Solar thermal greenhouse

The Defence Institute of High Altitude Research (DIHAR), Leh, a constituent institute of Defence Research and Development Organisation (DRDO) is engaged in the development of agro-animal technologies for high altitude cold deserts to cater to the fresh food requirements of armed forces through local farmers. Although different agro-technologies, including protected cultivation, have been developed and successfully transferred in these regions, they are useful only in the summer months, i.e. from March to September. However, agricultural activities are absent during the rest of the year due to sub-zero temperatures (up to –40°C). Further, during peak winter days, due to cloudy weather and frequent snowfall, air-lifting of fresh green vegetables also becomes difficult for weeks together. Hence, development of an alternative technology for vegetable cultivation in the peak winters, especially when the temperature goes to subzero (up to –40°C) is imperative.

It is perceived that the greenhouse technology with controlled environment facilities would serve the purpose of providing the required ambient temperature and other conditions suitable for crop production. Practically, the technology should help maintain a temperature of about 20°C (±5°C) inside a structure when the outside temperature is about –40°C. Since there is ample sunshine (3–7 kWh/m^2/day) in the region for 300 days in a year, harnessing this non-conventional resource, i.e. solar thermal energy for heating would be cost-effective and eco-friendly.

A solar thermal greenhouse with floor area of 13.5 m × 4.5 m and height of 2.7 m has been constructed at DIHAR, Leh (Figure 1 *a*). To minimize heat losses, poly urethane foam (PUF) of 150 mm thickness is used. The PUF greenhouse is erected on reinforced cement concrete (RCC) foundation. Ante-room with an area 1.8 m × 1 m is provided at the entrance to ensure minimum heat loss while entering the greenhouse. The ante-room is also used to install the control panel and the PAR light timer (Figure 1 *b*). To use the maximum volume inside the greenhouse, a tier system is created using specially designed racks having dimensions 1.8 m × 0.76 m with three shelves at 0.9 m height (Figure 1 *c*). Provision for 350 mol/m^2/s PAR light at 0.9 m height is made for proper photosynthesis. The different sensors for temperature, humidity, etc. are installed to monitor and control the required suitable agro-climate in the greenhouse.

Using evacuated tube collectors (ETC), the solar radiation is harnessed for heating. ETC air heaters (12 units, each unit consisting of 15 ETC tubes) having aperture area of 16 m^2 are used for harnessing solar radiation during daytime and circulate the heated air inside the greenhouse. ETC thermic oil heaters (16 units, each unit consisting of 15 ETC tubes) having aperture area of 30 m^2 are used for harnessing solar radiation during daytime to heat the thermic oil and store it in the oil tank and circulate the heated oil in heat exchanger inside the greenhouse. A diesel-fired generator is also installed as an auxiliary source of heating. Experiments on cultivation of some vegetables are in progress (Figure 1 *c*).

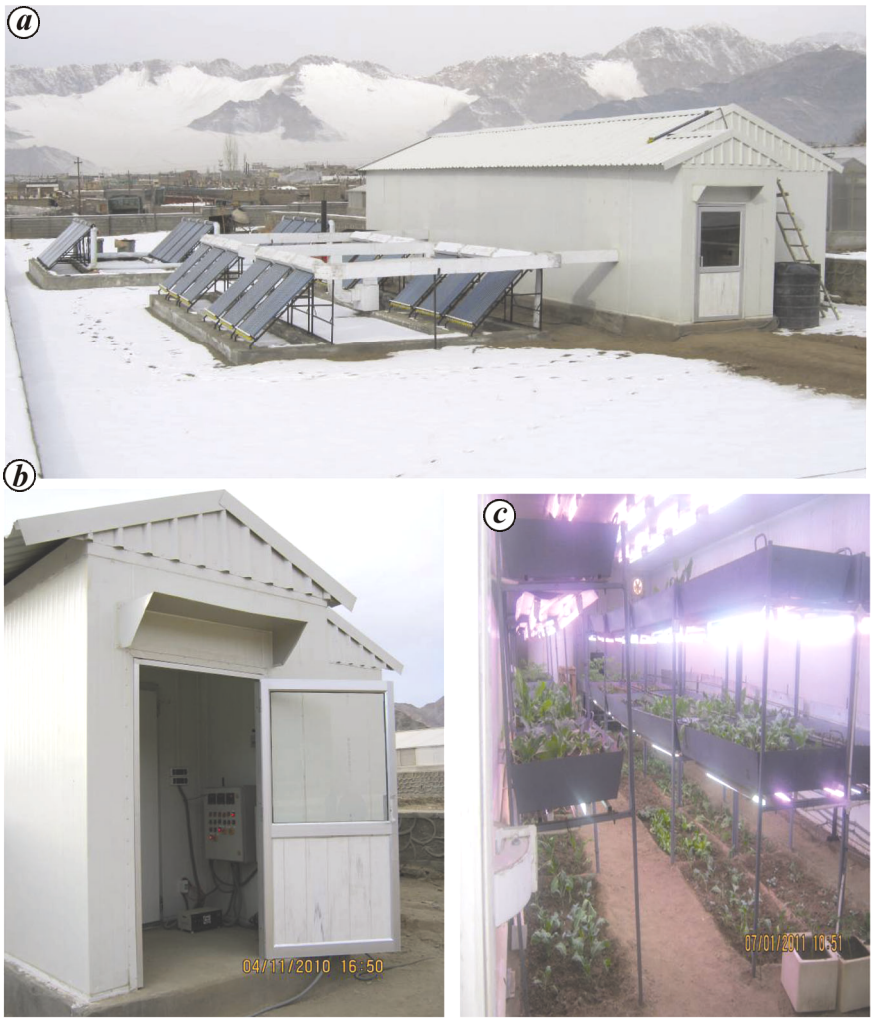

Figure 1. ***a***, Solar thermal greenhouse installed at DIHAR, Leh; ***b***, Ante-room of greenhouse with control panel; ***c***, Experiments on cultivation of some vegetables.

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