ON-FARM STORAGE TECHNOLOGY CAN SAVE ENERGY AND RAISE FARM INCOME

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In India a tremendous amount of quality deterioration of horticultural produce takes place immediately after harvest due to lack of on-farm storage facilities. In a tropical country maintenance of low temperature is a great problem. Mechanical refrigeration is energy intensive, expensive, not so easy to install and run in remote areas; in addition it is not always environment friendly. Due to lack of sufficient cold/cool storage space in our country a substantial amount of fruits and vegetables are lost after production. Considering the acute energy crisis and non-availability of abundant cool storage facility efforts were made to develop low cost/low energy, environment friendly cool chambers utilizing the principle of evaporative cooling.

EVAPORATIVE COOLING

Evaporative cooling is a gift of nature. The basic principle depends on cooling by evaporation. As water evaporates it has a considerable cooling effect, and the faster the rate of evaporation the greater the cooling. Evaporative cooling occurs when air, which is not already saturated with water, passes over a wet surface. An evaporative cooler thus consists of a wet, porous bed through which air is drawn. The water evaporates into the air raising its humidity and at the same time cooling the bed. The efficiency of an evaporative cooler depends on the humidity of the surrounding air. Very dry, low humidity air can absorb a lot of moisture so considerable cooling occurs. In the extreme case of air that is saturated no evaporation can take place and no cooling occurs. In theory the lowest temperature that can be reached is the wet bulb temperature of the air in question.

ON- FARM STORAGE:

On farm storage facility for the small and marginal farmers is totally absent. In order to overcome this problem low cost environment friendly cool chambers have been developed

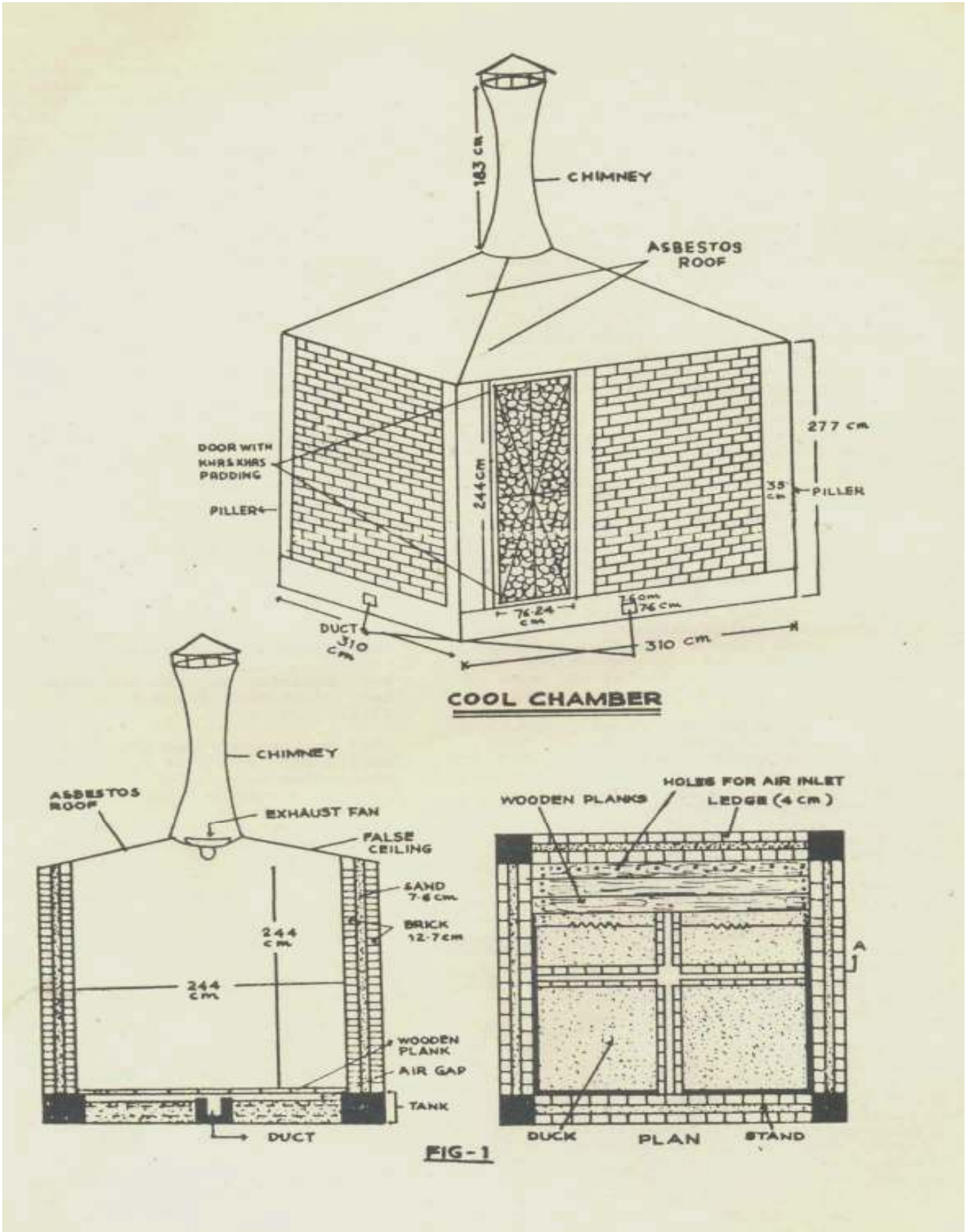
Concept of Zero Energy Cool Chambers

Based on the principle of direct evaporative cooling zero energy cool chambers have been developed. The greatest importance of this low cost cooling technology lies in the fact that it does not require any electricity or power to operate and all the materials like bricks, sand, bamboo etc. required to make the Pusa zero energy cool chamber are available easily and cheaply. It is a double brick-wall structure, the cavity is filled with sand and walls of the chamber are soaked in water. Even unskilled labour can build the chamber, as it does not require any specialized skill. The cool chamber can reduce the temperature by 10-15 ^{o}C and maintain high humidity of about 95% throughout the year that can increase the shelf life and retain the quality of horticultural produce. Small and marginal farmers may use it to store a few days'

harvest to avoid middlemen. Technology Vision 2020 has identified it as a low cost storage technology for 2020. National Horticulture Board is giving 100% grant in aid for the benefit of the farmer.

Low cost environment friendly commercial size cool chamber:

A low cost environment friendly commercial size cool chamber (6-8 ton capacity) has been developed utilizing the same principle of evaporative cooling. It is also a double brick-wall structure, the cavity is filled with sand and walls of the chamber are soaked in water from an overhead tank. The floor is made of wooden planks and the bottom of the chamber is provided with air ducts through which air is drawn with the help of an exhaust fan fitted at the center of the roof (Fig1). The fan can be run for a pre-determined time with the help of a sequential timer. Just like the zero energy cool chamber this chamber can also reduce the temperature and maintain high humidity throughout the year and can increase the shelf life and retain quality. The commercial size cool chamber has already been found to be useful for the storage of citrus, banana, potato, tomato etc. and during the rainy season onion can be stored if water supply is stopped in the big cool chamber. In the apple growing areas of Jammu and Kashmir, Himachal Pradesh and Uttrakhand these chambers would be useful for storing apples after harvest until they are required for sale. This chamber can also be used as a pre-cooling chamber, for mushroom growing and storage of bio-fertilizers.


183 cm
CHIMNEY
ASBESTOS ROOF
277 cm
DOOR WITH KHAS KHAS PADDING
PILLER
244 cm
35 cm
PILLER
76.24 cm
76 cm
DUCT
310 cm
310 cm
COOL CHAMBER
CHIMNEY
ASBESTOS ROOF
EXHAUST FAN
FALSE CEILING
SAND 7.6 cm
BRICK 12.7 cm
244 cm
244 cm
WOODEN PLANK
AIR GAP
TANK
DUCT
WOODEN PLANKS
HOLES FOR AIR INLET
LEDGE (4 cm)
A
DUCK
PLAN
STAND
FIG-1

Temperature and Relative Humidity

The cool chambers were found to have maintained considerably and relatively low temperature compared to field, shed and room temperature respectively. The fluctuations in maximum and minimum temperature was found to be maximum under field conditions, moderate in shed and minimum in CC (Table.1) The cool chamber maintained about 85-90% R.H. whereas both in shed and field it varied widely (Table.2).

Table.1 Comparative study of temperature behaviour of commercial size cool chamber (CC), field and shed

Months	CC		Field		Shed	
	Max.	Min.	Max.	Min.	Max.	Min.
Jan.	13	10	20	5	16	8
Feb.	16	14	24	9	19	12
March	24	21	29	13	24	17
April	25	22	35	18	30	23
May	29	26	40	23	34	27
June	29	27	39	27	34	29
July	30	29	38	28	34	30
August	29	28	33	26	31	27
Sept.	30	27	34	25	28	27
Oct	28	19	33	16	24	20
Nov	19	15	28	12	22	13
Dec.	14	11	23	7	18	10

Table.2 Comparative relative humidity (RH) % of commercial size cool chamber (CC), field and shed.

Months	CC	Field	Shed
Jan	94-89	93-34	92-49
Feb.	96-90	88-53	89-43
March	93-87	80-37	84-41
April	93-85	67-25	84-41
May	91-86	67-23	71-29
June	89-86	63-26	80-41
July	92-87	80-30	88-61
August	94-88	87-54	91-69
Sept.	92-86	91-55	90-55
Oct.	89-86	89-21	85-55
Nov.	91-87	93-27	85-49
Dec.	93-89	94-36	91-58

Shelf life of fruits and vegetables

It has been found that the shelf life of fruits and vegetables held in cool chamber increased as compared to storage at room temperature. The physiological loss in weight (PLW) was also found to be lower in cool chamber stored fruits (Table.3). Efforts are being made to bring down the temperature to around 15^{o}C during summer months so that it can be used conveniently for storage of tropical fruits without causing any chilling injury.

Table.3 Storage of fruits in cool chamber

Crop	Cool chamber		Room temperature	
	Shelf life (days)	PLW (%)	Shelf life (days)	PLW (%)
Aonla	18	1.72	9	8.70
Banana	20	2.50	14	4.80
Grape fruit	70	10.20	27	4.94
Guava	15	4.00	10	13.63
Kinnow	60	15.3	14	16.10
Lime	25	6.00	11	25.00
Mango	9	5.04	6	14.99
Sapota	14	9.46	10	20.87

Table.4 Storage of vegetables in cool chamber

Crop	Cool chamber		Room temperature	
	Shelf life (days)	PLW (%)	Shelf life (days)	PLW (%)
Amaranth	3	10.98	<1	49.82
Okara	6	5.00	1	14.00
Parwal	5	3.89	2	32.86
Carrot	12	9.00	5	29.00
Potato	97	7.67	46	19.00
Pudina	3	18.6	1	58.5
Turnip	10	3.4	5	16.0
Peas	10	9.2	5	29.8
Cauliflower	12	3.4	7	16.9

SCOPE OF COOL CHAMBER

The proposed cool chamber has great scope; these can be installed in different places of handling of fresh fruits and vegetables. It must be emphasized that a battery of such cool chambers, still bigger in size, can be installed in big wholesale markets, which are located near the big metropolitan cities. The present practice is that the fruits and vegetables arrive in the wholesale market early in the morning and are purchased by the retailer/consumer before noon. As the fruits and vegetables are handled in an open shed the freshness is prone to considerable deterioration. The Fig. 2 gives an isometric view of cool chamber sheds in which commercial size cool chamber units can be installed in two rows with a corridor in between. Each cool chamber unit will have two doors, one opening into the corridor and the other into loading/unloading platform. The walls, floor and tank below the cool chamber will be the same as shown in Fig.1. The ducts are open on the roadside as well as on the corridor. An overhead tank can perform the soaking of sidewalls and tank. The trucks can perform the loading and unloading on the platforms of each shed. If the fruits and vegetables are stored temporarily in the cool chamber units before the transaction then the freshness of the fruits and vegetables can be retained for a longer period.

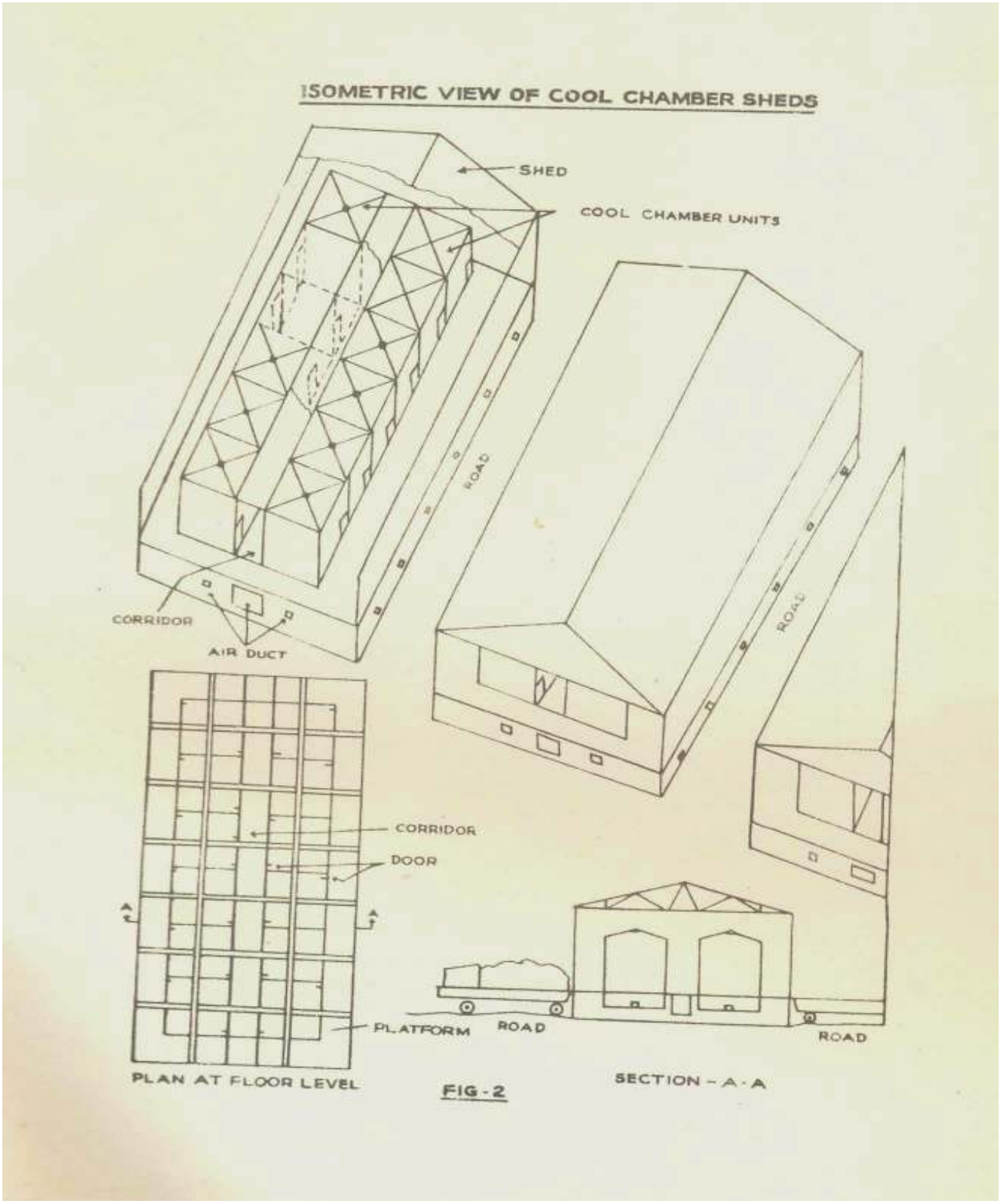

ISOMETRIC VIEW OF COOL CHAMBER SHEDS
SHED
COOL CHAMBER UNITS
ROAD
CORRIDOR
AIR DUCT
ROAD
CORRIDOR
DOOR
PLATFORM
ROAD
ROAD
PLAN AT FLOOR LEVEL
SECTION - A - A

FIG - 2

CONCLUSION

The proposed cool chamber can work on zero to very little energy and can retain the freshness of the fruit and vegetables for a short period. These units can be installed profitably where the fruits and vegetables are held temporarily viz. Farmer's field, packing stations, railway stations, village mandis, wholesale markets of metropolitan cities, super markets, retail markets, big hotels, institutional feeding places, defense establishments in remote places where supplies come once in a week, processing factories etc. If the idea of on farm storage/ low cost cool chamber is properly propagated and actually adopted then the availability of nutritious fruits and vegetables will increase and the consumer will pay less. The grower will also not be forced to make distress sale and will get better return.