The Andhra Agric. J 56(4):493-497, 2009

Performance Evaluation and Cost Benefit Analysis of Barn Drying of Chillies

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ABSTRACT

Large scale drying experiments using chillies in unutilized tobacco barns indicated that the average drying rate is 0.0633 kg/kg.hr. The thermal efficiency of the barn drying system was found to be 8.45%. The cost of barn drying varied from Rs.2.88 to 3.69 per kg of dry chilli depending upon whether the pod is, thin pericarp type variety or thick pericarp type hybrid. Farmers have to incur an additional cost ranging from Rs.2.11 to 2.76 per kg dry chilli in barn drying in comparison to farmer's method which costs only Rs.0.77 to 0.93 per kg dry chilli. However, the additional cost of barn drying can be compensated by additional income due to reduced percentage of discolored pods and by the premium price offered to the quality, particularly for export. Conversion of unutilized barns to produce quality dried chilli has a benefit-cost ratio of 1.57 and 1.76 for thin pericarp type varieties and thick pericarp type hybrids, respectively in comparison to farmer's practice which has a benefit-cost ratio of 1.28 and 1.51 for thin pericarp type varieties and thick pericarp type hybrids, respectively.

Key words : Barns, Benefit Cost Ratio, Chillies, Drying, Performance Evaluation

Guntur and Prakasam districts in Andhra Pradesh have large number of unutilized tobacco curing barns due to decline in tobacco cropping area in black cotton soils. Detailed studies to convert existing unutilized tobacco barns to dry quality chillies were conducted under National Agricultural Technology Project at Post Harvest Technology Centre, Bapatla. Harpal Singh and Anwar Alam (1982) reported that the cost of chilli drying with solar dryer was Rs.26.63 to 133.62/quintal as against Rs.25.15 to 93.91/quintal for open yard sun drying. A pit drier with indirect hot air aeration was developed to dry copra (Rachmat *et al.,* 1999). The average drying rate was reported to be 1.2% (w.b.) / hr at a drying air temperature of 50-60^{o}C. The drying efficiency was reported to be 10.72%. Mangaraj *et al.,* (2001) found that greenhouse solar drying of chillies was most economical followed by solar cabinet drying, mechanical drying and open yard sun drying. Itodo *et al.*, (2004) reported investigations on performance of an active solar crop drier. The drying rate, collector and system drying efficiency were 0.74 kg per day, 12 and 10% respectively. The drying rate increased to 1.6 kg per day after drier was modified into a direct forced convective type. Comparatively the drying rate for sun drying was reported to be 0.9 kg per day. Recent studies by Kaleemullah and Kailappan (2007) on evaluation of laboratory model rotary type chilli dryer of capacity 10.5 kg per batch showed that chillies can be dried from 330 % (d.b.) to safe moisture level of about 11% (d.b.). The heat utilization factor was reported to vary from 0.48 to 0.62 at the beginning and finally to about 0.08. It was concluded that the chilli dried at a capacity of 75% dryer volume was the best. The main objective of the present work is to test and evaluate the performance of barn and compute performance indices for effectiveness and to workout benefit-cost ratio to convert existing tobacco barns into chilli barns.

MATERIAL AND METHODS

Drying experiments were conducted to convert existing unutilized tobacco barns for large scale drying of chillies in Dharanikota village, Amaravathi Mandal of Guntur district (Anonymous, 2005). The barn drying of chillies was compared to the farmer's practice of open yard sun drying. Chillies have been grouped into two types depending upon the nature and thickness of pericarp, (1) Thin pericarp type varieties (thin walled chilli, typically S4) and (2) Thick pericarp type hybrids (thick walled chilli, Wonderhot). Average velocity of air was measured by anemometer (Lutron make, Model AM-4201). The relative humidity of the atmosphere and drying air was measured by wet and dry bulb hygrometer (Zeal make, UK) and a dual thermo sensor (Techno make, UK). The performance indices such as dryer factor, average drying rate, thermal efficiency, heat utilization factor and coefficient of performance (COP) were calculated (Chakraverty, 1997). As some of the performance parameters such as drying rate, heat utilization factor vary dynamically with changing conditions of ambient, drying and exhaust air, they are calculated considering average values (Anonymous, 2005).

RESULTS AND DISCUSSION

The performance indices of chilli drying barn were established based on the measured temperature of the drying air, exhaust air and furnace temperature, feed rate of the wood. Average drying time to dry chillies in barns was found to be 45 hours. Model calculations are as follows.

Model calculation based on average values

Initial weight of ripe chillies = 1150 Kg

Initial moisture content = 74.74 % (wb) = 295.88% (db)

Final moisture content = 9.77% (wb) = 10.82% (db)

Weight of bone dried sample

$$= 1150 - \frac{1150 \times 74.74}{100} = 290.5 \text{ Kg}$$

$$\text{Moisture evaporated} = \frac{2905 \times (29588-1082)}{100} = 828.1 \text{Kg}$$

I Dryer factor (fd)

$$= \frac{\text{Amount of moisture removed}}{\text{Initial weight of chillies}} = \frac{828.1}{1150} = 0.72$$

II Drying rate (R)= $dm/d\theta$

$$= \frac{\text{Amount of moisture removed}}{\text{Time taken (h) X Bone dried weight of sample}} = \frac{828.1}{45 \times 290.5}$$

= 0.0633 Kg/Kg-h

III Thermal efficiency (η_T)

$$= \frac{dm/d\theta \times Ws \times \lambda}{Q}$$

$$Q = \frac{60 x v_A x (h_1-h_0)}{v}$$

Where,

Q= energy given by drying air

v_A = Volume flow rate, m^3 / min.

v = Humid volume m^3 / kg

h_i, h_0 = Enthalpies, kJ / kg

Size of the top ventilator (exhaust) = 0.3 x 0.6 m

Average velocity of exhaust air = 0.0555 m/ sec.

v_A = 0.3x0.6x0.0555x60 = 0.5994 m^3 / min.

Temperature of ambient air 38° C

Temperature of drying air 55° C, RH 32%

Temperature of exhaust air 48°C, 45%

From psychometric chart, The value of h_i and h_0 are 142 and 130 kJ / kg, respectively.

Humid volume = 0.965 m^3 / kg

Q= 60x0.5994x (142-130) / 0.965 = 447.22

η_T = 0.0633 x 290.5 x 2520 / 1150x477.22 x 100 = 8.45%

iv Heat utilization factor (HUF) = T_1-T_2/ T_1-T_0 = 55-48 / 55-38 = 0.411

v Co-efficient of performance (COP) = T_1-T_0/ T_1-T_0 = 48-38 / 55-38 = 0.588

Experiments indicated that ripe chillies of 10 to 12 quintals of input capacity can be dried in about 38 to 50 hours depending upon whether chilli is hybrid or variety (Anonymous, 2005). Barn performance indices (Table 1) showed that although drying factor is 0.72 the thermal efficiency is low *i.e.,* only 8.45%. This value is reasonable for a barn drying structure built by brick masonry and ventilators made of wood and bare galvanized iron sheet. The low thermal efficiency of the barn can be attributed to indirect heating system in the barn, thin bare mild steel flue pipes and also loss of heat through exhaust pipe, top ventilator. The values are in close agreement with those reported by Rachmat *et al.,* (1999) and Itodo *et al.,* (2004). Cost of barn and open yard sun drying (farmers' practice) are worked out for both varieties and hybrids (Table 2 and 3). Cost of barn drying is Rs. 2.88 to 3.69 per kg of dry chilli depending upon whether the pod is thin pericarp type variety or thick pericarp type hybrid. Cost of drying in farmer's method is Rs.0.77 to 0.93 per kg dry chilli depending upon whether chilli is hybrid or variety. Farmers have to incur an additional cost ranging from 2.11 to 2.76 Rs./kg in barn drying. Conversion of barns to produce quality dried chilli gave a benefit-cost ratio of 1.57 and 1.76 for thin pericarp type varieties and thick pericarp type hybrids, respectively, in comparison to farmer's practice which gave benefit-cost ratio of 1.28 and 1.51 for thin pericarp type varieties and thick pericarp type hybrids, respectively (Table 4). Benefit cost ratios are dynamic variables that depend mainly on

Table 1. Performance indices of chilli barn

Sl. No.	Performance indices	Value
1	Dryer factor (fd)	0.72
2	Drying rate, R	0.0633 kg/kg-h
3	Thermal efficiency (η_T)	8.45%
4	Heat utilization factor (HUF)	0.411
5	Coefficient of performance (COP)	0.588

Table 2. Cost of barn drying of chillies

S.No.	Particulars	Total cost Rs./ Kg dry
A.	For thick pericarp type hybrids	
	VARIABLE COST	
	1. Repairs and maintenance	0.0121
	2. Labour charges	1.97
	3. Fuel charges	1.5
	4. Total variable cost	3.48
	FIXED COST	
	1. Depreciation	0.11
	2. Interest	0.0975
	3. Total fixed cost	0.2075
	Total cost of drying	3.69
B.	For Thin pericarp Type Varieties	
	VARIABLE COST	
	1. Repairs and maintenance	0.0097
	2. Labour charges	1.5
	3. Fuel charges	1.2
	4. Total variable cost	2.71
	FIXED COST	
	1. Depreciation	0.088
	2. Interest	0.078
	3. Total fixed cost	0.166
	Total cost of drying	2.880

market price. The advantages of barn drying are, 1. Produce can be dried early in the season particularly during winter months and put into the market to get the remunerative price before the arrival of the bulk of the produce. 2. There is an economic return to farmers as the percentages of white pods are only 0.5 to 2.5% in comparison to 10 to 15% in open yard sun drying. 3. The quality parameters such as improved colour retention and low level of aflatoxin in comparison to open yard sun drying fetches a premium market price. Increased recovery of red pods, good colour retention, luster and very low levels of aflatoxin in barn drying are all factored into the price by giving premium to the market price. The premium could be higher in the export market and if risk of unforeseen rains is also factored into the calculations. A farmer by converting available un-utilized barn can dry produce from 3.5 hectares

Table 3. Cost of open yard sun drying of chillies (Farmer's method)

S.No.	Particulars	Total cost Rs. /Kg dry
VARIABLE COST		
A.	For thick pericarp type hybrids	
	1. Charges for grading, packing	0.43
	2. Charges for turning of pods, watch and ward	0.50
	3. Total cost of drying	0.93
B.	For Thin Pericarp Type Varieties	
	1. Charges for grading, packing	0.43
	2. Charges for turning of pods, watch and ward	0.33
	3. Total cost of drying	0.77

Table 4. Benefit – cost ratio for barn drying of chillies

A. For thick pericarp type hybrids	Farmer's practice	Barn drying
Cost of cultivation per acre, (Rs.)	38000	38000
Yield, (quintals per acre)	20	20
Drying cost (Rs. Per quintal dry pod)	93	369
Total cost of cultivation, [Rs (I)]	39860	45380
Market rate, (Rs. per quintal)	3000	4000
Gross return (II)	60000	80000
Net return	20140	34620
B.C. Ratio (II/I)	1.51	1.76
Quintal basis		
Total cost of cultivation per quintal	1993	2269
Gross return per quintal	3000	4000
Net return per quintal	1007	1731
B.C. Ratio	1.51	1.76
B. For thin pericarp type varieties	**Farmer's practice**	**Barn drying**
Cost of cultivation per acre, (Rs.)	34000	34000
Yield, (quintals per acre)	15	15
Drying cost (Rs. Per quintal dry pod)	77	288
Total cost of cultivation, [Rs. (I)]	35155	38320
Market rate, (Rs. per quintal)	3000	4000
Gross return (II)	45000	60000
Net return	9845	21680
B.C. Ratio (II/I)	1.28	1.57
Quintal basis		
Cost of cultivation per quintal	2343.66	2554.66
Gross return per quintal	3000	4000
Net return per quintal	656.33	1445.33
B.C. Ratio	1.28	1.57

if it is hybrid chilli or 6 hectares of straight varieties provided the timing of fruit picking is well distributed throughout the season to effectively utilize the barn capacity. The study revealed that both cost of drying and benefit cost ratios to dry different hybrids and varieties of chillies vary considerably.

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