# Transforming Northern Greenhouses:
# A Report on Soap Bubble- Insulated Greenhouses

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## Introduction

In a world where global warming appears to be occurring presently rather than an event that may happen in the future, we feel it is important to be looking towards innovative technologies to find creative ways to lower our consumption of fossil fuels. One problem facing most greenhouse operators in the Yukon is high fuel usage for heating greenhouses during the spring and fall months. Heating is required for greenhouses to maintain minimum set point temperatures for plant growth. A large amount of the heat that is produced by burning fossil fuels is lost through the greenhouse walls at night. A technology has been created that insulates greenhouses during the night but allows light in during the day, therefore lowering the amount of fuel consumed.

The soap bubble-insulated greenhouse is a technology that may be used to lengthen our short Yukon growing season without having to rely solely on wood or fossil fuel heat to keep the greenhouse warm during the winter months.

Soap bubble-insulated greenhouses work by employing a foam generator to fill a cavity in a double walled greenhouse with soap bubbles, which insulates the greenhouse during the night. The insulation can then be removed during the day to gather passive solar heat and to allow light in for plant growth.

On January 18th, 2006 Andy Lera visited Ross and Kat Elliot in Perth, Ontario. Ross Elliot is a consultant who works closely with individuals, communities and companies who are interested in developing soap bubble-insulated greenhouses. The Elliot's built their soap bubble- insulated greenhouse in 2001 and have been operating it continually since then. A large part of the information compiled in this report was gained through Andy's meeting with Ross Elliot in which he toured this soap bubble-insulated greenhouse.

## Description of Soap Bubble-Insulation Technology

### How Soap Bubble-Insulated Greenhouses Work

A greenhouse is built that has two layers of plastic - an outer layer spaced 30 inches from the inner layer. This space is similar to one found in a double layered greenhouse except that it also acts as a cavity for a layer of soap bubbles to be created to reduce nighttime heat losses. These bubbles create an insulating blanket that equals R-1 per inch of bubbles. The cavity is 30 inches deep creates an R-30 wall. In the morning, the bubbles are destroyed to allow light to penetrate into the greenhouse. UV transmission is similar to a double wall greenhouse. As well, during hot sunny days, the bubbles can be used to shade the greenhouse, reducing the interior temperatures to suitable levels.

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### How Soap Bubble-Insulated Greenhouses are Built

The greenhouse is constructed with standard greenhouse frame materials. The frame is bolted to an inner foundation wall and covered in plastic, much the same as a standard single wall greenhouse. The outer layer of plastic is attached to both the end walls, as well as to an insulated foundation wall 30 inches away from the inner wall. There is a ridge beam that supports the outer layer of plastic to maintain the 30-inch cavity, as well as to support the bubble generators. The ridge beam is bolted to the two end walls, which are 30 inches higher than the frame. This ridge beam then rests on top of the inner layer of plastic. The ridge beam, the outer foundation wall and the end walls are all that is needed to support the outer layer of plastic. An inflator fan maintains the spacing along the rest of the wall to produce a uniform cavity. Two soap bubble generators are located at each end of the beam and facing in opposite directions so that each soap bubble generator fills opposite sides of the greenhouse. A poly tank stores the bubble solution and a pump moves the solution through pipes to the bubble generators. Between the foundation walls is a lined trench that returns the soap solution to the storage tank. The trench is separated into two layers with pond liner plastic to allow rainwater collection for greenhouse irrigation. The rainwater collection trenches also act as a thermal mass to reduce heating requirements. These trenches hold 5,000 gallons of water, providing 42,000 pounds of thermal mass. A heat recovery ventilator (HRV) can be installed to vent excess humidity in the winter and bring in fresh air and carbon dioxide to the sealed greenhouse space.

### How The Soap Bubble Generation System Works

A surfactant soap solution (99% water, 1% soap) is stored in an underground poly tank. Timers are used to run a pump to bring the solution to the bubble generators under pressure. The solution goes through a water turbine that turns a fan in the bubble generator. After the solution leaves the turbine it is sprayed on to a screen and is blown through the screen by the fan. This produces a large volume of bubbles that fill the walls of the greenhouse in about four minutes. To maintain the bubble insulation, timers occasionally operate the pumps thereby replacing bubbles that have dissipated. During the day, when the bubble insulation is not needed, the timers are set to leave the pump off in order to allow the bubbles to naturally dissipate, which takes about two hours. If it is necessary to remove the insulation quickly, fans can be installed at the lower part of the wall to destroy the bubbles. As the bubbles are destroyed, the soap solution drains down to the lined trench and is returned to the soap solution tank. The solution is 100% water-soluble so therefore leaves no residue on the plastic to reduce UV transmission.

The Advantage of the Soap Bubble-Insulated Greenhouse

Growing food in greenhouses during the winter in the Yukon is presently not economically viable due to the high cost of heating and the low thermal resistance of standard greenhouses. It appears that soap bubble-insulated greenhouses may allow northern growers to extend the operating season by increasing the thermal resistance of the greenhouse wall to reduce or eliminate fossil fuel consumption. This would allow longer season crops to be grown or multiple harvests of short season crops. As well, the reduction in heating lowers the yearly expenses for the operator.

## Soap Bubble- Insulated Greenhouse Technology in the Yukon

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New Market Opportunities

Presently, there are some crops that are difficult to grow commercially in the Yukon. For example, tomatoes require a longer growing season and presently in the Yukon most green house growers find it necessary to heat a greenhouse in the spring and in the fall in order to successfully grow tomato plants. The soap bubble-insulated greenhouse might be able to make it possible to successfully grow vegetables such as tomatoes or squash without having to account for the extra cost of heating the greenhouse during the spring and fall months. As well, indeterminate varieties could be grown for a longer time period so as to harvest a larger amount of fruit.

Vegetable crops such as spinach or mixed greens that are cold hardy could offer another new market opportunity as they could be grown in the early and late winter for commercial production. These extra crops could quickly pay back the increased costs of building the soap bubble-insulated greenhouse.

Increasing Profitability of Existing Markets

It appears that there is a thriving bedding-plant market in Whitehorse. In order for these businesses to be successful they need to heat their greenhouses using wood, propane or oil during the spring months in order for their bedding plants to be ready for sale in May and June. The soap bubble-insulated greenhouse may be able to significantly reduce the amount of fuel needed to keep the greenhouses warm during the months of March, April and May. As well, the season could be extended earlier to allow certain plants to be started from seed rather then from purchased plugs.

Diversification Into New Crops

One of the goals of the soap bubble-insulated greenhouse would be to lengthen the growing season for Yukon greenhouse growers. With a longer season available to growers there may be new crops that could be grown that are presently underutilized by Yukon growers due to the length of growing season needed to have a successful crop. These crops may include eggplant, squash or chili peppers.

Maximizing Environmental Stewardship

Our food supply is trucked from producers approximately 3000 kilometers away. It takes approximately 400 gallons of fuel to feed one person for a year. Vast quantities of fossil fuels are used in order to transport food from farms far way to our dinner plates. This food has often been harvested in an immature state so that it can survive the long traveling time and has lost much of its nutritional value in the process.

There are two main ways in which the soap bubble-insulated greenhouse works towards maximizing environmental stewardship. First of all, by using a very small amount of non-renewable resources to heat the greenhouse this technology strives to conserve fossil fuels. Secondly, by utilizing soap bubble-insulated greenhouses to grow more local food, the Yukon may be able to rely less on diesel-fuel trucks to transport food from producers located thousands of miles away.

## Comparing the Double Walled Greenhouse to the Soap Bubble-Insulated Greenhouse

Table 1

Economics play a large role in deciding what type of infrastructure to build when choosing a greenhouse. Table 1 breaks down the costs of the individual components of the double walled greenhouse and the soap bubble-insulated greenhouse. As well, Table 1 compares the heating costs of both greenhouses and the length of time it will take to recover the extra cost of the soap bubble-insulated greenhouse through savings on fuel costs.

Table 2

Other factors that greenhouse growers must consider when building a greenhouse are environmental factors and labor. These topics are covered in Table 2.

Table 3

As the main goal of the soap bubble-insulated greenhouse is to use less fossil fuels while having a longer growing season, Table 3 compares the amount of propane, oil and wood needed to heat a greenhouse with and without soap bubble-insulation.

Information About Figures in All Tables

In all the three tables, the amount of fuel is based on the climate and growing season in Ontario. Mainly, we have relied on numbers supplied to us from Ross and Kat Elliot in Perth, Ontario. We are aware that the amount of oil, propane and wood needed to heat a greenhouse in the Yukon both with and without soap bubble-insulation is most likely higher then presented in the tables. Also, all figures are based on a 30 ft x 50 ft greenhouse.

## Comments From Yukon Greenhouse Growers

*To be included after the presentation being held on March 16th at the Whitehorse Public Library from 7-8:30pm.*

**Table 1**

| | **Double Walled Greenhouse** | **Soap Bubble- Insulated Greenhouse** |
|---|---|---|
| Package including frame, double poly roof cover, inflator fan, end covers, spring lock | $4,084 | $4,084 |
| Heater | $2,000 | $1,800 (smaller size) |
| | | |

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|---|---|---|
| Poly Tank for soap solution | | $200 |
| Bubble Generators | | $7,800 |
| Soap solution | | $200 |
| Pump / pipes | | $400 |
| Ridge Beam | | $600 |
| Foundation | | $1,000 |
| End wall framing / Insulation | $600 | $1,000 |
| | | |
| Total cost to build | $6,684 | $17,084 |
| | | |
| Difference in cost to build | | $10,400 more expensive |
| | | |
| Cost to heat / year **PROPANE** | $1137.50 | $146.25 |
| Years to recover extra building costs in heat savings | | 10.5 years |
| | | |
| Cost to heat / year **OIL** | $1206.85 | $155.17 |
| Years to recover extra building costs in heat savings | | 10 years |
| | | |
| Cost to heat / year **WOOD** | $543 | $70.50 |
| Years to recover extra building costs in heat savings | | 22 years |

**Table 2**

| | **Double Walled Greenhouse** | **Soap Bubble -Insulated Greenhouse** |
|---|---|---|
| Typical Length of growing season | 6 months | **10-12 months** |
| Environmental factors | -Large amounts of fuel to heat, even at shorter seasons | **-lowered fuel usage for heat<br>-more local food production means less transport of food** |
| Labor to operate **propane, oil** | -Regular heating system maintenance<br>-plastic replacement every 3 to 5 years | **-reduced heating system maintenance<br>-plastic replacement every 3 to 5 years<br>-grease bubble generators 1 time per year (20 minutes)<br>-seasonal timer reprogramming (20 minutes)** |
| Labor to operate **wood** | -frequent stoking of fire (up to 3 times / day)<br>-plastic replacement every 3 to 5 years | **-decreased stoking of fires (approx. every 1-2 days)<br>-plastic replacement every 3 to 5 years<br>-grease bubble generators 1 time per year (20 minutes)** |

| | | |
|---|---|---|
| | | -seasonal timer reprogramming (20 minutes) |

| | PROPANE HEATED | | | OIL HEATED | | | WOOD HEATED | |
|---|---|---|---|---|---|---|---|---|
| | Without Bubbles | With Bubble Insulation | | Without Bubbles | With Bubble Insulation | | Without Bubbles | With Bubble Insulation |
| R-Values | 2 | 30 | | 2 | 30 | | 2 | 30 |
| BTU's / Hour Heat Loss | 90,000 | 18,000 | | 90,000 | 18,000 | | 90,000 | 18,000 |
| BTU's / Year | 31,872,750 | 4,097,925 | | 31,872,750 | 4,097,925 | | 31,872,750 | 4,097,925 |
| Amount of fuel / Year | 1750 liters | 225 liters | | 1283.88 liters | 165.07 liters | | 3.62 cords | 0.47 cords |
| Cost to Heat / Year @ (fuel price) | $1137.50 ($0.65/liter) | $146.25 $0.65/liter) | | $1206.85 ($0.94/liter) | $155.17 ($0.94/liter) | | $543 ($150/cord) | $70.50 ($150/cord) |

**Additional Information is available at:**

www.homesol.ca click on "**building consulting**" and then "**greenhouses**"

www.tdc.ca/bubblegreenhouse.htm

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www.groups.yahoo.com/group/solaroof

www.newfarm.org/news/2002/110802/greenhouse.shtml

www.solaroof.org