R. P. F. III

FINAL REPORT

1. Institute Code No. Tech. VIII(231)

2. I. C. A. R. Code No. P2-87/2-ICI-M10/0311

3. Name and Address of Research Institute/Centre:
Central Plantation Crops Research Institute, Kasaragod 670 124

4. Project Title: Evaluation of dryers, dehuskers and other equipments developed by CPCRI in farmers' field.

5. Name and Designation of Project Leader:
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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.	S.J.J. BOSCO, Scientist (ASP)	5 manmonths	The 400 nuts capacity dryer evaluated in the farmers' field. The 3000 nuts capacity dryers was evaluated at Central State Farm, Aralam. Based on the evaluation report, some correction hasbeen made. The working condition ofthe manually operated coconut dehusker was demonstrated.

7. Location of Research Project with complete address (Division/Section/Sub-Centre)
Technology Section, CPCRI, Kasaragod 670 124

8. Date of start

March, 1987

9. Date of termination

February, 1989

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

1. To evaluate the devices/equipment developed by CPCRI, Kasaragod in farmers' field. Based on the evaluation report, if needed, device has to be modified accordingly.

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

By evaluating the newly developed devices/equipments in farmers' field (real working condition), the defects in the devices can be determined which can be rectify by modifying the design of the devices.

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE

KASARAGOD-670 124, KERALA

R P F III

Project No. Tech VIII(231)

11. Technical Programme

Date of Start: March, 1987

For the year 1987

(a) Field evaluation of CPCRI Copra dryers and getting the feed back data

(b) Evaluation of coconut dehuskers.

For the year 1988

(a) Evaluation of dryers and dehuskers.

(b) Testing and evaluation of 3000 nuts capacity dryer.

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE

KASARAGOD-670 124, KERALA

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Project No. Tech VIII(231)

12. Final Report 19 87 19 88 Date of Start: March 1987

I. Evaluation of the copra dryers in the farmers' field

The drying operation of the small and medium holders' dryer were demonstrated in the farmers' field. For evaluating these dryers, a proforma was prepared and given to the farmers those who are being used thedryer and asked them to fill up the proforma. From this evaluation, it was observed that the farmers were not operating the dryer properly which leads to get bad quality copra and longer drying time. To give a proper guidelines to them, a write-up entitled as "DO's and DON'T's while using copra dryer of 400 coconuts per batch capacity" was prepared and supplied to the farmers those who are already using thedryer. A copy of this write-up was also given to the manufacturer of these dryers and asked them to supply this material along with thedryer to customers.

The remark was also received from the farmers about the breakage of asbestos sheet while the dryer is being used. It was noticed that the side asbestos sheets except at the front are not exposed to high temperature or direct fire. Therefore a suggestion was given to use the plywood of 3 mm thickness in the place of asbestos sheet except at the front side of the dryer.

II. Construction and evaluation of 3000 coconut capacity dryer

For constructing the larger size copra dryer of capacity 3000 coconuts per batch, technical advise/assistance was given. The dryer was constructed as per the design. After the completion of the construction of the dryer, test trials were conducted and the following defects in the dryer were observed.

(i) In some parts of the dryer, the construction was not so perfect which led to enter the smoke into the drying chamber, over heating of copra just above the flue pipe, etc. The suggestion was given to correct defects.

(ii) The strength of the drying bed grid was not sufficient to hold the coconut. Because of this, more sagging was observed in the grid. Therefore, the suggestion was given to give some more additional support.

(iii) There was more gap where the drying bed and asbestos sheet surface were come to contact. Because of that more hot air was passing through these gaps instead of through the coconut cups which leads to uneven drying of copra.

After rectifying the above mentioned defects, the test trials were conducted and observed that the working condition of the dryer was good. Then ten trials were conducted by changing the fuel feeding rate and loading capacity of the dryer. From these trials, it was observed that

the dryer performance was good. This dryer can be used to dry 3000 to 4500 coconuts per batch. The number of coconuts to be dried in the dryer depends on the size of the coconut. In other words, it can be loaded with about 900 kg of wet coconut kernel in a batch of drying which will approximately yield 500 kg of copra with 4-6 per cent moisture content.

Description of the dryer

The dryer mainly consists of drying chamber, plenum chamber, burning-cum-heat exchanging unit, etc. The materials used for constructing this drier is given in Table I. The isometric view and thedesign detail drawing of the dryer are shown in Figs. 1 to 5. The overall dimension of the dryer are: length 4.5 m, width 2.6 m, height 2.6 m and it requires a housing shed of 24 m^2 area. The drying chamber has an area of 12 m^2. The drying bed grid frame is made up of MS channels, flats and angles. Above this grid, wire mesh is spread above the weld mesh. The whole drying bed platform is supported by two side masonry brick walls. These masonry walls extended above the drying bed to form drying chamber. At the bottom of these walls 4 holes are provided for the entry of fresh air into the plenum chamber. The plenum chamber is just below the drying chamber. It has a trapezoidal vertical cross section. On either sides of the plenum chamber, an opening of 150 mm wide is provided at the bottom along the length of the dryer for air flow into the plenum chamber. The cement coated gunny bag/coir mat fixed on the wooden frame work is act as sides of the plenum chamber. This chamber is housed in between the side walls. At the centre of this chamber burning-cum-heat exchanging unit is housed longitudinally. It is a 600 mm diameter cylinder made of 18 guage MS sheet. Five brick masonry brick pillers are constructed to place this cylinder in such a way that the cylinder is placed at a inclination of 2.5° to the horizontal for smooth flow of flue gases to the flue pipes. The lower end of the cylinder is fixed with a damper having holes for entry of air required for combustion of fuel. The other end is connected to two flue pipes at the top of the cylinder. These flue pipes are come along the sides in such a way that 200 mm just below the drying bed and 150 mm away from the side panel of the plenum chamber. The angle of inclination of these pipes is 1.5° to the horizontal. The flue pipes are made up of 22 gage G.I. sheet. The flue pipes are connected to the cylinder by a smooth curve. The other end of the flue pipes are connected to the smoke pipes. The fuel is burnt inside the cylinder on a flat tray made up of M.S. rods.

Operation of the dryer

The fuel is burnt in the fuel feeding tray inside the burning cylinders. The heat from the cylinderial drum surface is transferred by radiation to the surrounding fresh air entering from the bottom of the plenum chamber and this heat transfer generated a natural connection air current. The hot air moves up through the wet produce kept in the drying chamber and the hot air laden with moisture creapes from the top of the drying chamber. This phenomenon helped in the natural connection of the air through the drying bed.

Table 1. List of materials required for fabricating the dryer.

Sl No.	Material	Size	Quantity
1.	Laterite stone	350 x 210 x 140 mm	500 Nos
2.	Cement	50 kg bags	15 Nos
3.	Sand		3 cum
4.	40 mm metal		1 cum
5.	Empty gunny bags		50 Nos
6.	M.S. angle	40 x 40 x 6 mm	100 kg
7.	M.S. flat	30 x 6 mm	25 Kg
8.	M.S. angle	25 x 25 x 6 mm	25 kg
9.	M.S. rod	10 mm	7 Kg
10.	M.S. Sheet	8 guage of 8 x 6'	6 Nos
11.	M.S. Sheet	18 guage	5 kg
12.	Welder mesh	1" x 1"	8 sqm
13.	Wire mesh		8 sq.m.
14.	Country wood		0.1 cum
15.	Channel	75	45 Kg
16.	Oil drum	200 liters	4 Nos
17.	A.C. sheet	8' x 6'	3 Nos
18.	Nail/screw/nut & bolt		1 Kg

Testing of the dryer

The dryer was intensively tested for drying coconut. Hourly observations on various parameters like drying air temperature at different zones, exhaust air temperature, relative humidity of ambient air and exhaust air, velocity of air flow, moisture content of the produce and fuel feeding rate were taken and the drying parameters were standardised for drying copra.

(a) Fuel feeding: For getting more uniform heating through out the drying bed, the fuel feeding tray was kept in many points of the burning chamber cylinder and the following observations were taken.

(i) In the beginning, the tray has to be kept at about 1.0 m inside. After the next fuel feeding, it should keep at about 2.5 m inside. Thus the tray should keep in these two position alternately.

(ii) The frequency of fuel feeding and the quantity of fuel to be fed in each feeding is given as below:

Table XX. Frequency of fuel feeding

Drying phase	Drying time 'Hours'	Time interval between fuel feeding 'Minute'	No. of husks per feed	Net husk consumption
I	12	15	7-8	350
II	8	15	6-7	200
III	8	20	6-7	150
IV	8	20	5-6	130
Total	36			830

To avoid the charring of copra due to higher temperature towards the end of the drying period, the phase drying is recommended which will help to get good quality copra and to reduce the fuel consumption. The temperature just below the drying bed is decreasing as the drying is in progress due to decrease in fuel feeding. But the temperature recorded at the middle layers is less in the first phase when compare with the second phase of drying, inspite of feeding more fuel in the first phase. This is because the heat load required in the first phase of drying for sensible heat gain by the produce and the moisture and for latent heat of evaporation are more. Inspite of decrease in the fuel feeding in the subsequent phases of drying, the temperature of the hot air at the middle layer of the drying bed is almost equal. This is because of that the quantity of moisture evaporated in these subsequent phases is decreased. The moisture content at the end of each phase of drying and quantity of moisture removed in each phase is given Table IV.

Table IV. Drying rate

Phase of drying	Drying time (hr)	Mean moisture content of copra at the end of the period (%) (d.b.)	Quantity of moisture removed (%)	Drying bed thickness (mm)
I	12	25.3	68.1	400
II	8	15.4	10.6	270
III	8	9.5	6.2	220
IV	8	5.6	3.2	220

The majority of the water is evaporated during the first phase of drying. During this phase, almost all the unbound moisture and portion of bound moisture were evaporated. Then in other three phases, the quantity of moisture evaporated is less because the bound moisture movement from inner to outer layer of copra is very slow.

In a batch type thick bed - natural convertion dryer it is nearly impossible to get uniform heat distribution at all points of particular layer of the drying bed. The performance of the dryer depends on the degree of uniformity of heat distribution. The degree of uniformity is measured as uniformity coefficient which is calculated by using the formula:

$$U = 100 \left(1 - \frac{\Sigma x}{\Sigma X}\right)$$

where U = uniformity coefficient in per cent
x = numerical deviation of individual observation from the mean value of the all observations in °C;
X = value of the observation in °C.

The temperature recorded on each phase of drying at the nine points of the middle layer of the drying bed are used for this calculation and is given in the above table.

A uniformity coefficient of 100 per cent is indicative of absolutely uniform temp. A uniform coefficmicient of 85 per cent or more may be considered as satisfactory. During all the drying phase, the uniformity coefficient is above 85 per cent. In the first phase of drying this coefficient value is more when compare with the other three values. This is because of that in the first phase of drying the coconut cups are arranged in such a way that the hot air will pass through the cups freely without any blocking. During the other phase of drying, kernels without shell are loaded as such. Because of that there is a possibility of blocking of the hot air.

Since the temperature of the hot air in the subsequent layers from the bottom of the drying bed is decreased, the rate of drying is high at the bottom layer when compare with the other layer copra. To avoid non-uniformity of drying, after removing the shell the copra is mixed well so as to bring bottom layer copra to top. At the end of the drying period, copra samples were taken randomly and moisture content was determined. To know the uniformity of drying, the uniformity coefficient is calculated and obtained as 89-92 per cent which indicates the uniform drying of copra.

(c) 3. Thermal Efficiency:

The thermal efficiency of the dryer is calculated by using the formula:

$$E = \frac{Q \lambda (M_0 - M_f)\ 100}{W.C.\ (100 - M_0)}$$

where E = Thermal efficiency of the dryer in per cent

M_0 = Initial moisture content in per cent wet basis

M_f = Final moisture content in per cent wet basis

Q = Quantity of final dried product at M_f moisture content level in Kg.

λ = Latent heat of vaporization at 50°C in k cal /Kg

W = Quantity of fuel used in Kg

C = Calorific value of fuel in kcal/Kg

The thermal efficiency of the dryer is obtained as 19.98 per cent.

(d) Labour requirement

The labour requirement for drying one batch of copra is also optimised and the same is given below:

Table V. Labour requirement

Operation	Labour requirement		Working time (Hours)	Man hours required
	Men	Women		
Husking	2	-	8	16
Splitting	2	7	4	36
Shelling	8	-	4	32
Loading & Unloading	1	1	1	2
Fuel feeding	-	1	26	18
			Total	104
				≈ 13 man days

The labour who is feeding the fuel may also do some work simultaneously since the fuel feeding frequency is 15-20 minutes only.

ECONOMIC ANALYSIS OF THE DRYER

Cost of the dryer	:	Rs.10,000.00
Expected life of the dryer	:	10 years
Use of the dryer in days in a year	:	240 days
Time required per batch	:	4 days
Labour requirement per batch	:	13 mandays
Quantity of copra obtained from one coconut	:	160 g/coconut
Salvage value @ 10% of cost of the dryer	:	Rs.1000.00
Capacity	:	3000 coconuts/batch

Fixed cost per batch

(i) Depreciation $= \frac{10000-1000}{10 \times 60} = 15.00$

(ii) Bank Interest @ 15% of the average cost $= \frac{(10000+1000)}{2} \frac{15}{60 \times 100} = 13.75$

(iii) Overhead charges @ 10% of the initial cost $= \frac{10000 \times 10}{60 \times 100} = 16.67$

Total fixed cost = 15.00 + 13.75 + 16.67 = 45.42

Running cost per batch

(i) Labour charges @ Rs.30/manday	=	Rs.390.00
(ii) Cost of repair maintenance @ 6% of initial cost	=	6.67
(iii) Cost of fuel @ Rs. 0.06/husk	=	60.00
Total variable cost	=	456.67

Cost of making copra

(i) Fixed cost per batch	=	Rs. 45.42
(ii) Variable cost per batch	=	Rs.456.67
(iii) Cost of 3000 coconuts @ 2.85 per nut	=	Rs. 8550.00
Total cost	=	Rs.9052.09

Returns from one batch of drying

(i) Value of copra @ Rs.19.75 per kg	=	Rs.9,480.00
(ii) Value of husk @ Ps. 5 per husk	=	Rs. 120.00
(iii) Value of shell @ Ps. 5 per shell	=	Rs. 240.00
Total return	=	Rs.9,840.00
Net profit from one batch	=	Rs. 788.00
Net profit in a year	=	Rs.47,280.00
Cost of drying per husk coconut (including cost of husking, splitting, etc.)	=	Rs. 0.18

Conclusion

During rainy season it is not possible to make copra by sun drying. A low cost larger mpm capacity dryer was developed and tested at Central State Farm, Araliam. It is a thick bed batch type dryer with a capacity of 3000 to 4500 coconuts per batch. By using 800 to 1000 husks as fuel, copra can be obtained in 34 to 36 hours. The quality of the copra is good as there is no direct contact of the smoke with copra.

The dryer mainly consists of brick masonry walls on two sides with asbestos sheet at front and back. The drying platform is made of rolled steel beam and MS plate with wiremesh and weldmesh spread. The fuel is burnt in a drum at the bottom of the dryer and the smoke goes out through two flue pipes. The cost of the dryer is about Rs. 10,000/-. A net benefit of Re. 0.25 can be obtained by converting one coconut into copra using this dryer. It can be constructed by local masons with the help of a fabricator having moderate workshop facility. No special skill or training is required to operate this dryer. It is suitable for farmers having more than 10 ha of coconut garden. No electricity or other costly fuel is required for operating this dryer. By controlled fuel feeding, the drying air temperature can be maintained at about 55°C to 70°C. The overall dimension of the dryer is length: 4.5 m width: 2.6 m and height: 2.6 m.

XII. Evaluation of coconut dehusker

The working condition of the CPCRI manually operated coconut husking machine was demonstrated to farmers and institute visitors. It was pointed out that the output of the machine is very low inspite of ease of working of the machine. The suggestion was also given that it can be made into power operated one. The suggestion was also given that it can be made into power operated one. Thus it was decided that a new project may be started for developing power operated coconut husking machine.

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

Rs. 30,000/=
The original estimated cost is Rs.54,500/=. The reason for decrease in expenditure is that the project is closed within 2 years instead of 4 years.

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

a) Research papers — One under preparation

b) Popular articles — One under preparation

c) Reports — Institute Annual Report

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

Nil

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

The 3000 capacity dryer had been modified as per the evaluation and test trial. Then the final design drawings of the same was prepared.

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

Data recording note book - 1
The dryer is at Central State Farm, Aralam. Because the cost for constructing the dryer was met by that farm.

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

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17. Signatures with name of Project Leader and Associates:

S. JOHN DON BOSCO
(Project Leader)

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

Madhavank

(K. MADHAVAN)
Head of the Section

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

(V.K. RAIN)
Director