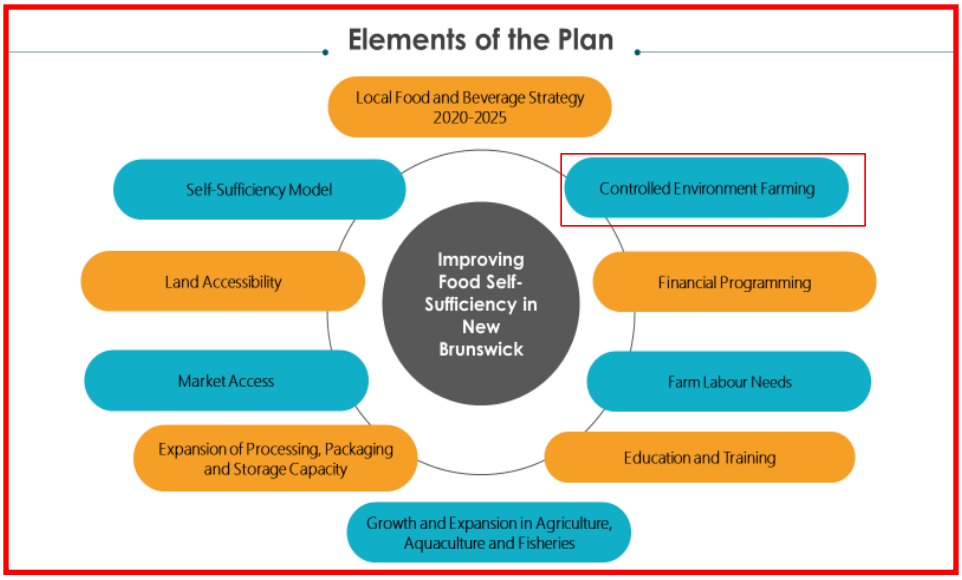
Improving Food Self-Sufficiency in NB
DAAF's Self-Sufficiency Action Plan



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CEA Action Plan 2021-26

Objective:

Double area in CEA in NB over the next 5 years

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Key Result Areas

A- Develop Value Proposition to attract & support investment

B- Build Knowledge and Leadership

C- Adopt Regulatory Framework and Programing that support CEA Industry

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Value-proposition Status

Availability and cost of fuels (comparative analysis)	√
Energy requirements (heating & lighting)	√
Climate info: Solar radiation, temperature, supplemental lighting, CO2 and site selection	√ **OG**
Feasibility Assessment (1 ha model)	√
Build value-proposition	√ **OG**
Identify and work with investors	**OG**

√ = Done, OG = on-going

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Build Knowledge Status

Develop DAAF webpage	**OG**
Identify and work with out-of-province CEA expertise	√ **OG**
Build staff knowledge	**OG**
Provide technical support to growers, new entrant and indigenous communities	**OG**

√ = Done, OG = on-going,

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Build Knowledge Status

Benchmarking (collect valuable info about sector)	**OG**
Promote opportunities for First Nations to partner with industry and/or with other FNs	**OG**
Support R&D initiatives	**OG**
Stakeholder Awareness	√ **OG**

√ = Done, OG = on-going

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Regulatory and Programming Status

Launch Fruit & Vegetable Industry Dev. Program (FVID)	√
Identify funding gaps, including for those year-round capital intensive projects	OG
Identify regulatory barriers & mitigate (also under Pillar 10)	OG
Understanding electricity rates and support programs	OG
Continue to explore geothermal opportunities in the Sussex area	OG

√ = Done, OG = on-going

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CEA Consultation Project

Funded by the Canadian Agricultural Partnership (CAP)

Work with out-of-province CEA/Greenhouse expertise

With consultant visit NB producers who grow in tunnels, greenhouses and indoor facilities (vertical farms)
… to identify knowledge and technology gaps

Analytical component (preliminary work)
- **Greenhouse Soil Analysis**
- **Detailed Field Soil Analysis**
- **Water Analysis (chemical analysis)**
- **Organic Soil Amendment/Fertilizers Analysis**

Organize winter Training Webinars
… tailored to NB grower needs

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Report from visits

15 farms

- 8 growers are growing in the soil

- 5 growers are growing through in hydroponic

- 2 growers are involved in year-round vertical farming

Most growers are involved with direct marketing

Some of them used season extenders only (tunnels, hoop houses)

Some used season extenders, greenhouses and/or vertical farms.

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Findings from the visits

CEA/Greenhouse Business Environment:

- **Almost non-existent (only a few suppliers, limited technical support and network, …)**

General observations:

- Tunnels and greenhouses should be managed to optimize growing conditions "climate" to maximize yields and profitability.

… these structures offer more than a sheet of plastic

… some gh crops produce more in 2.5 week than if the are grown during the entire summer in the field.

Greenhouse structures: Not all made equally.

(light penetration, trellising/ventilation/heating/CO2 options, which impact yield and profitability).

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Findings from visits

Climate control:

Growers must manage their structure to maintain optimal growing conditions by monitoring and adjusting the environmental conditions

- **Optimal temperature ranges vary and are not only based on the crop type but also on sunlight, canopy density, crop growth stages, …**
- **Optimal relative humidity is also important and must be managed especially when indoor and outdoor temperature differences are significant (spring and winter).**

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Findings from visits

Plant density (row and plant spacing) must be optimized to ensure maximum yield and quality of produce.

Irrigation: Irrigation must be based on plant needs.
Growers often water their crops when they have time or during hot/dry summer periods.
Growers need to know how to water the crops and need to monitor the moisture in the root zone.

Fertilization: Fertilization must be based on crop needs.
Crops are often fertilized like they would be when grown in the field (not for optimal greenhouse yield).
Growers need to understand the basics of fertilization for in soil and hydroponic systems and need to monitor their fertilization practices (soil/tissue/fertigation water analysis)

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Findings from visits

Pest control:
- **Few growers are using biological controls or aware of pest control options.**
- **Need to know the various pests, their biology and tools used to monitor and control.**

More growers need to graft their tomato plants
- Those growing in permanent greenhouses (in the soil)
- Those wanting to grow over long season (three seasons +)

Cultivar selection:
- **Need to focus on cultivars that are bred and selected for CEAs,… good disease resistance package, adapted to optimal growing conditions, superior yield and quality, and for longer production periods.**

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The good news:

Most improvements do not require major investments… as they are knowledge based

Growers are interested in increasing their knowledge and improving yields and profitability

Growers are considering climate controllers and automation

- **Winter training webinars tailored for NB growers**
- **Year 2 project:**
  - **More extension activities**
  - **Transfer of knowledge and technology**

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What you should know about these CEAs:

Mini (low) tunnels

Caterpillar high tunnels

High tunnels (multi-bay)

Hoop houses

Minimally heated greenhouse

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Mini (low) tunnels

Low structures (0.5m to 1.0m high) that can cover single rows or several rows. Hoops are used to hold perforated plastic, thermal row covers, or insect netting. Mini-tunnels can also be used inside high tunnels and hoop houses to provide additional thermal benefit, frost protection and pest protection.

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Mini (low) tunnels

Mini-tunnels consisting of metal hoops and perforated plastic.

- Installed via tractor

Sheet of perforated plastic over small hoops

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TunnelFlex

Mini-tunnel consisting of retractable perforated plastic on custom bent hoops and held with bungee elastics.

TunnelFlex sold by:
Quebec manufacturer and distributor

- Installed manually

Wind can be an issue for these

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Mini (low) tunnels

Mini tunnel for thermal row cover supported with commercially available plastic covered hoops.

Mini tunnel for insect exclusion netting supported by farm made hoops

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Caterpillar high tunnels (non-permanent)

Structure comprised of individual hoops, anchoring system, lacing rope to hold the plastic on the hoops, clamps/hooks to hold the plastic up for added natural ventilation and pony tail style tie-down ends. Hoop spacing 4, 5, 6 ft

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Caterpillar high tunnels

View of lacing rope

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Caterpillar tunnel

View of lacing rope

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Devices used to hold the lacing rope

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Caterpillar tunnel with multiple ropes - between each hoop

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Caterpillar high tunnels

C. tunnel with 4 diagonal stiffeners to add stability at the ends of the structure

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Caterpillar tunnel

View of pony style tie-up for the end.

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Clamp and hooks used to hold plastic to ensure good ventilation

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Caterpillar high tunnels

C. tunnel with tomatoes in center row, trellised with rebar/twine in black plastic over two drip lines per row and straw mulch

C. tunnel with tomatoes in center row trellised with rebar/twine in black plastic and clover ground cover

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C. tunnel with over-head sprinklers great to encourage germination and for the production of greens

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Caterpillar tunnels

Early spring spinach, carrots and stand-up sprinkler system

Farm-bent hoops with purlins to support tomatoes and cucumbers, two drip lines per bed

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Purlins used to reinforce the structure and to support trellising wires

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Some growers are bending their own hoops

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Caterpillar tunnels

C. tunnel with landscape fabric
Images: Wolpin Enterprise

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Commercially available zipper doors

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Caterpillar tunnel with some row covers

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Wind can be an issue for these tunnels

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Not intended for winter use but …

This unit also includes a metal purlin clamped to each hoops for the full length of the tunnel.

What is the wind rating on your caterpillar tunnels? - Farmer's Friend LLC (farmersfriend.com)

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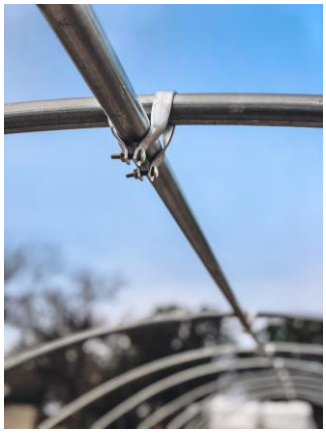
Specialty devices:



Attachment for purlins

lift kits to add height

Wire holder for trellising

https://www.farmersfriend.com/products

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High tunnels (multi-bays), non-permanent

Each bay is typically 28-32x100 ft. Hoops:10ft apart
Roll-ups on side walls, roof and curtains as end walls to allow proper natural ventilation.

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High tunnels (multi-bays)

High tunnels with no end walls
- Quebec

High tunnels with closed end wall curtains

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High tunnels (multi-bays)

Raspberry production in high tunnels - Quebec

Squash production in high-tunnel - Quebec

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High tunnels (multi-bays)

Bush type tomato production (determinant) trellised on rebar and twine

Pepper, herbs and pole bean production in high tunnels - Quebec

Lettuce production in high tunnels

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Drainage for high tunnels

French drain (gravel and drain tile) around the perimeter and between each high tunnel bays to improve drain and help evacuate roof water

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High tunnels (multi-bays)

Curtains used as end walls

Roll-up outside wall

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High tunnels

View of roll-up side walls

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High tunnel

Single bay high tunnel

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Black plastic used in high tunnel

Soil preparation can be done with tractors

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High tunnels (multi-bays)

Plastic shield to protect young seedlings from the wind. Black plastic under the header irrigation line to deter weeds

High tunnel with row covers for added frost protection

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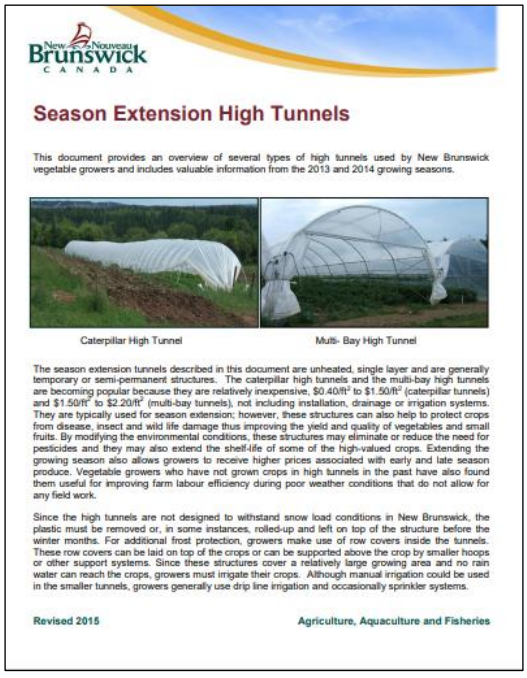

New Nouveau Brunswick CANADA

Season Extension High Tunnels

This document provides an overview of several types of high tunnels used by New Brunswick vegetable growers and includes valuable information from the 2013 and 2014 growing seasons.

Caterpillar High Tunnel | Multi- Bay High Tunnel

The season extension tunnels described in this document are unheated, single layer and are generally temporary or semi-permanent structures. The caterpillar high tunnels and the multi-bay high tunnels are becoming popular because they are relatively inexpensive, $0.40/ft^2 to $1.50/ft^2 (caterpillar tunnels) and $1.50/ft^2 to $2.20/ft^2 (multi-bay tunnels), not including installation, drainage or irrigation systems. They are typically used for season extension; however, these structures can also help to protect crops from disease, insect and wild life damage thus improving the yield and quality of vegetables and small fruits. By modifying the environmental conditions, these structures may eliminate or reduce the need for pesticides and they may also extend the shelf-life of some of the high-valued crops. Extending the growing season also allows growers to receive higher prices associated with early and late season produce. Vegetable growers who have not grown crops in high tunnels in the past have also found them useful for improving farm labour efficiency during poor weather conditions that do not allow for any field work.

Since the high tunnels are not designed to withstand snow load conditions in New Brunswick, the plastic must be removed or, in some instances, rolled-up and left on top of the structure before the winter months. For additional frost protection, growers make use of row covers inside the tunnels. These row covers can be laid on top of the crops or can be supported above the crop by smaller hoops or other support systems. Since these structures cover a relatively large growing area and no rain water can reach the crops, growers must irrigate their crops. Although manual irrigation could be used in the smaller tunnels, growers generally use drip line irrigation and occasionally sprinkler systems.

Revised 2015 **Agriculture, Aquaculture and Fisheries**

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Hoop houses

These unheated structures look like greenhouses with a single layer of poly and are generally vented naturally with roll-up sides and end wall doors. Hoop houses and cold frames are basically very similar structures.

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Hoop houses

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Hoop house

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Hoop house

- Often not well adapted for tall growing crops such as indeterminant tomatoes and cucumbers (generally not equipped with crossbars or robust bracing near end walls).
- Often difficult to modify them for three-season heated greenhouse production (end walls are lightly build and not able to support heating system and fans and louvers).
- Single layer structures are not suitable for heated greenhouse.

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Bracing system to reinforce the end walls to make sure they can withstand weight of trellising wires and crops

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Custom designed trellising systems

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Moveable hoop house

Rolling Thunder by Rimol Greenhouse systems - Image from website

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Moveable hoop house equipped with rollers and tracks

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Greenhouses

Structures that are designed for three-season and year-round production, with double layers of plastic, polycarbonate panels or glass with lots of height.
Build to include: cross bares to hold trellising wires and strings, heating system, ventilation, and climate controls …

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With cross bars and well reinforced end walls to carry trellis system and crop

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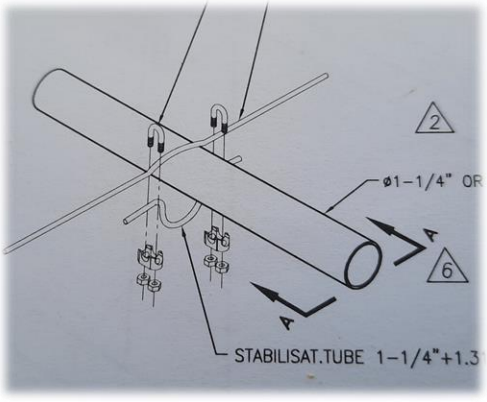
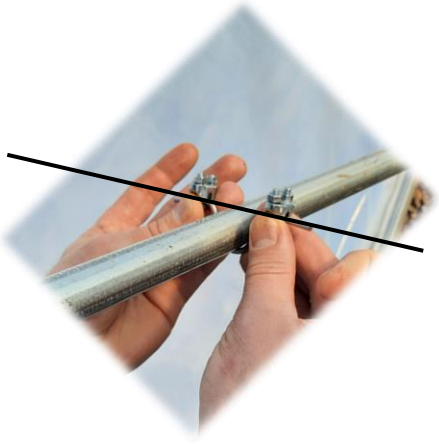
Specialty devices: to hold trellising wires





Clamp used to hold the trellising wire in place to reduce strain on end wall

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Greenhouses

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Greenhouses

Gutter connected greenhouse with high gutters for optimal crop management and yield.

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Comparaison

Structure	Width (ft)	Length (ft)	Workable Height (ft)	Hoop spacing (ft)	# of beds
Mini-tunnels	Single row or full cover		< 3 ft	n/a	1 +
Caterpillar tunnels	14-17	50-100+	6.6 -7	4,5 or 6	3
High tunnels	28-31	100-150	9-10	10	5
Hoop houses	16-30	30-100+	6.5+	3, 4	4+
Minimally heated greenhouse	24-36	60+	7+	4+	4+
Year-round heated greenhouse	24-36	60+	7-18+	5 +	4+

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Comparaison

Structure	Border effect on outside beds/rows	Adapted for high wire trellising	Adapted for snow load	Layers of plastic	Frost protection
Mini-tunnels	n/a	No	No	1	+
Caterpillar high tunnels	+++ No skirting	No	No	1	++
High tunnels	++	No, yes	No	1	+++
Hoop houses	++	No, yes	yes	1-2	+++
Minimally heated greenhouse	+	yes	yes	2	yes
Heated year-round greenhouse	None	yes	yes	2, polycarb. or glass	yes

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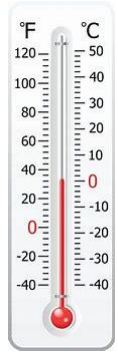
Frost protection



Single layer structures offer little frost protection: 0.5 to 1.5 ºC

The larger the structure the better it is.
- Mini-tunnels < Caterpillar t. < Hoop houses ≤ High t.
- more air volumes offer more buffering

The earlier you close-up the structure in the afternoon the better it is to avoid night-time frost conditions (spring and fall).

It is possible to add thermal row covers or blankets inside the tunnels.

► Last and first frost dates are important factors
There are significant regional differences
Careful with frost sensitive & heat loving crops.

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However, single plastic layer structures

Can extend the growing season

Protects crops from weather events (e.g. rain fall).

Protects crops from some diseases, insects and wildlife

Provides thermal benefits during sunny conditions

► **soil warming, more growth, improved and earlier ripening, increased yield and quality, ...**

► **Out of season produce fetch higher prices**

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Comparaison

Structure	Cost per $ / ft^2	Ventilation	Yield potential
Mini-tunnels			n/a
Caterpillar tunnels	2.20 +	Push-up sides	++
High tunnels (with screw type anchor post)	3.75 +	End wall curtains, roof/side wall roll-ups	++
Hoop houses	3.75 +	Roll-up sides, End wall doors	++
Minimally heated freestanding greenhouse	10.00 +	Roll-up sides, End-wall doors, Mechanical ventilation: Exhaust fans/louvers or positive pressure system	+++
Heated year-round greenhouse (all buildings and systems)	30.00 to 50.00+	Roll-up sides, roof vents, Mecanical ventilation:	++++

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Yield - Grower survey conducted in Quebec

Crops	Type of structure	Marketable Yield (kg/m^2)	Harvest Period
Beef Tomato (indeterminate)	Caterpillar t.	8-15	End of July to end of Sept
	Hoop house	10-20	3rd wk of July to end of Sept
	3 season greenhouse	20-30	Early June to early Nov
Bush tomato (determinate)	tunnel	5-11	End of July to end of Sept
Peppers	Caterpillar t	4.8-6	Mid-Aug to early Oct
	Hoop house	5.5-6.8	Early August to end of Oct
	3 season greenhouse	7-10	3wk of June to early Nov

Adapted from Guide de production de poivrons et tomates biologiques sous abris (CRAAQ)

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Interesting French reference – CRAAQ
- Organic Pepper and Tomato Guide, under Protected Structures

Guide de production : Poivron et tomate biologiques sous abris (PDF)

Éditeur : Club Bio-Action et MAPAQ
Type : Document électronique

Gratuit

Une valeur de 59,99 $

Vous devez être connecté pour voir ce document.

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Practical information

- Site preparation
- Drainage
- Irrigation
- Fertilization
- Colour of ground cover

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Site preparation and installation - Drainage

French drains: gravel and perforated drainage pipe

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Drainage

French drain with gravel and drainage tile covered with fabric to take rainwater away from the structure

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Greenhouse drainage and ground insulation project

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Open ditching to divert water away from greenhouse

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-Raised platform for improved drainage for in ground production

Top soil is moved and brought back to build a well drained platform. Sub-soiling or deep tilling can be used to loosen-up the soil before completing the side-walls and end-walls.

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- Drainage for in ground production

Growers can adjust the soil pH and fertility status as soon as the greenhouse is erected or,

If the site drainage is adequate and minimal site work is required, these adjustments should be done at least one year ahead of planting.

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Site preparation and intallation

Robust metal screen “hardware cloth” installed along the bottom perimeter of the structure to deter rodents. Screen is buried below ground level.

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Conditioning the soil with black silage tarp

Black silage tarps to warm-up the soil, eradicate weeds and to encourage crop residue break-down.

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Ground covers ?

Black ground covers are great to control weed and warm up the soil but …

Soil pH and fertility status must be adequate
Hard to manage drip lines and monitor irrigation
Hard to add fertilizers and amendments to the crop
- fertilizing in the hole is not the best approach

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Ground covers « Black or White »

Rule of thumb:

Black for unheated structure

- Soil warming
- Weed suppression

White over black for heated greenhouses

- Reflect sunlight into canopy
- Weed suppression

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Irrigation management

White over black plastic with 2-4 drip lines per bed

Tensiometer to determine soil moisture

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Irrigation management “monitoring”

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Fertilization – soil based production

The plastic is useful to keep the soil surface with enough moisture to stimulate mineralization (critical in organic production).

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Fertilization:
based on crop needs, soil test and target yield

Mini-tunnels

Caterpillar tunnels

High tunnels

Hoop houses

Minimally heated greenhouses

Year-round greenhouses

Like growing the crop in the field

Adjusted based on target yield

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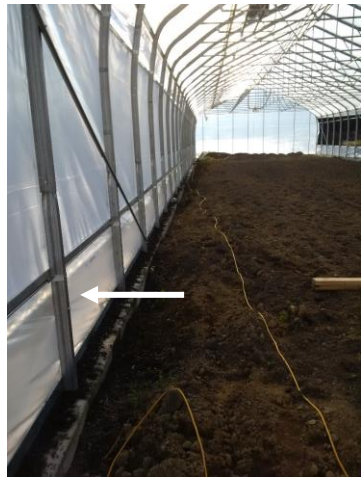
Skirting below the roll-ups



Skirting is useful to keep pests outside the structure and to protect seedlings from damaging wind.

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Border effect on outside rows

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Insect exclusion netting, under roll-ups

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Ventilation and insect netting

Hoop houses and greenhouses that use roll-up sides must make sure the roll-up area is sufficient to allow enough air movement.
Insect netting will interfere with the natural movement of the air.
Rule of thumb: 25% opening or 7½ for / 30ft wide structure

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Insect exclusion netting, for roof vents, accordion style

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Farm made design: screened end-wall

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Greenhouse with both natural ventilation (roll-ups) and mechanical ventilation (fans and louvers)

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Greenhouses with mechanical ventilation with fans and louvers

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Greenhouses with
Mechanical ventilation with fans and louvers

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Vestibule (entrance area) for biosecurity

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Frost-free « self-draining » hydrant

Very useful for seasonal and three-season hoop houses or greenhouses

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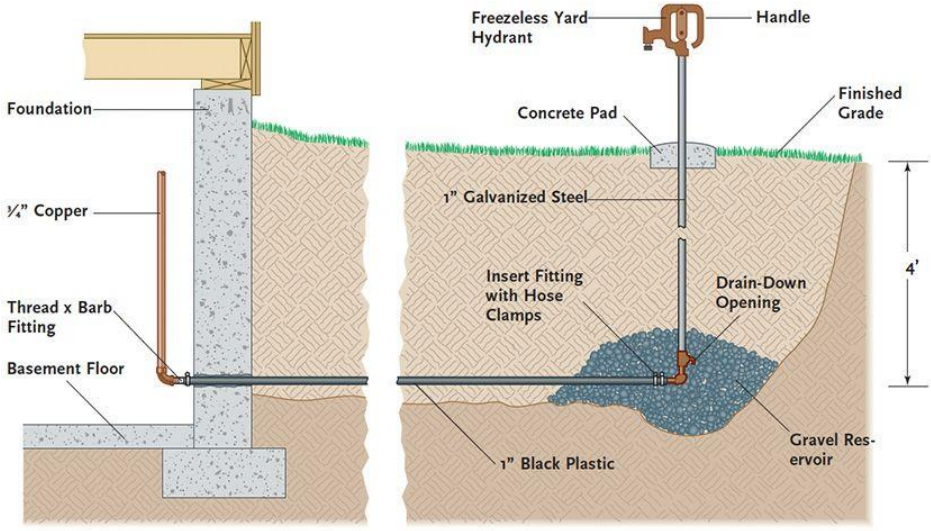
Frost-free « self-draining » hydrant



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Heating system
Minimally heated greenhouses (propane system)

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Hot air distribution system

To direct the hot air at the base of the plants or below grow benches

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Hot water heating system

Pipe network used to circulate hot water and to carry the utility carts

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Hot water insulated water reservoir used to hold hot water

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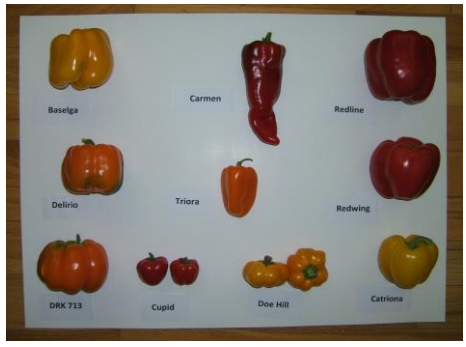
Cultivar selection for hoop house and greenhouse production



Greenhouse cultivars are bred and selected for CEAs
Have superior disease resistance package
Can remain productive over longer period of time
Superior yield and quality

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Special thanks to the following growers for sharing their experiences and images

Strawberry Hill Farms
Codiac Organic Farms
Jemseg River Farms
Natures Route Farms
Bantry Bay Farms
Ferme Pouce Vert –Green Thumb
Windy Hill Farm
Good Spring Farms
Ferme Alva Farm
Terre Partagée
Diddley Squash Farms
M. Tomate
Les légumes à Reno
Rainbow Harvest Farms
Willow Farms
Jolicure Farm
Quebec Growers

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Next week …

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Upcoming Fruit and Vegetable Greenhouse and indoor Production Webinars

Four (4) technical sessions
Part of the CEA Consultation Project
Focus on heated and year-round production systems
Valuable knowledge for beginning and experienced growers

- **Infrastructure and Crop Planning (Dec 15th, 2021)**
- **Fertilization and Plant Protection, Jan 12, 2022**
- **Irrigation for Soil Based and Hydroponic Systems, Jan 19,**
- **Managing Crop Balance for Optimal Yield, Feb 2, 2022**

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Who is Climax Conseils ?

A greenhouse and indoor production consulting firm

3 senior greenhouse agrologist and 14 field agrologists and technicians

Provides technical services to over 280 vegetable greenhouse growers

Organic and hydroponic growers (large and small scale growers)

In business since 1999 (22 years)

Previously involved with the ACORN Greenhouse Project in 2015/2016

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Thank you !

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