Use of coolbot technology for construction of low cost-low capacity cold storages on farms

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Although mechanical refrigeration is the best technology for coolrooms and transportation systems, conventional reefers are economically and practically infeasible for limited resource farmers. Under a project under **HortCRSP**, Amity University was invited to collaborate with UC Davis under the project entitled **" Coolroom and coolchain transport for small scale farmers".** In this project a device "CoolBot" was to be tested along with selection of low cost insulation technology. Cool-bot is a device conceptualized by Mr. Ron Khosla, which turns a conventional room air conditioner into a produce cooler. The air conditioner's thermostat is heated so that the unit keeps running until the room temperature reaches the Cool bot set point. To prevent icing of the fins, the Cool-bot measures the fin temperature and stops the compressor (through the thermostat heater) when ice builds up. The ice on the fins continues to cool the room air until it melts and the compressor turns on again.

The CoolBot turns any brand of off-the-shelf, window-type air conditioning unit into a turbo-charged cooling machine. With it a highly-insulated room can be transformed into a walk-in cooler, keeping the commodity fresh and thermostatically controlled cool down to 4-5^{o}C. CoolBot saves not only on installation and repair costs but also helps to save electricity, reducing the operating costs when combined with new energy efficient air conditioning units

Functioning of the Coolbot

The problem with window air conditioner units is that they are electronically limited so that one can't go below 16-18 ^{o} C degrees. With some electrical bravery and skill, one could snip, solder and bypass the electrical controls so you could go lower. It will work better, but still not very well, because the ability to actually access the cooling power drops drastically as one approach only 16° C. This is because there are no fans and extra surface area built into normal walk-in cooler compressor/condensor/evaporator units which dissipate the cold without freezing up.

CoolBot uses new technology to replace the brute force approach of fans and surface area with a micro-controller "brain" that intelligently interfaces with the air conditioner - controlling and co-ordinating its output so that one can access nearly all the cooling power.

The **CoolBot** is not just a thermostat. It uses multiple sensors and a programmed micro-controller to direct the air conditioner's compressor to operate in such a way that it can run at the desired temperature without ever freezing up. The multiple sensors and microcontroller allows the CoolBot to work even during the heat of summer and even when people are opening and closing the door all day long but if the door is left open too long it can cause problems.

Installation of the coolbot

- Install any good energy efficient window A/C unit Cut a hole in the wall, put the A.C. unit into the hole, and then use foam sealant to seal up the gaps.
- Plug the CoolBot into a standard A.C. outlet
- There are three labeled wires coming out of CoolBot: one measures the temperature of the room, let it hang free.
- The second wire (labeled frost sensor) has to be stuck into the cooling vent fins of the A.C. unit. It holds there on its own, one does not need to tape it or screw it.
- Attach the third wire to the temperature sensor which sticks out of the front of the A/C unit. Wrap the CoolBot wire and the end of that temperature sensor together using a small 1/2 inch by 1 inch piece of aluminum foil to ensure a good thermal connection.
- There are three buttons on the CoolBot - Set the first one (labelled Room temperature) to your desired temperature and the frost button. The temperature on the frost button should be lower than the room temperature.

The coolbot project of Amity University

Our main focus was to develop a prototype low cost storage structure for the small and marginal farmers from locally available insulating material and to test the effectiveness of CoolBot/room air conditioner combination. The construction details of our cool room are as follows-

This system can be easily installed and built at the farm with locally available materials like rice husk and mud. Farmers can plan there production and marketing and do not have to resort to distress sale in case of glut production which will help in fetching them better price. This technology is also environmentally friendly because of lower electricity consumption and low carbon emissions. Once initial trials of this proposed cool room are successful this technique will be replicated through out the country through self help groups.

Methodology used for cool room construction

- The internal dimension of the room is 12 ft X 12 ft.
- The thickness of the wall is 2ft 9 in.
- The insulation selected was a thick mud wall with rice husk as binder.
- To provide support and stability to the wall 9 inch thick untreated bricks are used on all walls.
- On both side of the brick there is 1 ft wide mud wall made of special clay mud.
- This mud is mixed with rice husk in the ratio 2:1 i.e. 2 parts mud and 1 part rice husk.
- An air lock room of 5ft X 6 ft is also constructed so that the cool room door is opened only when absolutely necessary.
- The door of the cool room is a standard cold store door with 30 mm thick PUF s with appropriate hinges and locking.
- Roof has been made with girder, kota stone, thermocol enclosed inside polythene to also act as vapour barrier, tiles and on top two layers of small stone chips and cement.
- Thermocol has been used for insulation with density 20 Kg/ sq. mt and thickness- 6 inches.
- The roof has a slope on one side for easy drainage of rain water.
- Four coatings of the paint are given.
- First is the clay coating, second cement based coating called 'Putty', a layer of water proof coat branded 'FIXIT' and a layer of heat reflective paint.
- A videocon window air conditioner 21,000 BTU was installed.
- The CoolBot is connected to the air conditioner as described above.

Construction cost

The capacity of the cold room is 8-10 tons with 25 % free space. The room size is 144 sq. mt with a height of 9 mt sloping on one side for water flow. The external dimension is 18 *18 sq. mt and the roof dimension is 19 * 19 sq. mt. The construction cost of the cool room of this capacity and the proposed cooling temperature is presented in the table 1 -

Table1 : Construction cost of the coolroom

Component	Amount (Rs.)
Mud 3100' x 2.50 Rs. Per foot	7750
Mud Transport	12000
JCB Loading	2700
Kota Stone 490	12005
Girder SPS 17'5" spc	10937.5
Girder stone transport	1750
AC Frame Size 20 x 30"	800
Stone crusher	9450
Tile 1700 P.S. x Rs 3.40 Bricks	5780
800 P.S. x Rs. 3.20 Bricks	2560
Cement 40 Bag	10000
Front Door 1 pc Air locked door	1250
Mason	17680
Labor	21860
Bricks	20400
Door Transport	1000
Painting work cool store with material & Labor	18500
Door (30 mm PUF)	6000
Thermocol (6 inch) for roof	3000
Total	**165422.5**
Videocon Window AC (2 tonne)	22300
5 KVA Automatic Voltage stabilizer	
Sinewave Inverter 5.5 KVA	84000
Automotive battery 120 AH (8 pc)	
Battery rack / trolley	
Coolbot	15000
Total cost Rs.	286722.50


Construction Stage

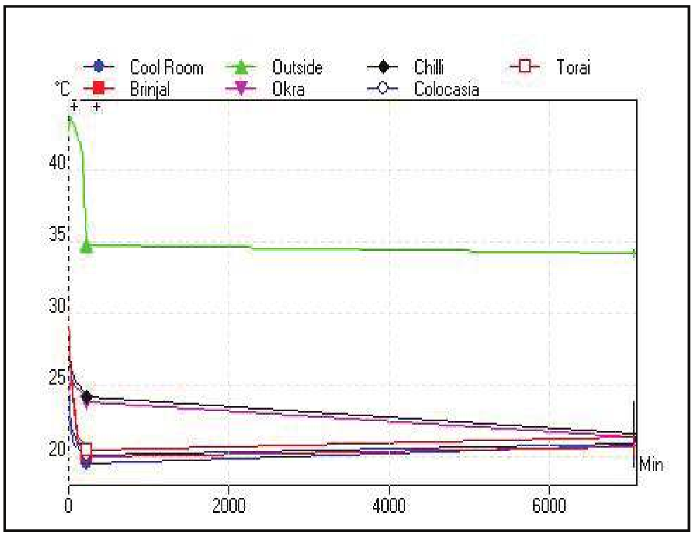

Completed Cool Room

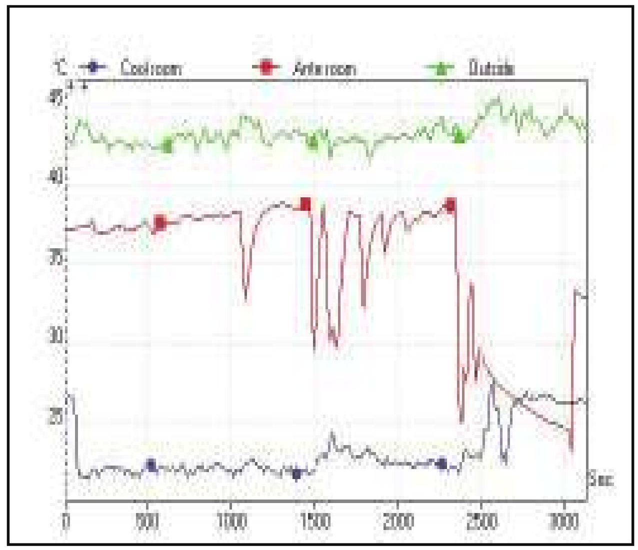

CoolBot fitted in Room A/C

This cost is based on as per actual expenses. The total cost of the cool room was two lakh eighty six thousand seven hundred and twenty two rupees and fifty paisa. The cost may vary depending upon the labour charge and number of days required for construction. The project is proposed for small and marginal farmers so invertors is necessary depending upon the requirement of the area. The size of the AC varies with the size of the room.

Results

The preliminary results indicated a temperature level down to 4-8°C when the temperatures in the outside showed a great fluctuation. The insulation material we used with 2ft 9 in thickness mud and 6 in thermocool in the roof was found satisfactory in maintaining the desired temperature at the experimental level. The chart presented below clearly shows that the coolbot cool room maintains the lower temperature below 10°C when the outside temperature ranges from 42-45°C in the peak summer month of May-June.





The commodities that is chilli, torai, brinjal, okra and colocasia which were harvested at a higher temperature quickly cooled down to the 12-15°C and maintained the temperature throughout. The vegetables were firm, marketable and fresh after the storage period with no visible injury.

Vegetable inside the cool room

Date recording through picologer

Table 2 Pulp temperature of some crops inside the cool room and in ambient temperature

	Cauliflower		Tomato		Cabbage		Okra	
No of days	Control	Cool Room	Control	Cool Room	Control	Cool Room	Control	Cool Room
3	25.06	9.53	31.6	9.23	28.61	8.61	29.8	9.09
7	25.05	9.53	32.8	9.24	28.31	8.61	29	9.08
14	25.03	9.54	36.5	9.23	28.31	8.61	29.6	9.08
21	25.07	9.51	37.5	9.25	28.35	8.62	30.2	9.07

The table presented above clearly shows the pulp temperature inside the cold room much lower than the ambient temperature. The pulp temperature has a direct bearing on the shelf life of the produce. Lower the pulp temperature means higher the life of the produce.

The results prove that the mud wall, thermocool and coolbot in combination with room AC was found effective in maintaining the desired temperature of the commodity and increasing the shelf life to 7-21 days depending upon the product. The pulp temperature of the commodity has been also gradually reduced once they were inside the coolroom.

These are the initial data after the installation of the coolbot and we are testing the system at field level at Sultanpur so that commercial success of the project is tested. Once it is found to be commercially viable it will be recommended to the farmers for the commercial usage.

Benefits of the technology

The major outcomes of the technology are increased profits through:

- Enables access to a key postharvest management tool – cold storage
- Low cost technology puts cold storage within the financial reach of small and marginal farmers
- Extends shelf life of produce – quickly lowering produce temperature after harvest extends shelf life by reducing metabolic activity and microbial growth.
- Therefore, cold storage extends the life of vegetables without effecting (after taking out of the cold storage) their natural rate of decay.
- Allows farmers to leverage market factors such as price fluctuations, thereby minimizing potential for distress sales by small farmers
- And above all increased employment opportunity with increased standard of living, nutrition, health and education.