TECHNICAL BULLETIN 13

Small Holder's Dryer for Plantation Crops Using Agricultural Waste as Fuel

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Small Holder's Dryer for Plantation Crops Using Agricultural Waste as Fuel

INTRODUCTION

Drying is an important operation in the processing of plantation crop produces like copra, arecanut, cocoa beans etc. For safe storage and further processing, fresh coconut meat which contains 45–55% moisture has to be dried to 6% moisture level; fresh ripe arecanut with 70% moisture has to be dried to 9% moisture; fermented wet cocoa beans has to be dried from 60% to 6% moisture.

During rainy season, with restricted sun shine, drying by artificial method is the only possible solution for processing plantation crop produces. The direct type kiln dryers are not desirable for copra and cocoa beans as the products become inferior in quality due to smoking and improper drying. The other indirect type dryers using electricity or oil as fuel are uneconomical for small farmers. Hence a small indirect type dryer to meet the requirement of farmers with small holding (about 1 ha.) using cheaper fuel has been a long-felt need. An indirect type dryer suitable for small holders, using easily available low cost agricultural waste as fuel has been designed and developed at the Central Plantation Crops Research Institute, Kasaragod.

Description of the Dryer:

The dryer is of "batch type" having indirect heating and natural air convection arrangements.

The dryer is mainly comprised of a) drying chamber b) plenum chamber c) burning cum heat exchanging unit and d) chimney with regulators. The dryer is constructed from locally available materials such as asbestos cement sheet, G. I. sheet, MS angles and flats, wire mesh, asbestos rope etc. (Fig. 1).

A. Drying chamber

The drying chamber is the upper portion of the dryer which is supported on MS angle frame. It is made of asbestos cement sheets on sides and wiremesh tray at the base (drying platform). The produce to be dried is kept in this chamber.

Fig. 1. Small holder's dryer for plantation crops

B. Plenum chamber

This is the chamber just below the drying chamber and the air gets heated up in this chamber for drying. It is made of asbestos cement sheets supported on MS angle frame. The cross section of the chamber is of trapezoidal shape as illustrated in Fig. 2. An adjustable opening is provided at the bottom to facilitate entry of fresh air into the chamber.

C. Burning cum heat exchanger unit

The unit is located in the centre of the plenum chamber. It is a 30 cm diameter cylinder made of 22 guage corrugated GI sheet. Corrugated GI sheet is used for obtaining greater heat transfer with more surface area. One end of the cylinder is covered by a damper with holes for entry of air for combustion. The agricultural waste 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

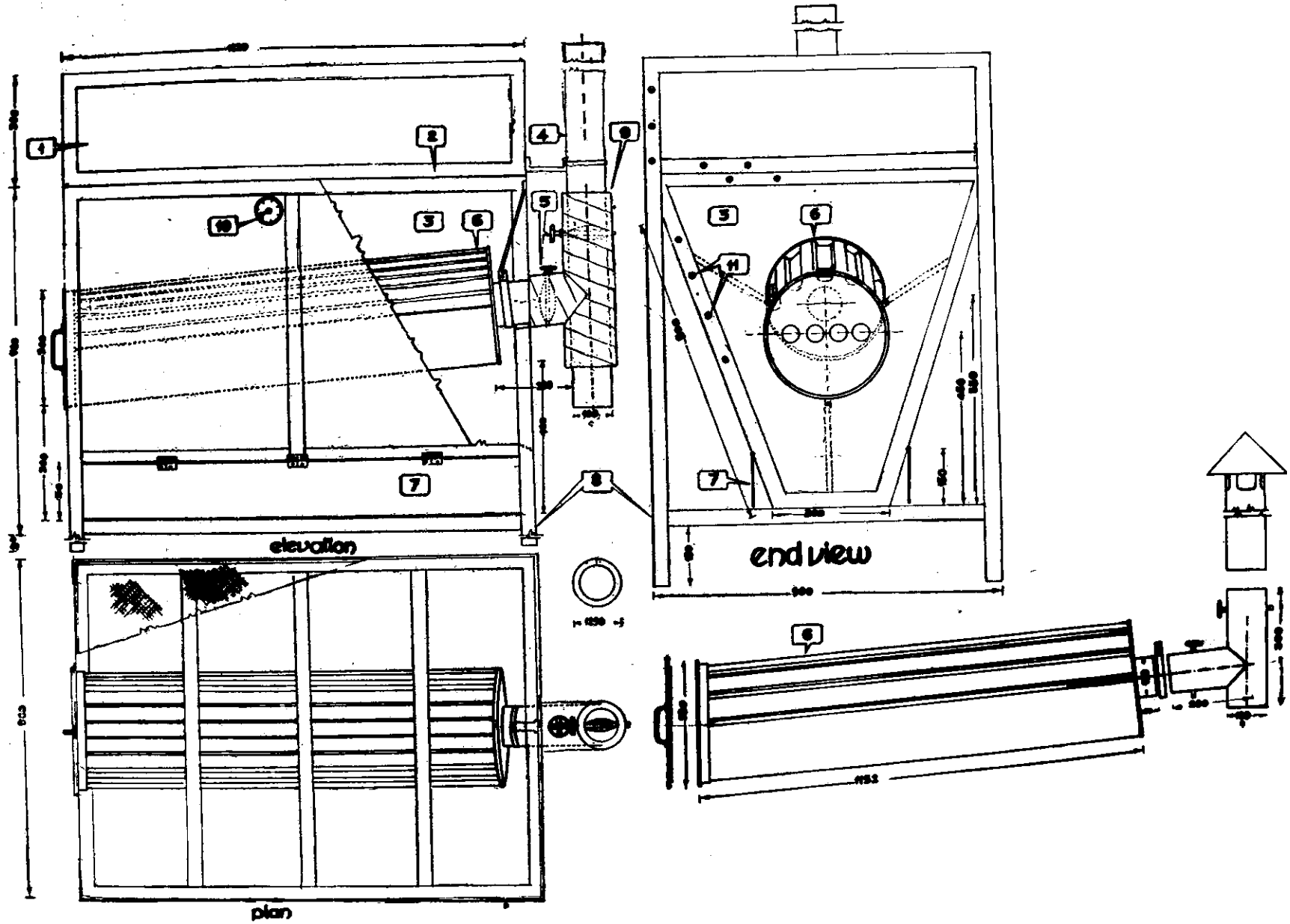

Fig. 2. Small holder's dryer for plantation crops

1. Drying chamber, 2. Drying platform, 3. Plenum chamber, 4. Chimney, 5. Valves, 6. Burning heater unit, 7. Air inlet damper, 8. Frame, 9. Asbestos, 10. Thermometer, 11. Fastening screws.

exhaust side. The inclination is provided for smooth flow of the flue gases. The outer surface of the cylinder at the ends on the plenum chamber sides is sealed with plaster of paris.

D. Chimney

10 cm diameter 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 covered by asbestos rope cemented with plaster of paris to avoid any danger during handling.

OPERATION OF DRYER

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 escape through the top of the drying chamber. A dial thermometer fixed just below the drying platform will help to monitor the drying air temperature.

Copra drying

Four hundred fully mature coconuts selected, dehusked and split into two halves. The nut water is drained off. The cups are kept inverted for 15 minutes to drain the adhering water. The split cups are loaded into the drying chamber. The first two 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 weld mesh 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 hr of drying the shells from which the kernels have loosened 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 shell removal has been found difficult are kept at the bottom facing up and kernels whose shells were removed are kept over that. At the end of 15 hr, 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 over four days with overnight breaks till the moisture content of copra reached 6% for safe storage. The actual time taken for drying will be about 36 hr.

Cocoa drying

The wet fermented beans of about 40 kg are accommodated in the drying chamber at 10 cm thickness. The firing of fuel is carried out as mentioned for copra drying. The drying air temperature is kept at 70–80°C. Frequent mixing of the beans by stirring is required for uniform drying.

During first eight hours, drying of the surface moisture takes place and it needs constant mixing at every half an hour. After this, intermittent drying is done with tempering for one hour after every three hours of drying. The seed coat drying takes three hours and the inner cotyledon drying takes seven hours. Total drying time required is about 18 hr, over a period of 2 days. Since cocoa is a highly flavour sensitive product, it is required to use a separate insertible drying chamber made of aluminium or GI sheet with wiremesh bottom. The chamber can be inserted into the drying chamber of the dryer.

Arecanut drying

About 150 kg of arecanuts can be loaded into this dryer. Drying is carried out intermittently with overnight tempering of the produce. The drying air temperature is kept at 80°C and it takes about 100 hr. (10 days) compared to about 45 days to complete the drying to the desired level of 9% moisture content.

Performance of the dryer

The performance of the dryer for drying the various plantation crop produces is given in Table I.

Table I. *Dryer performance details*

Produce	Capacity	Drying air temp °C	Drying time hr.	Type of fuel	Qnty. of fuel reqd. in kg.	Cost of drying/kg of final produce (Rs)
Copra	400 nos	70	36 (4 days)	Coconut husk shell/ mixed	28	0.75
Cocoa	40 kg	70–80	18 (2 days)	–do–	23	1.00
Ripe arecanut	150 kg	80	100 (10 days)	–do–	75	1.05

ADVANTAGES

1. The dryer is versatile as many of the plantation crop produces can be dried
2. It is useful during the monsoon season where sundrying 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 produce dried 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 $2m^2$ area for housing and temporary shed is sufficient for keeping the dryer
9. It is portable to short distances and three to four persons can lift and transport the dryer
10. It can be fabricated locally
11. The dryer costs only about Rs. 1800/=

SPECIFICATIONS AND LIST OF MATERIALS

A. Descriptions :

1.	Type	:	Batch type
2.	Heating mode	:	Indirect heating with agricultural waste as fuel
3.	Air circulation	:	Natural air convection
4.	Capacity	:	400 coconuts, or 40 kg of fermented cocoa beans or 150 kg ripe arecanuts
5.	Area for housing	:	2 m^2

B. Bill of materials :

	Materials	Size	Quantity
1.	MS angle	38 × 38 × 3 mm	20 m
2.	MS flat	38 × 3 mm	22 m
3.	MS flat	25 × 6 mm	5 m
4.	Corrugated GI sheet	22 guage	3 m^2
5.	GI sheet	22 guage	0.5 m^2
6.	Asbestos cement sheet	3 mm	6 m^2
7.	Asbestos rope	12.5 mm	1 kg.
8.	Hinges	5 cm	6 nos.
9.	Bolts and nuts	lumpsum	2 pkts.
10.	Plaster of paris		1 kg.

COST ANALYSIS OF DRYING

BASIC DETAILS

1. Cost of the unit – Rs. 1800.00
2. Expected life – 10 years
3. Use of the dryer in a year – 200 days

		Copra	Cocoa	Arecanut
4.	Time required for drying per batch–days	4	2	10
5.	Capacity of dryer (Initial)	400 coconuts	40 kg	150 kg
6.	Quantity of final produce/batch–(kg)	64	20	80 kg
7.	Labour requirement for operating the dryer–mandays	1.5 (including dehusking, splitting etc.)	0.5	2
8.	Fuel required/batch–(kg)	28	23	75

FIXED COST

1.	Annual depreciation	Rs. 180.00	180.00	180.00
2.	Annual interest on half the new cost–10%	90.00	90.00	90.00
3.	Annual maintenance cost 10% of annual depreciation	18.00	18.00	18.00
	Total fixed cost (1+2+3)	288.00	288.00	288.00
	Fixed cost/batch	5.75	2.90	14.40

OPERATING COST

1.	Labour charges at Rs. 25/day/man	37.50	12.50	50.00
2.	Cost of fuel at Rs. 0.20ps/kg	5.60	4.60	15.00
	Operation cost/batch (1+2)	43.10	17.10	65.00
	Total cost/batch (Fixed cost + Operation cost)	48.85	20.00	79.40
	Cost of drying per kg of dried produce (Rs)	0.75	1.00	1.05

Published by
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Text prepared by
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Edited by
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January 1986

Printed at
The Mathrubhumi (MM) Press, Calicut, 673 001 Kerala, India