'Liquid Solar' Insulation and Shading System:
changing microclimate to reduce climate change

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Key Points

1) Why greenhouses don't work in very cold or very hot weather.
2) How bubbles provides summer cooling
3) How bubbles provides winter heating.
4) Other applications, "open source" technology

Introduction

Fresh, unprocessed, locally-grown organic produce should beat the heart of an environmentally-sustainable food system, yet a typical Canadian meal has been transported over 2000 kilometres from producer to market, consuming vast quantities of fossil fuels in the process. Growing food in winter greenhouses is often uneconomical due to the low thermal resistance of glazing systems and the rising cost of fossil-fuel heat. Conversely, greenhouse overheating is a common daytime problem, and excess solar gain is generally vented rather than stored for later use in winter, or deflected with shading systems in summer. If a way could be found to produce food locally in cold seasons using only captured solar energy, this would reduce reliance on long-distance transportation of fresh produce, lower carbon dioxide emissions, slow climate change and increase food self-sufficiency.

Use controlled environments to reduce greenhouse gases and produce fresh, local, organic food...
Finite fossil fuels threaten global food security...

Materials and Methods

We built the 1500 square foot 'Lively Up' Winter Harvest solar greenhouse prototype to research the use of soap bubbles to create a replaceable and removable layer that allows shading or R-30 insulation as needed. This layer prevents overheating by collecting and storing excess solar gain, reduces the Design Heat Loss of the building dramatically at night, while allowing maximum light availability for optimum plant growth during short winter days. A series of mist sprayers between the two glazing layers cool interior temperatures while collecting solar heat in 20,000 litres of water. The 'Liquid Solar" Insulation & Shading System should eliminate the need for fossil-fuel heating or powered ventilation to maintain optimum growing conditions year-round in any climate. This is the first operational hoophouse of this kind in the world. Results of this research will be applied to creating a 9000 square foot gutter-connected commercial greenhouse operation as well as many other projects currently planned or underway worldwide. All results will be published as "open source — technology" with commercial users invited to "pay it forward". For further details see www.solaroof.org

Results and Discussion

The greenhouse was completed to the first layer of plastic by the end of 2001. at which point further construction was suspended due to the onset of winter. Crops of lettuce, mesclun coriander, swiss chard, parsley and beets grew vigorously all winter long under row covers, while the constantly circulating 42,000 Ib. liquid thermal mass within the insulated foundation reached a low of 5C and kept the soi fro m freezing. This was without any bubbles or even a second layer of plastic, so we assume there is geothermal heat at 5" below grade maintaining the greenhouse at this temperature. A 4-channel data logger continuously records the greenhouse environment The completed system was commissioned in April of 2002 and has been operating continuously since, while producing crops of peppers, tomatoes, cucumbers, edible flowers, erbs and salad greens- Various issues have been identified as needing further attention, and we will be making changes to the system in the spring of 2003 to optimize the greenhouse for extreme cold. Ultimately we plan to take this technology to the far North, where communities import all their produce, as well as cold countries facing famine such as North Korea and Mongolia.

Conclusions

Preliminary results show that the greenhouse works as planned through the hot summer, shading and cooling crops as needed with dramatic results. Mid winter operations in 2002 resulted in no frost damage to the crops even at -30C outside, although supplemental heat was needed at times due to technical glitches with the system. Further research needs to be completed and we welcome financial support from government, industry or individuals for further investigations into agricultural and residential applications of this "liquid solar" technology.

References

Based on work first published by Inventor Nelson, Richard (1994) Test Results of Prototype Operations and Operating Principles of the Thermactive Systems Technology", and his subsequent collaboration with us on this project.

1 Shamim, Tariq, P.E., Me Donald, Thomas W., PhD., PJB. (1995) "An Experimental Study ofHeatTransfer Through Liquid Foam". ASHRAE Tiaasactbns: Research

2 Modelled icing HOT2XP ver.2.104 0001), Natural Resources Canada software, 85% rcdncion h heat bss @ 20C interior temperatures / -13C exterior temperatures. Zero purchased heat needed to maintain above freezing temperatures even at -30C exterior temperatures.