

# Design, Fabrication, Installation and Field Evaluation of 1000 kg Capacity Solar Drier for Chilgoza Seed Extraction

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## ABSTRACT

*The Energy Centre in Nauni, Himachal Pradesh, India has designed and fabricated solar driers of 1000 kg capacity of chilgoza cones extracting 100 kg chilgoza nuts in one lot. Five such solar driers have been installed in different high altitude villages of Kinnaur district. A study was carried out in Rarang village of Kinnaur district to assess the performance of the solar driers in field conditions. The results revealed that the seeds were extracted from the chilgoza cones in six days time while in open sun drying, the extraction time was 18 days.*

## 1. INTRODUCTION

Drying is one of the effective traditional methods for preserving food products. The traditional method of products drying which consists of spreading the product in open sun, is very simple but suffers from many drawbacks. The drying of products in solar driers offers a better alternative to traditional drying as a better quality dried product is obtained which is free from dust contamination and insect damage. Solar driers of several designs have been developed throughout the world. These driers could be classified as: natural convection solar drier which is based on the principle of green house effect; indirect type solar drier in which solar radiation is not incident directly on the product to be dried but hot air from air heater enters into the drying chamber where the product is kept; and forced circulation type solar drier in which hot air is continuously blown over the food product. However, the solar driers have not found wide acceptability in rural areas as yet due to the high costs involved and information gap. This points to the need for promoting the use of low cost solar drier for rural areas. With this aim the Energy Centre in Nauni has developed a green house type direct solar drier of 1000 kg capacity for chilgoza seed extraction. The five solar driers of 1000 kg capacity designed by Energy Centre for chilgoza seed extraction were installed in those villages where the chilgoza trees are found in large quantity.

The chilgoza tree is mainly found at an altitude between 1600 m to about 3300 m. In India, chilgoza is found in Kinnaur district of Himachal Pradesh. The monthly average temperature in Kinnaur district is between  $-1.5^{\circ}\text{C}$  to  $29.8^{\circ}\text{C}$ . The tree grows naturally in the dry temperate zone where there is little summer but there is a heavy winter snowfall. A tree of about 2.5 m girth yields

Table 1. Meteorological data of Regional Horticulture Research Station, Sharbo, Kinnaur (Altitude 2200 m above mean sea level) for the year 1993-1994.

Month	Wind Velocity (km/hr)	Temperature (°C)				Humidity (%)		Rainfall (mm)	Snowfall (mm)	Sunshine hours (hr)
		Minimum		Maximum		8 a.m.	2 p.m.			
		8 a.m.	2 p.m.	8 a.m.	2 p.m.					
July 93	4.71	16.2	18.0	21.9	27.7	76.4	61.6	64.0	-	5.35
August 93	6.07	14.1	23.0	22.0	29.8	75.2	51.7	50.0	-	7.15
September 93	4.53	09.6	13.7	18.5	26.8	74.7	66.9	27.0	-	5.5
October 93	5.13	07.2	14.3	16.0	23.6	78.0	58.8	-	-	7.0
November 93	4.40	03.4	05.4	14.2	16.6	71.6	61.6	30.0	-	5.05
December 93	4.55	01.5	02.5	16.0	15.7	55.9	31.2	-	-	5.30
January 94	4.21	-01.0	02.2	08.2	08.9	68.5	38.0	40.0	6.3	3.30
February 94	4.25	-01.5	02.4	05.7	07.1	60.0	46.5	-	5.8	4.15
March 94	4.95	04.6	04.5	17.0	16.4	59.0	23.4	38.5	-	5.15
April 94	4.13	05.6	08.9	16.3	17.8	66.5	45.0	205.2	-	5.30
May 94	4.28	10.0	17.0	23.9	24.4	49.3	42.4	1.2.8	-	7.30
June 94	5.32	18.0	20.3	27.4	27.4	72.6	52.2	29.0	-	5.0

about 400 cones on the average. The moisture content of green cones varies from 60% to 70% (w.b.). The cones from the tree are cut and seeds are extracted out of the cones and farmers get Rs. 110 to Rs. 200 per kg. Table 1 shows the meteorological data of the Regional Horticulture Research Station in Kinnaur.

## 2. TRADITIONAL METHOD OF SEED EXTRACTION

The green cones are cut from the tree and placed in a dark room covered with thick layer of chilgoza needles for warming and water is sprayed to keep moisture in the cones in order to make the cones soft and bulky. After almost one month, the cones are removed and nuts are extracted by cutting the cones with the help of tools. Large quantity of nuts are damaged due to fungus and cone borer attack during storage. The traditional method of seed extraction is a laborious work which can cause bleeding of the hand of the person who extracts only 2 kg of seed per day.

## 3. SEED EXTRACTION USING SOLAR DRIER

Chilgoza seeds are extracted using direct solar dryer. The cones are kept on the trays inside the solar drier and ventilators provided at the bottom of the south side and at the top of the north side are kept open for the removal of moist air. After two to three days, some of the cones in the first tray start to open and seed can be extracted by only shaking the cones. The drier can also be used to dry fruits and vegetables. The quality of the product improves due to controlled drying. The drier also protects the product from rain, uneven weather, dust, fungi and bacteria.

The drier has an area of 6000 mm × 3000 mm, with south side height of 2000 mm and north side height of 3740 mm above the ground. It has five shelves consisting of four trays each as shown in Fig. 1.

## 4. FABRICATION AND INSTALLATION

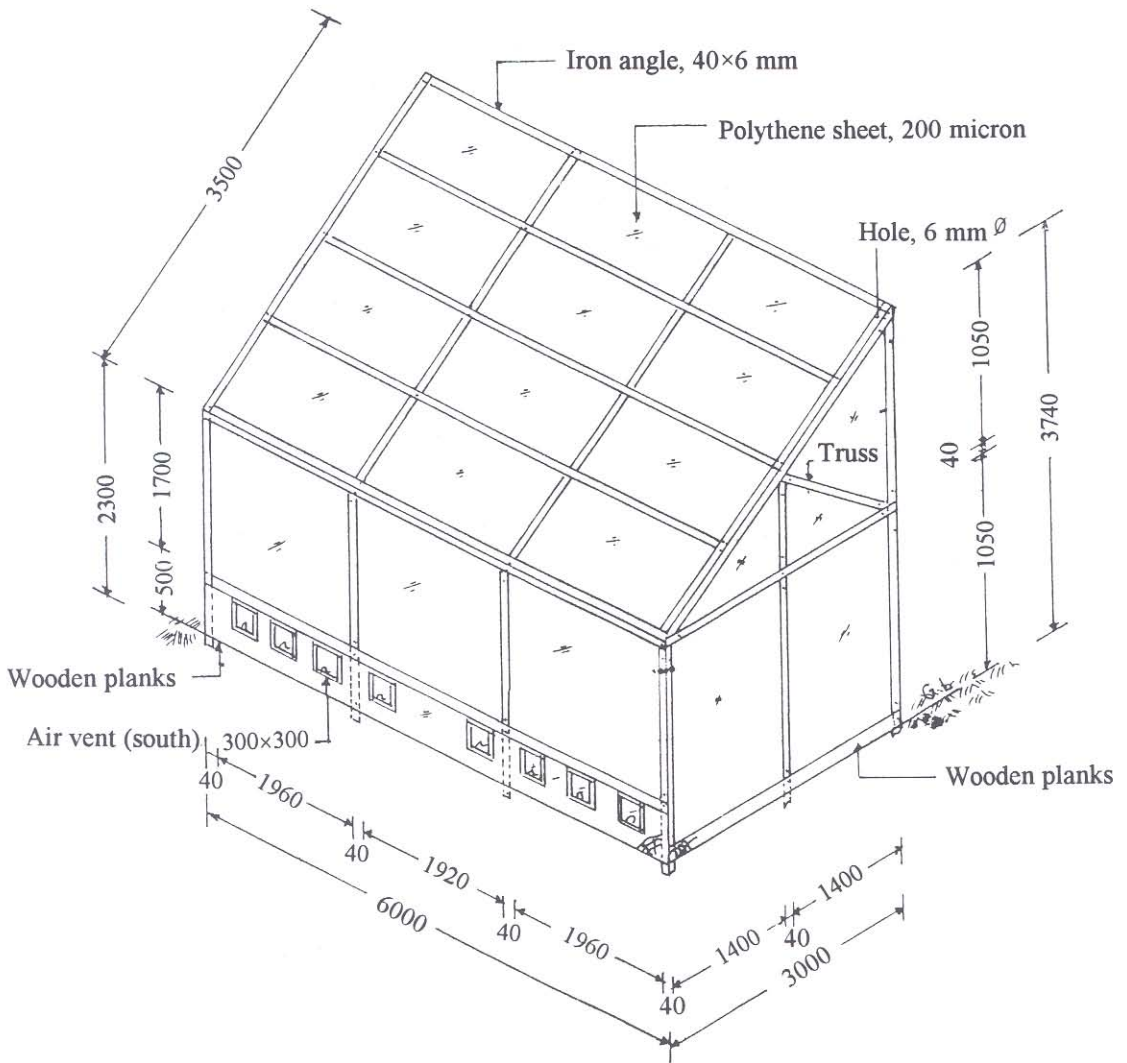
The components of the solar drier were prefabricated at the Energy Centre and carried to different villages where parts were assembled and installed. The various components are discussed below.

### 4.1 Iron Angle

The iron angle used in the drier are listed in Table 2.

Table 2. Iron Angle.

Sr. No.	Length (mm)	Direction	No.
i	2300	Fixed vertically in the south side	4
ii	4040	Fixed vertically in the north side	6
iii	3170	Vertically in the east and west sides	2
iv	6000	Fixed horizontally on top of the south and north sides and one at a height of 2 m from the ground on the north side	3
v	3000	Fixed horizontally in the east and west sides	2



Note: All dimensions are in mm

Fig. 1. Isometric view of solar drier.



## 4.2 Trusses

Four trusses (Fig. 2) were fabricated with iron angle of 40 mm x 40 mm x 6 mm to give strength to the superstructure. The structure can bear the weight of snow up to 165 kg/m<sup>2</sup> and wind velocity of 100 km/hr. Tribal area experiences heavy snow fall during winter (November-March). The trusses were fixed at the top joining the north and south sides of the drier.

## 4.3 Ventilator

Ventilators were fabricated with wooden planks of thickness 25 mm and fixed at the bottom of the south side and at the top of the north side. A ventilator (Fig. 3) consists of two wooden planks of size 3000 mm x 25 mm x 25 mm. Total height of ventilator is 55 mm. The holes are covered with wooden flapper so that holes could be opened or closed for air circulation. The iron mesh is provided at the back of the ventilator to protect the product from the attack of small animals.

## 4.4 Door

The door was fabricated with wooden frames of sizes 1800 mm x 75 mm x 25 mm and 1200 mm x 75 mm x 25 mm. One wooden support of 1200 mm x 75 mm x 25 mm size is provided horizontally at the middle of the door. The G.P. sheet is fixed on these wooden frames. The door is fixed at the north side of the drier for loading and unloading of the products.

## 4.5 Tray stand

Since the drier is multi-shelves, the tray stands were fabricated with iron angle (50 mm x 50 mm x 6 mm) on which trays were fixed to bear the heavy weight of chilgoza cones. The total height of tray stand is 2000 mm from the ground. Five iron angle were welded equally at a distance of 290 mm apart. The stands were fixed at different distances so that all the trays (size 205 mm x 1230 mm each made up of iron angle (40 mm x 40 mm x 6 mm) supported at the middle with MS Flat (50 x 6)mm and welded mesh), adjust themselves as shown in Fig. 4.

## 4.6 Polythene Sheet

All the sides except the north side are covered with ultraviolet resistant polythene sheet. The roof is also covered with polythene sheet to get maximum solar radiation. The inner side of the drier is painted black to absorb maximum solar radiation.

## 5. RESULTS AND DISCUSSION

One hundred cones were kept inside the solar drier in all the trays. The temperatures were recorded using digital temperature indicators. The ventilators were kept opened during sunlight and closed in the evening to reduce heat loss. Inside and outside temperature variations are shown in Fig. 5 with  $T_1$  to  $T_5$  indicating temperature in the first tray up to the fifth tray. The drier temperature was reduced due to non insulation of the ground. The maximum temperature in the upper tray was 550°C while in the lowest tray it was 390°C when the ambient temperature was 220°C. After three days the cones in the upper tray were opened and the nuts were extracted. The cones in the lower tray

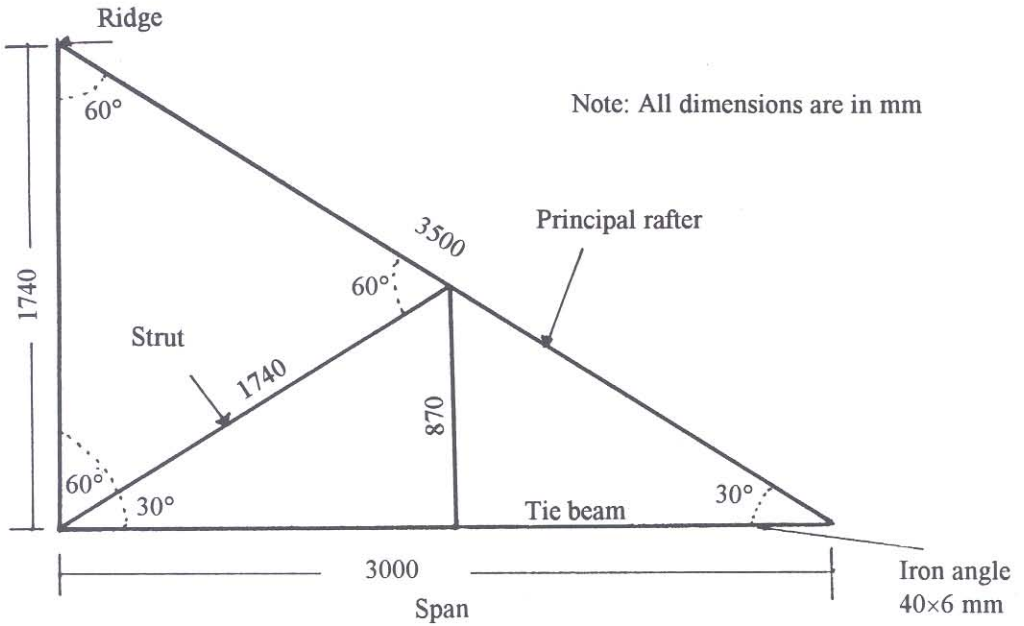


Fig. 2. Truss (Iron angle).

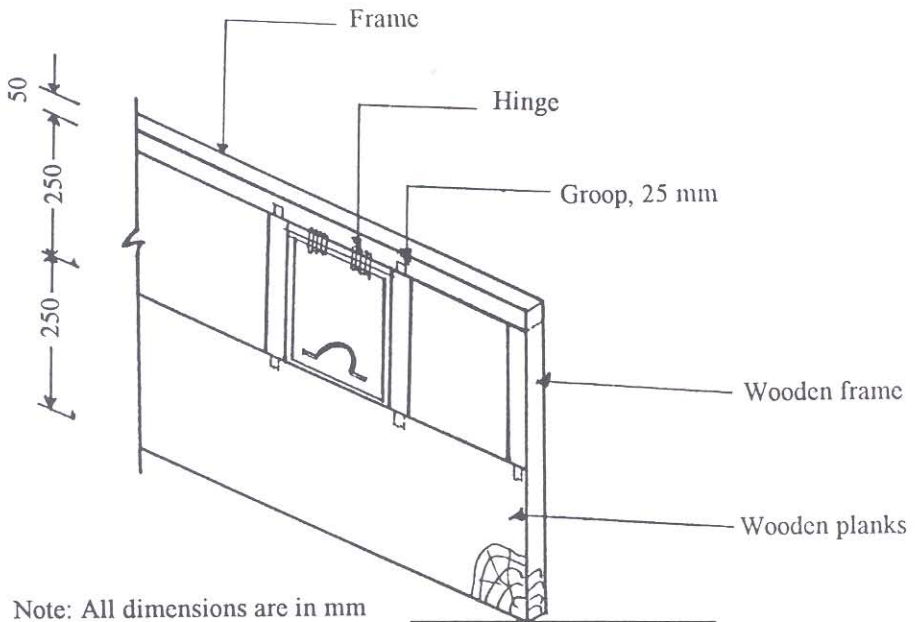


Fig. 3. A view of ventilator.

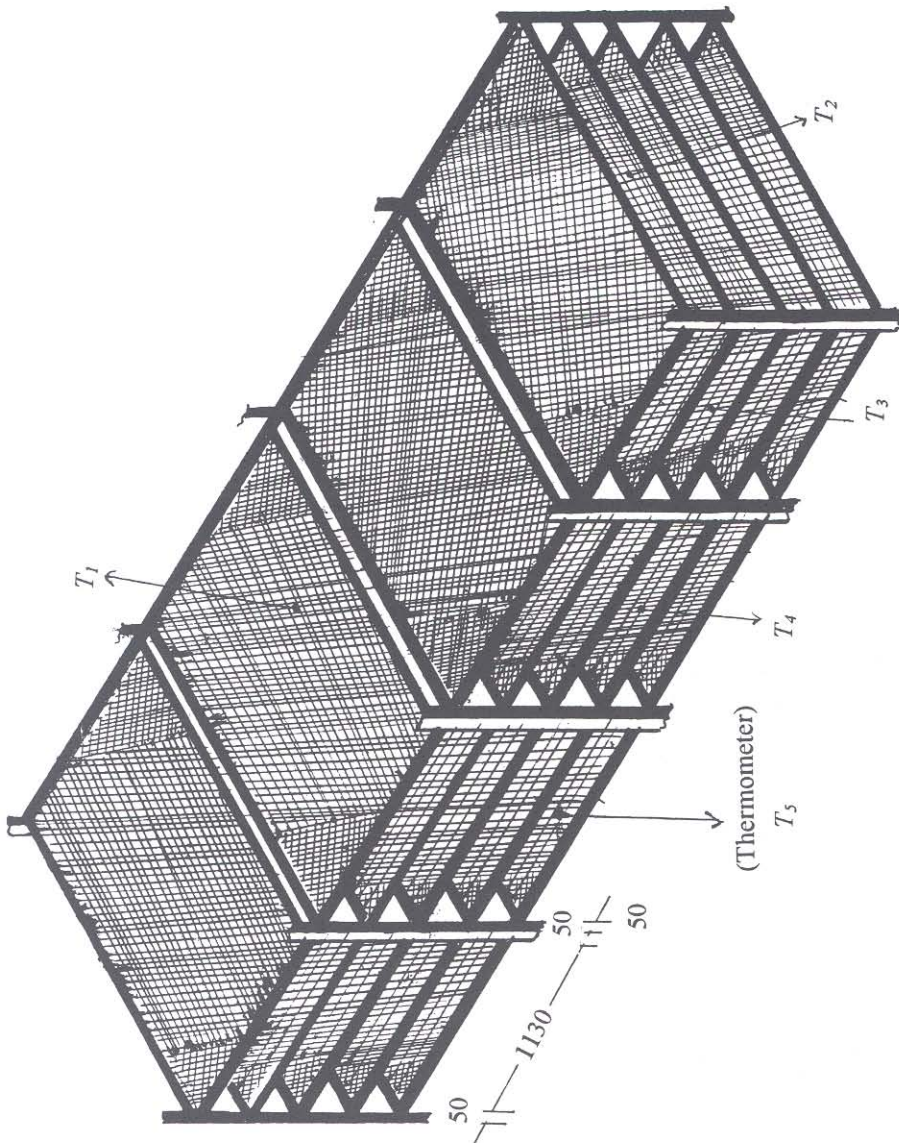


Fig. 4. Isometric view of tray superstructure.



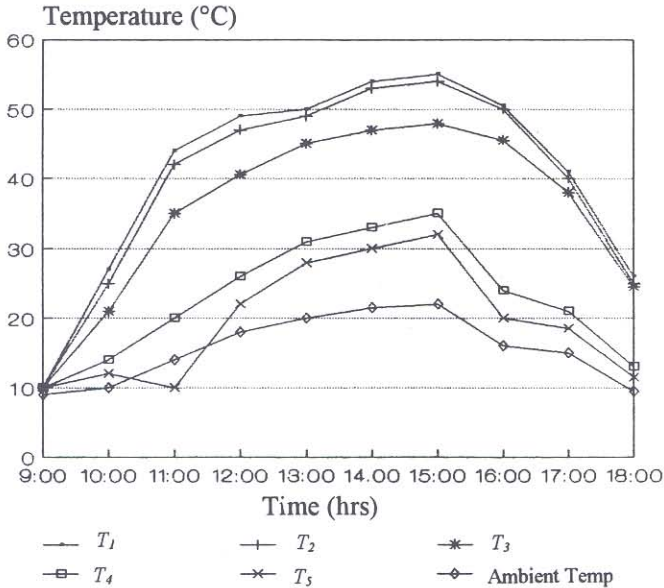


Fig. 5. Temperature variation inside and outside the solar drier on 7 October 1994.

were replaced to the upper tray and it was observed that after six days all the cones were opened and Chilgoza nuts were extracted. On the average each cone yielded 80 seeds with length of 15 mm to 25 mm and with thickness of 4 mm to 8 mm. The average weight of each seed was found to be 0.42 g. The moisture content of fresh cones was 72% whereas the moisture content of extracted seeds was 30% which is a safe moisture level for storage. The seed extraction efficiency was 88%. The seeds were not dried as it reduces the weight resulting less income to the tribal people. The villagers were trained during the testing of the drier. The general view of the tribal people was that the drier is easy to operate and the extracted nuts are better in taste than those extracted by traditional method but they have a fear of losing the weight of the seeds due to over heating resulting in loss of revenues. However, the dried nuts are sold at a higher price.

## 6. CONCLUSION

The solar drier of 1000 kg capacity is useful for chilgoza seed extraction which is a major cash crop of tribal people. The other cash crop like apple, apricot and almond can also be dried. The product can reach the market within ten days after plucking from the trees. The drier which can easily be fabricated by local artisan who can be trained by the Energy Centre will generate source of income for tribal people. The size of the drier can be changed as per need depending upon the quantity of the product to be dried. It is an appropriate low cost technology which is in the reach of the common masses. However, there is a need to provide training to local artisans in the fabrication of solar drier. The awareness training programs to popularize the technology and user's education training programs have to be organized to make the solar drier technology a success in the cold desert area of Himachal Pradesh. The solar drying technology will help in improving the living standard of the tribal people as solar driers generate more income for them. This will also generate scientific knowledge among



tribal people, however it will take some time to break the psychological barrier of traditional method. These driers can also be propagated in other parts of the state. The material cost of 1000 kg capacity drier is Rs. 60,000 (US\$ 1 = Rs. 42.41) and has long life except for the polythene sheet.

## 7. REFERENCES

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