Michelle Rogan

The Last Place on Earth

Greenhouse Gardening at the South Pole

Antarctica is a continent of rare beauty. It is also one of the most inhospitable places on Earth in which to work and live. But every year over 5,000 people from many different countries, do just that.

The southern most continent is certainly the coldest. Temperatures at the South Pole can drop to 94 degrees below zero (-70 C) in any given austral winter. The plateau of the continent is also one of the driest spots in the world. Although surrounded by snow and ice, the south geographical pole has an average precipitation of less than 1/4 inch per year.

If the bone-chilling climate doesn't make you think twice about going to Antarctica, the isolation will. The majority of the people who go there during the summer go home before the austral winter sets in. Less than 500 people a year "winter-over" on the ice.

Antarctica is a continent of research. The signing of the International Antarctic Treaty has guaranteed that for now and for the near future the continent will not be exploited or explored for its mineral potential, but will be used solely for scientific advancement. Therefore, it might be considered the largest laboratory in the world. That's why every year so many people journey to Antarctica.

The United States, through the financing of the National Science Foundation, supports three year-round research bases, McMurdo Base, Palmer Station and Amundsen-Scott South Pole Station. Many other countries support year-round facilities, including the Soviet Commonwealth with Vostok Base, the New Zealanders with Scott Base, the Italians with Terra Nova and the United Kingdom with Halley Bay Station.

Most "winter-over" bases are unreachable from March to October. This isolation not only stops people from coming and going, but halts the flow of mail and supplies, including fresh foods such as vegetables. It was the inability to store perishable foods that caused many of the bases to

design greenhouse facilities that would support small winter-over populations.

Hydroponics was chosen over conventional gardening methods due to its high yield capacity and to adhere to the Antarctic Treaty, which forbids bringing foreign soils onto the continent. At the Pole there is no "local soil" readily available.

The New Zealander's Scott Base greenhouse facility is a building consisting of two water storage tanks. The shape of the tanks provides a greenhouse "in the round." Flexible tubing around the inside edge of the two tanks serves as plumbing for the transport of nutrients. The tanks are small, but with a winter-over crew of only ten people, they are enough.

McMurdo's greenhouse was built out of several wooden 8- by 12-foot prefab buildings. It is probably the largest hydroponic greenhouse on the continent, but it also must provide for the largest winter-over population.

South Pole's set-up was a design that mirrored McMurdo's greenhouse facility, but on a smaller scale. With only 20 people at the Pole during the '89-'90 season, a smaller facility would be adequate. All the greenhouse equipment, including the building, came from materials around the station that were designated to be thrown out.

The building was an old "do not freeze" cargo storage hut that had been replaced with a larger building in the summer of 1989. The old building was brought into the giant dome that is the main architectural structure at South Pole station. Although unheated, the dome provides much needed protection from the wind and blowing snow. An all-aluminum structure, the dome was built between 1974 and 1975. Separate wooden buildings inside provide sleeping quarters, a kitchen, recreation room, weight room, a science facility, computer room, communications facility, food storage areas and a bar.

Once the greenhouse building was moved inside the dome, much work had to be done to convert the old cargo hut into a working hydroponic greenhouse. First, the entire structure was gutted. Next, a vestibule was added to help minimize shock to the plants every time the door was opened and cold air rushed inside. Then a layer of insulation was added to the floor.

The building was vapor sealed by painting the walls with two coats of paint and then covering the walls and the ceiling with aluminum foil. The foil would also add to the reflectivity of the fluorescent lighting. Heating was already provided by two Chromalox heaters that had been installed in the building when it was used as a cargo storage area.

PVC pipe was chosen as the best way to transport the nutrient solution to the plants. The PVC had to be cut to lengths suitable to the size of the building and holes for holding the plants had to be drilled in the top of the pipes. Because of the lack of space in the room, the hydroponic system uses a single pump; different plants have to share a common nutrient solution. The system is V-shaped with the PVC pipes on two levels. A 55 gallon container is used as the reservoir for the system, a bubbler adds oxygen, and a small pump circulates the nutrient.

The nutrient is pumped to the upper level of pipes, where it circulates through and then flows down thin rubber tubes to the lower level pipes. From there it flows back into the reservoir to be recycled again.

The system is monitored daily for changes in humidity, temperature, pH, and nutrient conductivity. Humidity of about 70 percent is maintained by one small humidifier. The temperature is controlled by the heater thermostats. Ideally, the temperature is maintained at 68 degrees (about 25 C). Occasional power failures threatened the plants, but none lasted long enough to do any damage.

With the completion of the greenhouse structure, the only choice left was "What to grow?" Ornamental flowers would have been nice, but the Antarctic Treaty specifically states that anything grown on the continent must be edible. So, the simplest of vegetables and herbs was the choice. Lettuce, peppers and tomatoes were the main crops, but sprouts, basil, kale, oregano and strawberries were also planted.

The biggest success by far was the peppers. Red chilies and jalapeno were the favorites among the crew, but sweet green peppers also thrived. The

Peppers, red chiles and jalapenos, were one of the favorites of *the crew. Other crops included basil, oregano, lettuce and strawberries.*

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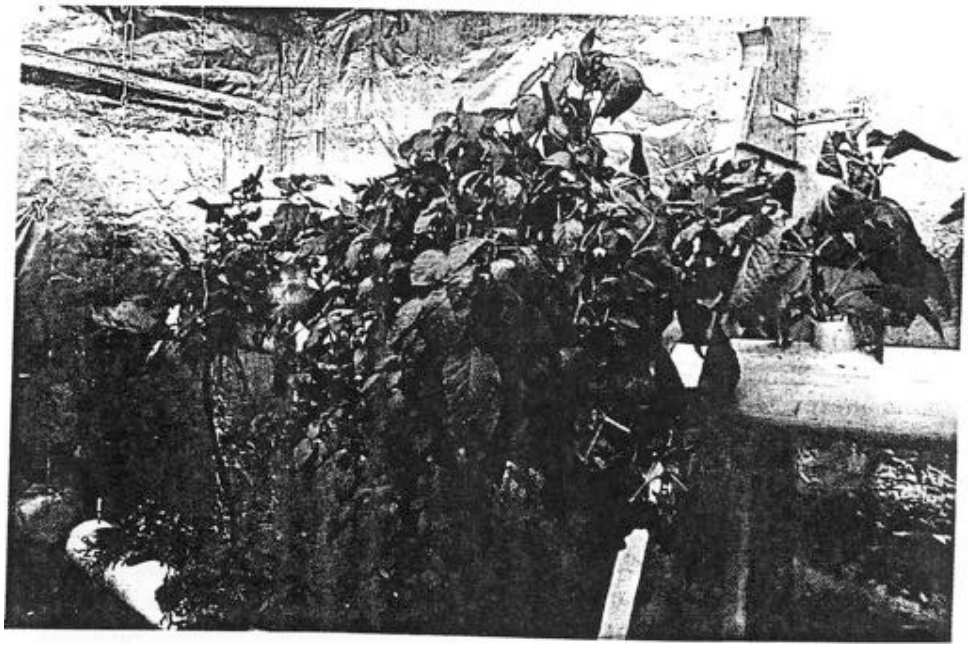

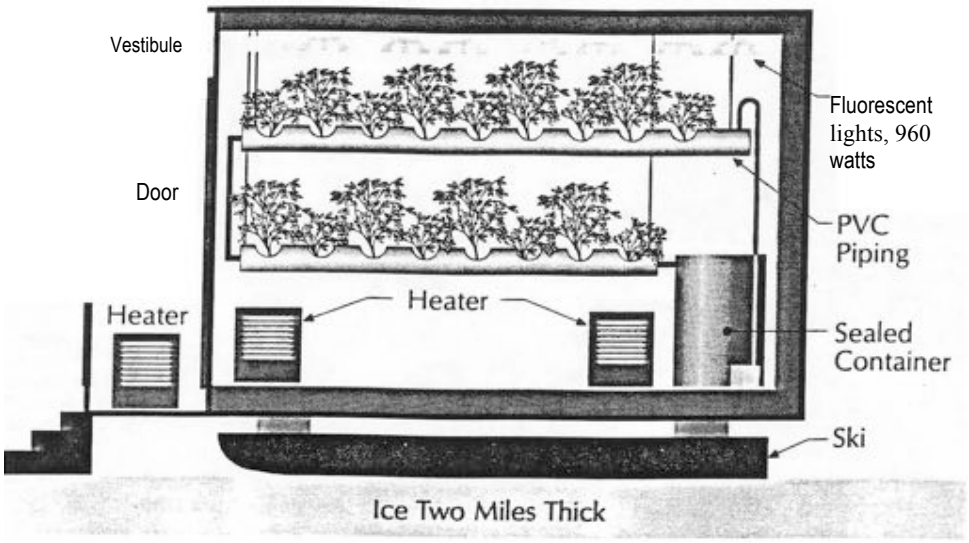

original plants that were started in March lasted the entire season and were healthy and bushy even after the station opening on October 31 at the end of the southern winter.

Lettuce was the second most popular crop. Although big salads at every meal were not possible, it was always a treat to provide lettuce for sandwiches or small salads. Sprouts were popular as sandwich garnishes also.

The tomatoes caused most of our worries. Although the plants seemed healthy and would bud often, pollination was difficult. Thin paint brushes and fans were used to help with the pollination process, but few tomatoes were produced. Either the lack of CO2, or the extremely high altitude (the base has an actual altitude of 9,301 feet, but due to prevailing low pressure systems over the pole, it feels as if you are standing at an altitude of somewhere around 12,000 feet) may have caused the problems.

More testing needs to be done to come up with a solution. The herbs quickly grew lush and green and could be pinched back for use in salads and sauces.

One unexpected bonus from the project had nothing to do with fresh vegetables and salad greens. Because of the dryness at the Pole, breathing in air that contained 70 percent humidity was always a treat. Also during the six month night that is the Antarctic winter, the brightness of the green house lighting provided welcomed energy to tired minds and bodies.

Sun lamps were later installed on timers and a wooden sun bed was built that could be placed in the center of the greenhouse for sunning and then stored under the PVC pipes when not in use. This way people could put on some tanning lotion and soak up some rays surrounded by green living plants- a great boost to the mental health.

In general, the greenhouse was a great success and it seems hydroponics has a promising future on the ice. After 17 years of faithful service, the South Pole station is coming to the end of its useful life. A new, improved base is already in the advanced planning stage and will include a specially designed 40-square-meter hydroponic greenhouse. The environment will be carefully controlled and it is hoped that it can supply 50 percent of the fruit and vegetable needs of the winter-over crew.

The growing plants would use the waste water from the base showers and kitchen to provide primary water treatment and to reduce energy consumption. With the low carbon dioxide levels at the Pole, there are also plans to incorporate a microbrewery that would supply the plants with carbon dioxide as a waste product and the human population with some liquid refreshment.

In the more distant future, there are plans for another station on the high plateau. This base would be situated at the highest point on the Antarctic plateau where the altitude is such that the base would need to be pressurized. This station would be an ideal test for a future space habitat including the development of high-yield, soilless greenhouses.

In the next several decades the use of Antarctica as a simulation of a Martian or Lunar environment is planned to expand. Antarctica offers conditions similar to these environments while being accessible enough to allow routine logistical support.

So, who knows? With the results obtained from the Antarctic hydroponics projects, maybe the next generation of "winter-overs" will have fresh green veggies. But they won't be living on the ice of Antarctica. How about munching lettuce on Mars!

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