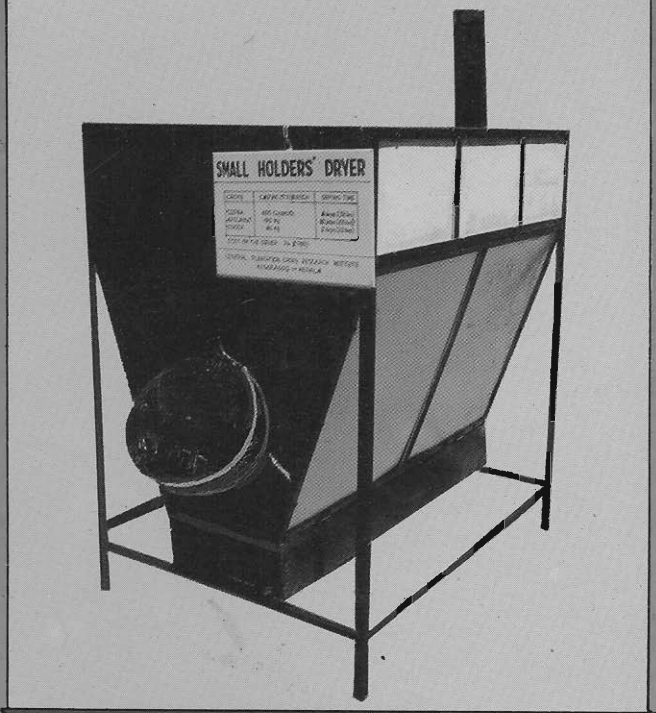
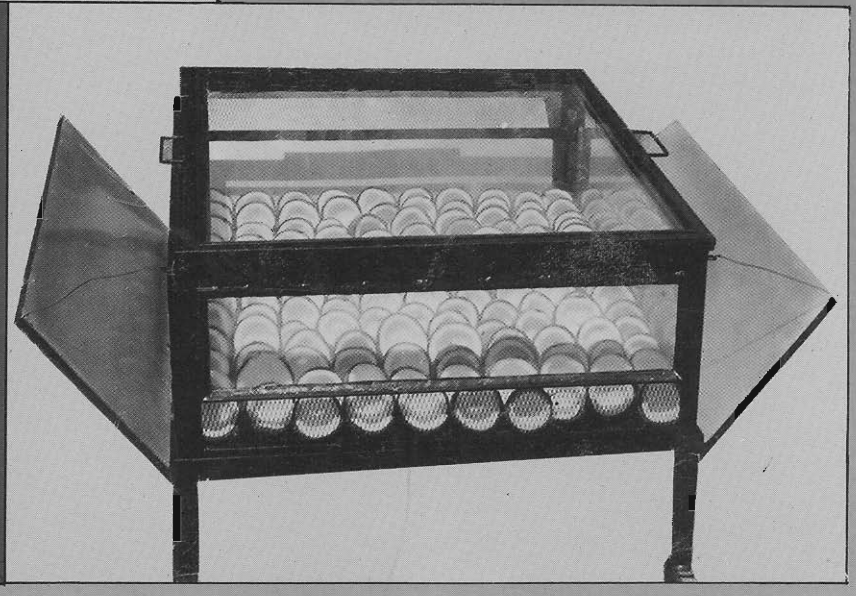


COPRA DRYERS



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CENTRAL PLANTATION CROPS RESEARCH INSTITUTE
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
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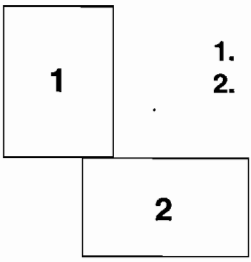

1. **Small holders dryer**
2. **Solar dryer**

COPRA DRYERS

1. INTRODUCTION

Drying is an important post-harvest operation in the processing of coconut for the extraction of oil. For the efficient storage of copra and easy extraction of oil, fresh coconut meat which contains 45-55 per cent moisture, has to be dried to 6 per cent mois ture level to obtain the copra. The common practice of making copra is by drying the split coconuts under open sun on cement or mud-floor for 7-10 days. Copra obtained by this method is often of poor quality because of prolonged exposure under open condi tion resulting in microbial infection. During rainy season, with restricted sunshine, drying by artificial method is the only possible solution for making copra. The direct-type kiln dryers are not desirable for copra as the copra becomes inferior in quality due to the smoking and improper drying. To obtain good quality copra, particularly during rainy season, a suitable dryer using indirect heating for drying is essential. The Central Plantation Crops Research Institute, Kasaragod has developed the following dryers to suit the above-said conditions :

1. Solar Cabinet dryer
2. Electrical dryer
3. Agricultural waste based dryers

2. PRE-REQUISITES FOR MAKING COPRA

Fully mature coconuts of 12 to 13 months old are to be harvested for making copra. After harvesting, the whole nuts are stored for about 4 to 6 days in heaps under shade. The husk is removed and the nut split into two halves. The split halves are kept inverted for 15 to 30 minutes to completely drain off the water taking care to see that the kernel does not come in contact with the soil or dust. Now the cups are ready for drying.

3. SOLAR CABINET DRYER

3.1 Description

This dryer is of chamber type having a direct type of heating and natural air convection arrangements (Fig. 2 on front cover). The dryer is mainly comprised of (i) a drying cabinet provided with selectively coated solar aluminium absorbent sheet (sun sheet) as the drying surface, (ii) a trolley which supports the drying cabinet, (iii) sliding type 4 mm transparent top cover (iv) adjustable aluminium reflectors on hinges on three sides, and (v) transparent glass cover on all four sides.

The drying surface capable of holding 100 nuts (200 cups) is kept at an inclination of 12.5° (equal to the latitude of Kasaragod). Thermocole insulation of about 25 mm thickness is provided between the sunsheet and plywood, for preventing heat loss. The aluminium reflectors with adjustable angle help in concentrating the solar radiation on the drying surface itself. The drying surface is so adjusted as to face the sun with the help of castor-wheels and an indicator rod placed on top of the frame.

For air inlet, a 10 cm wide opening covered with expanded metal is provided at the bottom of the front side of the dryer. The exhaust provided at the rear top is also covered with expanded metal. Detailed specification of the dryer is given in Table 1. The list of materials required for fabri cation of the dryer is given in Table 2.

Table 1 : Specifications of dryers

Description	Solar dryer	Electrical dryer	Agricultural waste based dryer			
			Marginal holding	Small holding	Medium holding	Large holding
Type	Chamber	Tray	Chamber	Chamber	Chamber	Chamber
Heating mode	Direct solar heating	Electrical energy	Indirect heating with agricultural waste as fuel			
Air circultation	Natural	Forced hot air	Natural air convection			
Capacity (No. of nuts)	100	1000	100	400	1000	3000-4500
Area of housing (m^2)	2.0	1.2	0.5	1.35	3.0	14.0
Overall Dimension						
Length (m)	1.60	1.00	1.05	1.47	2.50	4.00
Width (m)	1.25	1.20	0.45	0.92	1.20	3.50
Height (m)	1.00	2.35	1.00	1.38	1.75	1.90
Cost (Rs.)	3,300	12,500	1,300	2,700	5,600	15,000

3.2 Operation

The split nuts are loaded on the drying surface with the cups facing up. The dryer is positioned to face the sun with the help of the indicator rod. The dryer is moved to track the sun twice during the day at three hourly intervals for the effective trapping of solar energy. Heat is generated inside the cabinet due to the absorption of solar radiation which promotes the rapid evaporation of moisture in the copra. The moisture-laden air escapes through the exhaust vent. At the close of the day, the cups are covered with gunny cloth and the dryer is closed. At the beginning of the second day, the kernel is detached from the shell and kept for further drying. The drying is continued every day from morning till evening to reduce the moisture content to less than 6 per cent. The total drying time is 32 sun shine hours. The cost analysis and performance of the dryer are given in Tables 3 and 4 respectively.

3.3 Advantages

1. Drying time is reduced by 50 per cent compared to open sun-drying.
2. The quality of copra obtained is superior to that obtained by open sun-drying.
3. The dryer is versatile in design and can be adapted for drying other plantation crop produce also, such as cardamom, pepper, ginger, etc.
4. It is easy to fabricate locally.
5. It can be easily transported.
6. It is very easy to operate and the maintenance cost is low.
7. The cost of operation is almost nil as there is no fuel requirement.

4. ELECTRICAL DRYER

4.1 Description

It is a tray type dryer with mixed flow and forced hot air circulation, designed for drying 1000 coconuts (Fig. 1). The dryer is mainly comprised of drying chamber, ple-

Table 2 : List of materials

Material	Solar	Electrical	Agricultural waste based dryers			
			Marginal	Small	Medium	Large
(1)	(2)	(3)	(4)	(5)	((6)	(7)
M.S. Angle - 40x40x6mm	3.5m	—	—	—	—	11.0m
40x40x3mm	6.0m	—	—	20.0m	—	—
35x35x6mm	—	—	—	—	45.0m	—
25x25x5mm	10.0m	—	13.0m	5.0m	14.0m	24.0m
GI/MS sheet- 22G	—	9.4m²	—	3.5m²	—	5.0m²
18G	—	—	1.5m²	—	7.2m²	—
14G	—	1.0m²	—	—	—	7.0m²
M.S. rod 6mm	—	—	5.0m	5.0m	10.0m	12.0m
12mm	—	—	—	—	—	10.0m
MS expanded mesh	0.3m²	—	—	—	—	—
Welded mesh 35x25/25x25mm	—	10.0m²	0.5m²	—	4.5m²	8.0m²
Wire Mesh - 20 G	—	—	—	1.1m²	4.5m²	8.0m²
Asbestos sheet 4mm	—	—	4.0m²	6.0m²	14.0m²	18.5m²
M.S. Channel ISLC 125	—	—	—	—	—	9.2m
GI Bolts & nuts 25x6mm	—	—	0.25kg	0.5kg	2.0kg	1.0kg
MS hinges 75 x 25 mm	6	6	5	7	9	2
Wooden plank0.25m³	0.25m³	—	—	—	—	
Plain glass 3mm	2.0m²	—	—	—	—	—
Sun Sheet 1.0m2	—	—	—	—	—	
Caster-wheels 100mm	4 Nos.	—	—	—	—	—
Aluminium sheet 20G	1.5m²	—	—	—	—	—
Aluminium angle 25x25x3mm	—	50.0m	—	—	—	—
Electric strip heater - 1KW	—	6 Nos.	—	—	—	—
Blower 300 mm	—	1 No.	—	—	—	—
Electric motor with starter 0.5 HP, 1440RPM	—	1 No.	—	—	—	—
Laterite stone 440x230x140	—	—	—	—	—	400 Nos.
Cement —	—	—	—	—	—	10 bags
Sand —	—	—	—	—	—	3 m³

Table 3 : Cost analysis of dryers

Description	Agricultural waste-based dryer Capacity (nuts)				Solar dryer capacity (nuts)	Electrical dryer capacity (nuts)
	100	400	1000	3000	100	1000
1. Cost of the dryer (Rs.)	1300.00	2700.00	5600.00	15000.00	3300.00	12500.00
2. Expected life (years)	10	10	10	10	10	10
3. Use of dryer in a year (days)	240	240	240	240	200	240
4. Time required per batch (days)	4	4	4	4	4	2.5
5. Quantity of copra per batch (kg.)	16	64	160	480	16	160
6. Labour requirement per batch starting from dehusking (Man-days)	1.0	3.5	5.5	12.5	0.5	3.5
7. Fuel (Coconut Husk) required per batch (kg.)	16	20	110	250	—	140 units (Electrical Energy)
Fixed cost						
1. Annual depreciation (@ 10% of cost) (Rs.)	130.00	270.00	560.00	1500.00	330.00	1250.00
2. Annual interest on half of new cost @ 15% (Rs.)	97.50	202.50	420.0	1125.00	247.50	937.50
3. Annual maintenance cost (@ 10% of initial cost) (Rs.)	130.00	270.00	560.00	1500.00	330.00	1250.00
4. Total fixed cost (Rs.)	357.50	742.50	1540.00	4125.00	907.00	3437.50
5. Fixed cost per batch (Rs.)	5.96	12.38	25.67	68.75	15.12	35.81
Operation cost						
1. Labour charges (@ Rs. 30/day) (Rs.)	30.00	105.00	165.00	375.00	15.00	105.00
2. Cost of fuel (@ 25p/kg or 50p/unit) (Rs.)	4.00	7.00	27.5	62.50	—	70.00
3. Total operating cost/ batch (Rs.)	34.00	112.00	192.50	437.50	15.00	175.00
4. Total cost/batch (Rs.)	39.96	124.38	218.17	506.25	30.12	210.81
5. Cost of drying per coconut (Rs.)	0.40	0.31	0.22	0.17	0.30	0.21
6. Cost of drying per kg of copra (Rs.)	2.50	1.94	1.36	1.05	1.88	1.32

Table 4 : Performance of the dryers

Dryer	Capacity (No. of nuts)	Drying time (Hr.)	Source of heat energy	Quantity of fuel	Cost of dryer (Rs.)	Cost of Drying	
						Rs./nut	Rs./Kg. of copra
Solar cabinet dryer	100	32-36	Solar	—	3300	0.27	1.70
Electrical dryer	1000	30	Electricity	270 units	12500	0.20	1.24
Agricultrual waste based dryer							
Marginal holding	100	36	Coconut husk	16 kg	1300	0.38	2.38
Small holding	400	36	Coconut husk	28 kg	2700	0.30	1.88
Medium holding	1000	36	Coconut husk	110 kg	5600	0.21	1.31
Large holding	3000	36	Coconut husk	250 kg	15000	0.16	1.00

num chamber, heating unit and blower unit.

Drying chamber is made of jackwood planks lined with 22 gauge GI sheet inside. The air distribution chamber located vertically at the centre is made of GI sheet with perforations on both the sides. The drying chamber can accommodate 10 trays of 92 x 45 cm size and is made of welded wire-mesh.

Fig. 1. Electrical Dryer

The trays are kept on aluminium angle runners on both sides of the air distribution unit. The top of the drying chamber is open with an adjustable lid to serve as exhaust.

The heating unit consists of six strip heaters of 1 KW capacity each and a blower equipped with 0.5 HP, 1440 rpm motor. The air blown over the heaters gets heated up and distributed in the drying chamber by the hot air distribution unit. The motor operation is controlled by a direct on line starter. The specification of the dryer is given in Table 1. The list of materials required for fabrication of the dryer is given in Table 2.

4.2 Operation

Hundred split nuts are loaded on each tray with the cups facing sideways. During loading, the blower is switched on with the exhaust lid partially opened. After loading, the heaters are switched on. Desired temperature of the hot air is achieved with the energy regulator and by adjusting the inlet valve and exhaust lid openings. The temperature of inlet air is kept at 60°C for copra.

The dryer is operated continuously for 12 hours initially and is switched off. The trays are taken out and the shells separated from the kernel. Then the trays with the kernel cups are reloaded into the dryer with cups facing up and the dryer is switched on again. The drying is continued till the desired moisture level of 6 per cent is attained. Total drying time is 32 hours. The cost analysis and performance of the dryer are given in Tables 3 and 4 respectively.

4.3 Advantages

1. This dryer could be a feasible proposition for cooperatives, medium growers and copra processors.
2. The dryer can be used in rainy season also when sun drying is not possible.
3. The quality of copra is good, white and mold-free.
4. Dryer design is simple and can be fabricated locally.
5. It can be operated by a semi-skilled person.
6. Mixed type air flow provides uniform drying of the produce and hence no need for mixing.

5. AGRICULTURAL WASTE BASED DRYERS

5.1 Description

The dryers of various capacity viz. 100, 400, 1000 and 3000 coconut per batch using agricultural waste as fuel are available (Fig.1 on front cover). The specifications of these dryers are given in Table 1. These dryers are mainly comprised of (a) drying chamber (b) plenum chamber (c) burning-cum-heat exchange unit, and (d) chimney with regulators. These dryers are constructed

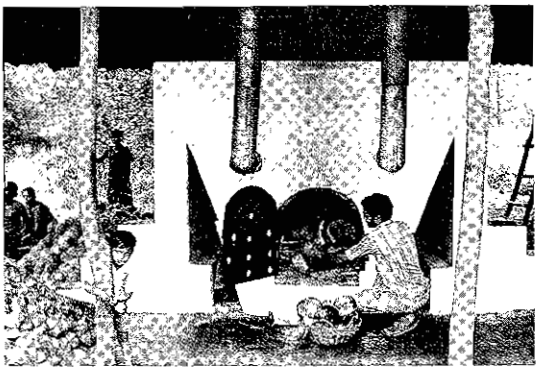

Fig. 2. Large holders dryer

from locally available materials such as asbestos cement sheet, G.I. sheet, MS angles, flats and wire mesh. For 3000 coconuts capacity dryer, bricks are used to construct side walls (Fig. 2).

The drying chamber is in upper portion of the dryer which is supported on MS angle frame/brick wall. It is made of asbestos cement sheets supported on MS angle frame. The cross section of the chamber is of trapezoidal shape. An adjustable opening is provided at the bottom to facilitate entry of fresh air into the chamber.

The burning-cum-heat exchanger unit is located at the centre of the plenum chamber. It is a metal cylinder made of 22 gauge corrugated/plain G.I. sheet/M.S. sheet. Corrugated GI sheet is used for obtaining greater heat transfer with more surface area. But care should be taken so that the coir dust does not fall into the corrugation, to avoid the corrosion of sheet. One end of the cylinder is covered by a damper with holes for entry of air for combustion. Coconut husk or any other agricultural waste to be used as fuel is burnt in a weldmesh

tray inside this cylinder. The other end of the cylinder is connected to the chimney. The cylinder is suspended in the plenum chamber at an inclination of 3° angle towards the exhaust side. The inclination is provided for ensuing the smooth flow of the flue gases. The outer surface of the cylinder at the end of the plenum chamber sides is sealed with plaster of paris (The flue gas is diverted into two flue pipes which pass through the top corners of the plenum chamber).

A cylindrical GI sheet chimney is provided with two butterfly valves to regulate the escape of flue gases. This in turn regulates the entry of air into the cylinder for combustion and thus controls the rate of burning of fuel. The drying air temperature is controlled effectively by adjusting these valves. The chimney is partially cover ed by asbestos rope cemented with plaster of paris to avoid any danger during handling. In 3000 coconuts capacity dryer, two chimneys are provided. The list of materials required to fabricate these dryers are given in Table 2.

5.2 Principle of drying

The produce to be dried is kept in the drying chamber. As the fuel is burnt in the burning chamber, the flue gases heat the GI sheet surface by conduction. The heat from GI sheet is transferred by radiation and convection to the surrounding fresh air entering from the bottom, generating a convection air current. The hot air moves up through the wet produce in the drying chamber and the hot air laden with moisture escapes through the top of the drying chamber. A dial thermometer fixed just below the drying platform will help to monitor the drying air temperature.

5.3 Operation of the dryer

The split cups are loaded into the drying chamber. The first two or three bottom layers are kept with cups facing up and the rest of the cups are kept facing down in brick fashion. The fuel comprising both husk and shell is kept in the weldmesh tray and fired. The tray is kept in the centre of the cylinder and the damper is closed. Fuel is fed as and when required to keep the fire burning. The drying air temperature is kept at 70°C by adjusting the valves in the chimney.

After 8-10 hrs. of drying, the shells from which the kernels have been loosen - ed can be removed. The drying may be continued after a few hours of tempering, as the migration of internal moisture to the surface of the kernel is slower. The cups from which kernel removal has been found difficult, are kept at the bottom facing up and the kernels freed from shells are kept over that. At the end of 15 hrs, shells from all the cups could be removed. The copra cups are to be raked every two hours for uniform drying. Generally, the drying is carried out for four days with overnight breaks till the moisture content of copra reaches 6 percent for safe storage. The actual time taken for drying will be about 36 hrs. The cost analysis and performance of the dryers are given in Tables 3 and 4 respectively.

5.4 Advantages

1. The dryer is versatile as many of the plantation crop produce like coconut, arecanut, cardamom, cocoa and pepper can be dried.
2. It is useful during the monsoon season when sun drying is not possible.
3. Any dry agricultural waste material can be used as fuel.
4. Controlled combustion ensures economic use of fuel.
5. Quality of dried produce is good, as smoke does not come in contact with the produce.
6. Temperature control ensures uniform and perfect drying.
7. It is simple in design and safe to operate.
8. It requires only 2 m^2 area for housing and a temporary shed of 4m x 4m area is sufficient for keeping the dryer.
9. It is portable (except large holding dryer) to move short distances and three to four persons can lift and transport the dryer.
10. It can be fabricated locally.