R. P. F. III

96

FINAL REPORT

1. Institute Code No. Tech.I(813)

2. I. C. A. R. Code No. P2-87/1-ICI-N10/2223

3. Name and Address of Research Institute/~~Centre~~: Central Plantation Crops Research Institute, Kasaragod - 671 124.

4. Project Title: Design and Development of Cardamom dryer suitable for small and medium holders.

5. Name and Designation of Project Leader:
SJD BOSCO
Scientist (ASPE)

6. Name(s) and Designation(s) of Project Associates including Project Leader and work to be done:

Sl. No.	Name and Designation	Time spent	Work done
1	SJD Bosco Scientist (ASPE)	9 months	A low cost portable green cardamom has been developed

7. Location of Research Project with complete address (Division/Section/Sub-Centre)

Technology Division
CPCRI
Kasaragod - 671 124

8. Date of start

March 1987

9. Date of termination

March, 1990

10. (a) Objectives (Not more than 150 words)

For improving the performance of the existing CPCRI Cardamom dryer, this project was proposed with the following objectives:

(i) To improve the performance of the dryer by changing some design aspects.

(ii) To find out the defined simple operating procedure of the dryer.

(b) Practical Utility including background information (Not more than 150 words)

The capacity of the traditional curing house is usually very high. Thus the operating cost like cost of fuel, is more. This will be further increased during lean season of harvest due to under utilization of the curing house. To overcome these disadvantages, a smaller capacity low cost portable dryer has been developed. This may be more useful for small and medium holder during through out the season and for large holders during the lean season of the harvest. The traditional method of drying of cardamom by small holders is sun drying in which the green colour fadded dried cardamom will be obtained. By using this dryer good green colour cardamom can be obtained which will increase the income of the farmer.

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE

KASARAGOD-670 124, KERALA

R P F III

Project No. Tech. I(813)

1. Technical Programme:

Date of Start: March, 1987

(i) For 1987:

1. Improving the low cost cardamom dryer developed by CPCRI with suitable modification.

2. Field evaluation of the dryer

(ii) For 1988

1. Fabrication of the dryer as per the modified design

2. Testing and evaluation of the dryer

(iii) For 1989

1. Determination of the capacity of the exhaust fan to exhaust the moist air from the drying chamber.

2. Testing of the dryer by using firewood as fuel.

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE

KASARAGOD-670 124, KERALA

R P F III

Project No. Tech.I(813)

Date of Start: March 1987

Final Report : 1989-90

~~Technical Programme~~

The low cost CPCRI Cardamom dryer had been evaluated to know the performance of the dryer. It was noted that the colour of the dryed cardamom was fadded. This is due to the following reasons.

(i) due to the accumulation of the moist air in the drying chamber

(ii) Condensation of the water inside the drying chamber

(iii) Non-uniform hot air distribution in the drying chamber

By considering these points, the dryer design has been modified. To avoid the accumulation of the moist air in the drying chamber, and for the free flow of the moist air out, the shape of the top cover of the chamber is put as pyramid in shape instead of flat top surface. To avoid the condensation, the side surfaces of the drying chamber was insulated with the coir pith. For more uniform hot air distribution in the drying chamber, a distribution duct was provided in all the four sides and at the centre of the drying chamber. The capacity of the dryer is also increased to 50 kg from 25 kg for effective utilization of the hot energy.

12.1. Description of the dryer:

The dryer consists of plenum chamber with heating unit, drying chamber and top cover. These three parts are separate pieces which has to keep one over another. Locally available materials has been used to fabricate the dryer. The specification of the dryer is given in the Table 1. The details of the dryer is given in the Figure I.

Tahle I. Specification of the dryer:

Name: Low cost portable green cardamom dryer

Type: Batch type with trays

Heating mode: Indirect heating with firwood as fuel

Dimensions: Length: 1.5 m

Width : 1.0m

Height: 2.4 m

Capacity: 2.5 kg of fresh cardamom/tray

No. of tray: 20

Materials used: MS angle, MS flat, MS sheet
Asbestos sheet, plywood etc.

Specification of the exhaust fan:

Type: Centrifugal blower

Blower capacity : 3.8 m^3/Min.

Horse power : 1/8 H.P

Speed : 940 rpm

phase : Single

The plenum chamber with heating unit is the bottom most part of the dryer which is fixed with four leg supports. It has a trapizoidal in all four sides. On either side of the plennum chamber, 150 mm wide opening is provided at the bottom along the length of the dryer for air flow into the chamber. The heating unit is fixed inside the plenum chamber. It consists of a cylinderical burning chamber and two flue pipes. The fuel will be burnt inside the burning chamber and the flue or smoke will be flow through the flue pipes by which burning chamber and flue pipes will get heated up. The drying chamber is of rectangular shape and the sides of which are insulated with coir pith. For more uniform hot air distribution, hot air distribution ducts made of perforated G.I. sheet has been provided in all sides and at the centre of the dryer. Provision has been given to keep ten trays on both the position of the dryer. The trays are made up of wire mesh framed by modern repairs. The shape of the top cover of the drying chamber is pyramid, made of asbestos cement sheet fixed on the iron frame. A hole in provided at the top to exhaust the humid hot air. Provision is made to fix a exhaust fan with 1/8 hp single phase electric motor on this hole in such a manner that it can be removed away from the hole whenever, there is no power supply.

12.2 Testing the dryer:

The cardamom capsule used for testing the dryer were obtained from Mercara . The dryer was tested without exhaust fan operation by using coconut husk as fuel. The fresh cardamom was washed well with water and after draining the water, 2.5 kg of fresh cardamom was loaded in each tray. To heat the dryer, the fueling was started 15 minutes before the cardamom loading.

12.2.1. Temperature distribution in the drying chamber.

The temperature distribution inside the drying and plenum chamber was noted at one hour interval. The mean value of the reading is given as below:

Position	L_1	R_1	L_5	R_5	L_{10}	R_{10}	B	FL	FR
Temperature in °C	47.9	46.9	43.6	44.8	44.3	42.6	64.7	72.6	80.3

Note: L_1, L_5, l_{10} are the reading at just above the tray No.1,5, 10 in left side and similarly R indicates right side chamber. B, FL & FR are the readings just above the drum, left flue pipe and right flue pipe respectively.

12.2.2. Drying Rate:

For the determination of the rate of drying with respect to drying time, cardamom capsules were taken at 3 hours interval and then moisture content of the samples were found out by oven method. The mean moisture content of the sample with respect to time, is as given below:

Time in hours	0	3	6	9	12	15	18
Moisture content % (w.b.)	81.24	78.81	74.32	70.77	64.94	61.75	52.98

21	24	27	30	33
40.25	32.17	21.56	12.62	7.89

12.2.3. Fuel feeding rate:

From the ealier trials, it was noticed that the colour of the capsules changed or discoloured when the drying air temperature at just below the drying chamber exeeeds 55°C. It was, therefore, decided to maintain the termperature at about 50°C. For this, the following way the fuel was fed into the burning chamber. Here, the coconut husk was only used as fuel.

Drying hours	Fuel feeding rate number of husks for every 30 minutes.	Net task consumption
0- 6	2½ - 3	30 - 36
6 - 18	2 - 2½	48 - 60
18 - 24	1½ - 2	18 - 24
24 - 36	1 - 1½	24 - 36
	Total:	120 - 156

Therefore the total fuel consumption was 120 to 156 number of husks (30 to 40 kg). Since the temperature distribution in the drying chamber is almost uniform, it is not necessary to interchange the trays. But capsules should be mixed well in all trays for every 6 hours once. It was also noticed that in the first six hours of drying, the side doors of the dryer should not be opened. At the end of the sixth hour, it can be opened for mixing the capsules. The colour of the capsules obtained from this dryer was with fedded green colour. Only one woman labourer is sufficient to operate this dryer. Since the capsules were spread in thin layer and dried at low temperature air, at the end of the drying period, almost all capsules were dried uniformly.

From the above trials it was noticed that the colour of the cardamom was little faded which is because of the accumulation of the moist air inside and above the drying chamber. Therefore, it was decided to test the dryer with the exhaust fan. And also the availability of the coconut husk in cardamom growing areas is very less. Therefore it was decided to test with the firewood as fuel.

A exhaust fan with 1/8 HP, single phase motor was fixed at the exhaust pipe in such a way that it can be move away from the exhaust pipe whenever it is not being used. This can be achieved by rotating a hand lever.

Then the dryer was tested with and without exhaust fan operating by using firewood as fuel. Trials were conducted by loading 2.5 kg of cardamom in each tray. The temperature at just above the burning chamber cylinder, flue pipes, bottom, middle and top trays on both sides and at humid air exhaust hole, the relative humidity of the ambient air and exhaust air and the exhaust air flow rate were noted at one hour interval. The cardamom samples were taken from the bottom middle and top trays on both sides at 4 hours interval to determine the rate of drying. The quantity of fuel and interval of feeding were also noted. The fuel feeding was done to maintain the temperature of ~~drying~~ dring air 45-55°C below the bottom tray. The fuel tray with fuel waskept at one third distance from the open end of the burning chamber. The fresh cardamom capsules was spread on all trays in this layers and then the trays were arranged in the drying chamber. The door of the drying chamber was closed tightly. Drying was carried out continuously. The door of the drying chamber was opened once in four hours of drying for taking samples. The capsules in the tray was mixed well and the trays were interchanged in such a way that the top tray should come to the bottom of other portion of the drying chamber. The drying was continued till the moisture content of capsules reached 8 to 10 per cent (w.b.) moisture content level.

12.3. Results and Discussion:

The dryer performance data are given in the Table II. About 2.5 kg of fresh cardamom can be spread on each tray. Thus, about 50 kg of fresh cardamom could be dried from 80 per cent (w.b) to 8-10 per cent (w.b) moisture content. The total drying hours is 30-32 hours using 25 kg of firewod as fuel and 34-36 hours using 21 kg of fireweod as fuel with and without exhaust fan respectively. It was observed that good colour cardamom were obtained when the dryer was operated with exhaust fan.

12.3.1. Heat distribution:

To know the heat distribution in the drying chamber the thermometer readings were taken at just above the bottom, middle and top trays on both the side of the drying chamber.

Position		B	Fl	FR	Ll	R5	R10	Rl	R5	R10
Temp- erature °C	Without fan	57.60	60.1	63.0	40.6	45.1	50.8	41.9	43.8	50.6
	With fan	50.6	56.2	60.0	43.3	45.2	47.7	40.9	44.7	45.4

Note: B, FL & FR are the readings jut above the burning chamber drums, left side flue pope and right side flue pipe respectively. L-left side, R-right side, the suffix number indicates the tray number from the top.

It is observed that the temperature distribution is more when the exhaust fan is used. Because of this the drying of the cardamom is almost uniform. In other case where the exhaust fan is not used, for getting uniform drying, the tray position is changed for once in every 8 hours of drying.

12.3.2. Relative humidity of exhaust air:

The relative humidity of the exhaust humid air coming out from the drying chamber was calculated by using its wet bulb and dry bulb temperature. The mean value obtained is given in the table.

Time Hours	RH in %		Moisture content (W.B.)		Drying rate kg/hr		Volume of the air when fan is not used m^3/min.
	W.F	WOF	WF	WOF	WF	WOF	
0	~~75~~	~~72~~	82.24	79.01	-	-	1.12
2	75 ~~82~~	70 ~~77~~	-	-	-	-	0.840
4	85	72	77.61	76.95	2.585	1.117	0.640
6	83	80	--	-	-	-	0.69
8	80	80	70.97	71.24	2.268	2.268	0.760
10	55	-	--	-	-	-	0.810
12	51	70	54.82	59.04	2.734	2.721	0.84
14	53	60	--	-	-	-	0.88
16	50	50	41.04	46.62	1.149	1.49	0.88
18	55	45	--	-	-	-	
20	60	50	28.90	34.57	0.643	0.905	0.96
22	61	55	--	-	-	-	0.98
24	50	53	19.31	25.61	0.371	0.483	1.04
26	48	48					1.05
28	48	47	13.81	19.43	0.176	0.271	1.08
30	40	48	11.38	-	0.142	-	1.1
32	38	45	8.94	14.60	0.134	0.111	1.12
34		40					1.11
36		40		10.80	0.105		1.12

W.F. with fan WOF without fan Table 1. Drying parameters

In both the cases, RH of the exhaust air is rised tomaximum immediately after the drying is started and then it is decreased. Then against there is a little increase during 20-24 hours of drying.

12.3.3. Moisture removal rate:

The moisture content of the cardamom was determined in 4 hours internel and the same is given in the Table 1. The moisture content is expressed in per cent wet basis. The ideal storable moisture content of the cardamom is 10-11 per cent (w.b). Thus, the drying time is 30-32 hours while the exhaust fan is used and 34-36 hours without fan. The colour of the cardamom is also good in the case of former and there was litle fade in the latter case.

12.3.4 Drying rate:

The quantity of moisture removed per unit time is calculated and given in the table 1. In both the cases, the drying rate is maximum during 8-12 hours of drying. When the drying was done with the fan, the drying rate increase upto 4th hour and then it is decreased in 4-6th hours and again it increased to peak.

12.3.5. Quantity of moist air exhausted:

By using anemometer, the blowing air velocity was measured. The mean air velocity is 6.339 in/sec.. The air vent size is 100 x 100 mm. Thus, the rate of removal of moist air is 3.8 m^3/min. When the exhaust fan is not used, the rate of removal of moisture is varying which is given in the table 4. When there was no load in the dryer and the drying chamber air temperature is about50°C, the volume of air movement at vent is 1.12m^3/min.

12.3.6 Frequency of fuel feeding:

The frequency of fuel feeding was observed to be different for both the cases. When the exhaust fan is used, the rate of fuel feeding is as follows. For the first 13 hours, 500 gm of firewood is used for every 30 minutes. In the remaining hours, it is 500gm for every 40 minutes. When the fan is not used, the fuel feeding rate is uniform through out the period at the rate of 300gm for every 30 minutes. Thus by feeding the fuel as mentioned, the temperature of drying chamber can able to maintain at 40-50°C.

12.3.7 Dryer Performance:

The overall performance of the dryer for both the case is given in the table 2.

Method	Capacity	Drying air temp.	Drying time hour	Quty. of fire-wood kg.	Cost of drying Rs/kg	Quality of produce
Forced air (with fan)	50 kg	40-50	30-32	25	1.24	Good
Natural connect-ion (with out fan)	50 kg	40-50	34-36	21	1.12	Little fade

12.5. Conclusion: A low cost portable green cardamom dryer has been developed to dry 50 kg of fresh cardamom. A provision has ben provided to fix a exhaust fan to exhaust the moist hot air from the drying chamber. The fan can blow 3.2 m^2/min. of air. The dryer was tested with and without exhaust fan by using firewood as fuel. It is a batch type dryer with 20 trays of capacity 2.5 kg of fresh cardamom in each tray. It

can dry the cardamom with exhaust fan in 30-32 hours by using/ 25 kg of firewood as fuel. In other case it is 34-36 hours and 21 kg of firewood. In both the case the drying is continuous.

The dryer is mainly consists of MS angle framework with asbestos sheets. The drying chamber is insulated by packing coir dust in between the asbestos and plywood sheets. Provision is also made for uniform heat distribution in the drying chamber. By controlled fuel feeding the air temperature was maintained at about 45-50°C in the drying chamber. The cost of the dryer is Rs.5500/- and that of the blower is Rs.1500/-. The dryer can be easily transported from one place to another as it can be easily separated into three parts. It can be fabricated locally with moderate workshop facility. The overall dimension of the dryer is length 1.5m; width 1.0 m; Height - 2.4 m.

Cost analysis:

The cost analysis of the dryer is done for assessing the economic viability. The analysis is done for both conditions with the following assumption:

	Without fan	With fan
Cost of the dryer	5500	7000
Life time of the dryer	10 years	10 years
Number of batches in a year	60	70
Capacity (fresh cardamom)	50 kg	50 kg
Fuel consumption (Firewood)	25 kg	21 kg
Electricity consumption		3 units
Fixed cost per batch:		
(i) Depreciation	8.25	9.00
(ii) Interest @ 15% of the average cost	7.56	9.63
Total fixed cost	15.81	18.63
Running cost per batch:		
(i) Labour charge	25.00	25.00
(ii) Cost of repair and maintenance @ 4% of initial cost	3.67	4.67
(iii) Cost of fuel @ R.0.50/kg	10.50	12.50
(iv) Cost of electricity	-	3.00
Total running cost	39.17	45.17
Total operating cost:	54.98	63.80
Total cost of drying per kg of fresh cardamom	1.10	1.28
Total cost of drying per kg of dried cardamom	5.50	6.38

13. Approximate expenditure incurred in the Project: (Give reasons for variation, if any, from original estimated cost)

Rs.5000/-

14. Publications and material (one copy each to be supplied with this proforma)

a) Research papers — to be written

b) Popular articles — to be written

c) Reports — -

d) Seminars and workshops (Relevant to the Project) in which the Scientists have participated:

Annual Workshop of AICRP on H & PHT during 1987 and 1990.

e) Material developed (such as new varieties of crops or breeds of farm animals, implements, products, etc.)

A low cost portable green cardamom dryer has been developed.

15. Details (Nos. etc.) of Field/Laboratory Note books and final material and their location

Observation taken during trials in Technology Division

16. Comments/suggestions of Project Leader regarding possible future line of work that may be taken up arising of this project:

- NIL-

17. Signatures with name of Project Leader and Associates:

S. John Don Bosow

S. John Don Bosow

(SJD BOSCO)

18. Signature (with comments, if any) of Head of Division/Section/Station:

This dryer will be of much use to smallholders as it can be fabricated locally, cost of the dryer much less, and capacity of the dryer 50 kg. The fuel used is the agricultural waste, fire wood etc. which is available in plenty in cardamom growing areas. Shri Bosco has done a good job.

Madhavank

(K.MADHAVAN)

HEAD, TECHNOLOGY DIVISION

19. Signature (with comments, if any) of Director:

(MK NAIR)

Director

Central Plantation Crops Research Institute

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