Performance Study of Small Solar Dryers

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Abstract

Two direct type small solar dryers, one made of bamboo and the other of wood, were fabricated and tested at the Bangladesh University of Engineering and Technology, Dhaka, in the months of September and October. The dryers were loaded with paddy and the results were compared with those obtained by the age-old traditional method of open exposure to the sun. At this stage of development, the bamboo dryer appears to be the best from the point of view of both moisture removal rate and cost.

Introduction

A high percentage of the total paddy produced in Bangladesh is harvested during the months of monsoon (July—Sept.) and the farmers attempt to dry their crop by the age-old traditional method of open exposure to the sun. But, because of frequent rain, overcast sky and high humidity, it becomes extremely difficult to dry the paddy to the desired level for even medium term storage. Sometime it becomes impossible to dry the crop at all. Besides, the open drying is associated with deterioration in the quality of the dried product by windborne dirt and dust and infestation from insects and other animals. This postharvest loss of the paddy during the monsoon can be avoided by speeding up the drying process with solar radiation in specially built units called solar dryers and the poor farmers and the members of their families will be greatly benefited both from economic and comfort point of view. Moreover, if the paddy production is increased significantly from the present level, post harvest drying deserves a serious consideration.

Basically there are three types of solar dryers—direct, indirect and combined. In direct dryers the product is heated by direct solar radiation and the moisture evaporated is removed by moving air. In indirect dryers the product is dried by moving air heated outside the drying chamber, whereas the combined dryers use both direct radiation and heated air. These dryers have certain advantages and disadvantages and they are being used in different countries with some success.

Dryers tested

Solar dryers are to be used by the poor farmers in the rural areas of Bangladesh primarily during the monsoon period. Therefore, those

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which appear to be successful in other countries, may not necessarily be suitable for our country as their climatic, technological and socio-economic condition might be quite different from those of ours. Basic ideas may be adopted, but detail design must have to be reconsidered.

For our farmers, the dryer should be reasonably cheap and of such simple design that they themselves can fabricate it. Use of indigenous materials like bamboo, wood, clay, etc. shall be maximised. No fan or blower should be incorporated in the system because of cost, complexity and non-avilability of power in the rural areas. As the dryer will be primarily used during the cloudy monsoon period, utilization of diffuse solar radiation shall be considered. Also adequate measures must be taken to prevent the entry of rain drops.

Taking the above points into account, direct type solar dryer of smaller size has been chosen. Two such dryers (Figs. 1 & 2) have been fabri-

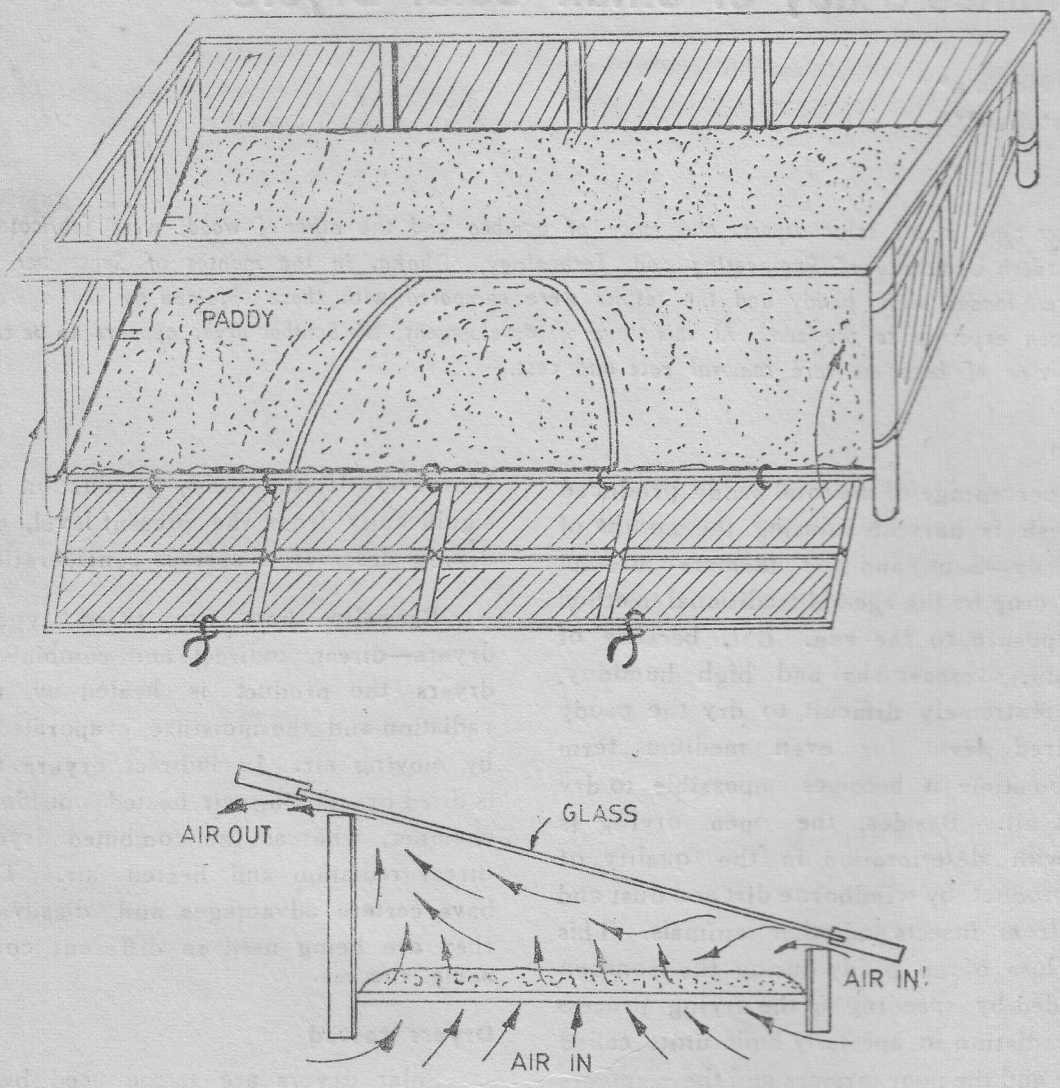
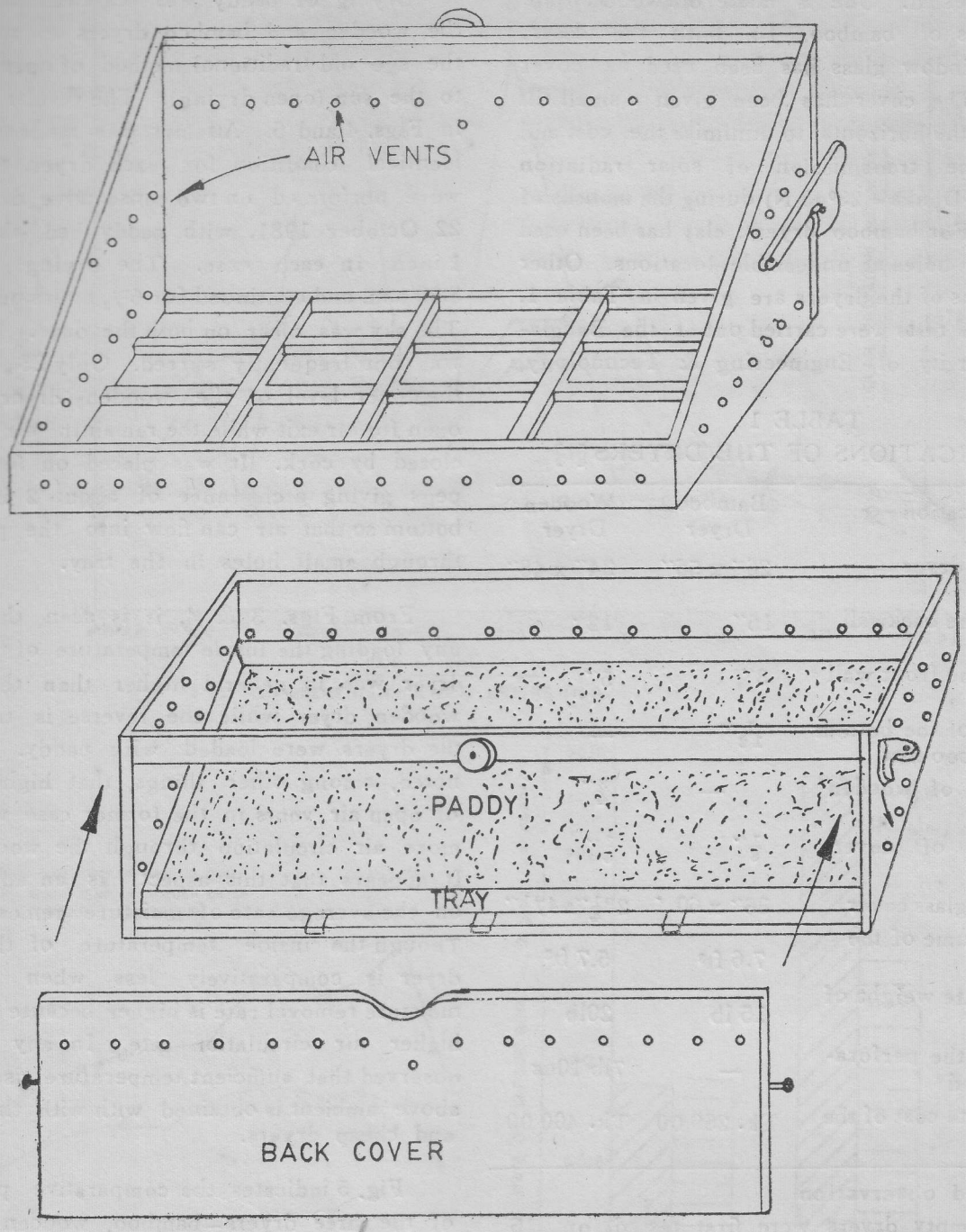


FIG. 1 BAMBOO SOLAR DRYER



FIG·2 WOODEN SOLAR DRYER

cated and tested. One is made of wood while the other is of bamboo. In both the cases, ordinary window glass has been used as cover material. The cover has been given a small tilt angle with the horizontal to minimise the cost and maximise the transmission of solar radiation (Latitude of Dhaka = 23°43 N) during the months of monsoon. For bamboo dryers, clay has been used to plug the holes at undesirble locations. Other specifications of the dryers are given in Table 1. Performance tests were carried out at the Bangladesh University of Engineering & Technology, Dhaka.

TABLE 1
SPECIFICATIONS OF THE DRYERS [1]

Specification	Bamboo Dryer	Wooden Dryer
Base of the dryer	26″ x 56″	24″ x 48″
Height of the backwall	15″	12″
Height of the front wall	3″	5″
Thickness of the bottom & side bamboo mat	$\frac{1}{12}$″	—
Thickness of wooden walls	—	$\frac{3}{4}$″
Thickness of cover glass	$\frac{1}{8}$″	$\frac{1}{8}$″
Size of the glass cover	36″ x 60″	$23\frac{1}{4}$″ x $47\frac{1}{2}$″
Inside volume of the dryer	7.6 ft³	5.7 ft³
Approximate weight of the dryer	15 lb	20lb
Weight of the perforated tray used	—	7lb 10oz
Approximate cost of the dryer	Tk: 250.00	Tk. 400.00

Results and observation

The empty dryers were first tested on 16 September 1981 and the results are given in Fig. 3. The temperature inside each dryer and the ambient temperature were recorded at different hour of the day. Total solar radiation on a horizontal surface at different hour was also measured. All the 52 air vents of the wooden dryer were kept open.

Drying of paddy was carried out in both the wooden and bamboo dryers as well as by the age old traditional method of open exposure to the sun (open drying). The results are given in Figs. 4 and 5. Attempt was made to maintain identical condition for each dryer. The tests were performed on two consecutive days, 21 and 22 October 1981, with paddy bed thickness of 1 inch in each ease. The drying started at 8:30 a.m. and continued for $6\frac{1}{2}$ hours on each day. The sky was clear on both the days. The paddy was not frequently stirred. Only 23 air vents at the upper level of the wooden dryer were kept open for air exit while the remaining air vents were closed by cork. It was placed on few wooden pegs giving a clearance of about 2 inch at the bottom so that air can flow into the paddy bed through small holes in the tray.

From Figs. 3 & 4, it is seen that without any loading the inside temperature of the bamboo dryer was in general higher than that for the wooden dryer while the reverse is true when the dryers were loaded with paddy. It may be noted, among other things, that higher number of open air vents in the former case was causing more air circulation through the wooden dryer. It appears that this aspect has an adverse effect on the average rate of moisture removal (Fig. 5). Though the inside temperature of the bamboo dryer is comparatively less when loaded, the moisture removal rate is higher because of probably higher air circulation rate. In any case, it is observed that sufficient temperature rise (15–20°C) above ambient is obtained with with these simple and cheap dryers.

Fig. 5 indicates the comparative performance of the three dryers—bamboo, wooden and open. For 1 inch thick bed, it is seen that the bamboo dryer is the best. In two consecutive days' operation of total 13 hours, 0.30, 0.21 and 0 17 lb of vapour per lb of paddy loaded on the first day, is removed by bamboo, wooden and open drying respectively. Moisture removal rate given in the figure has however been calculated on

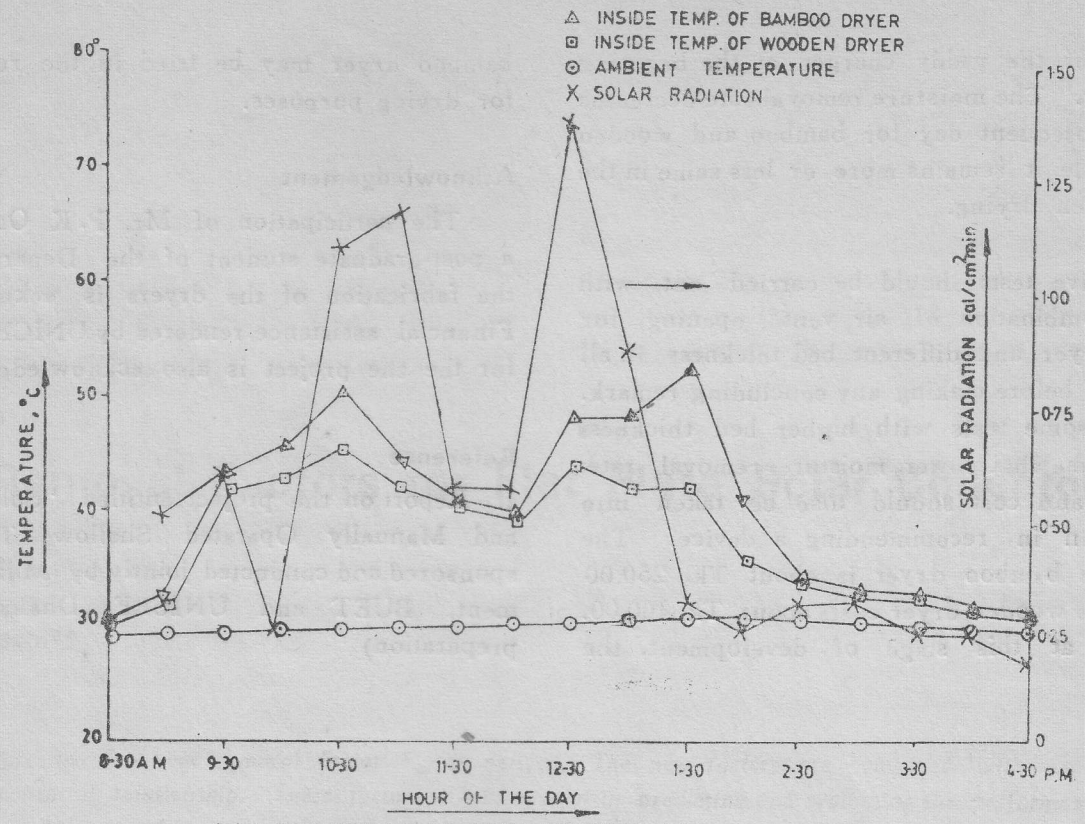


FIG.3 MEASUREMENTS ON EMPTY DRYERS (16-9-81)

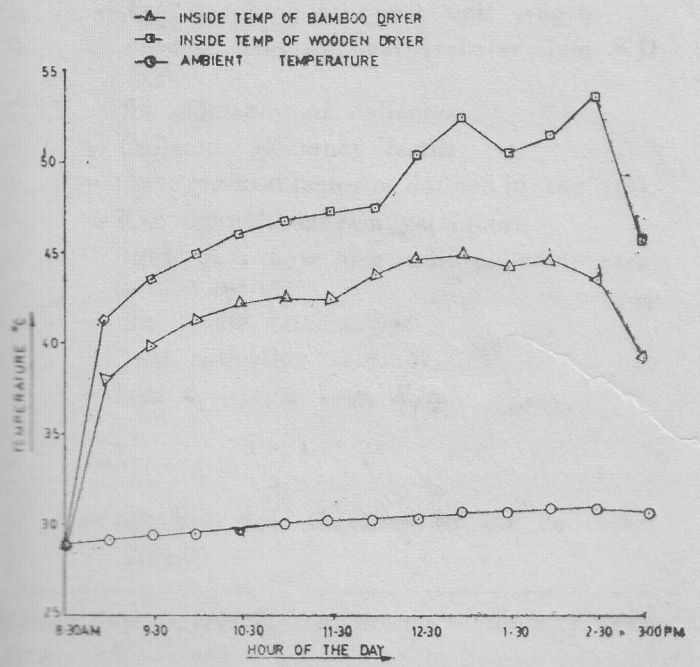


FIG 4 MEASUREMENTS ON DRYER LOADED WITH PADDY, 1 INCH THICK BED (21-10-81)

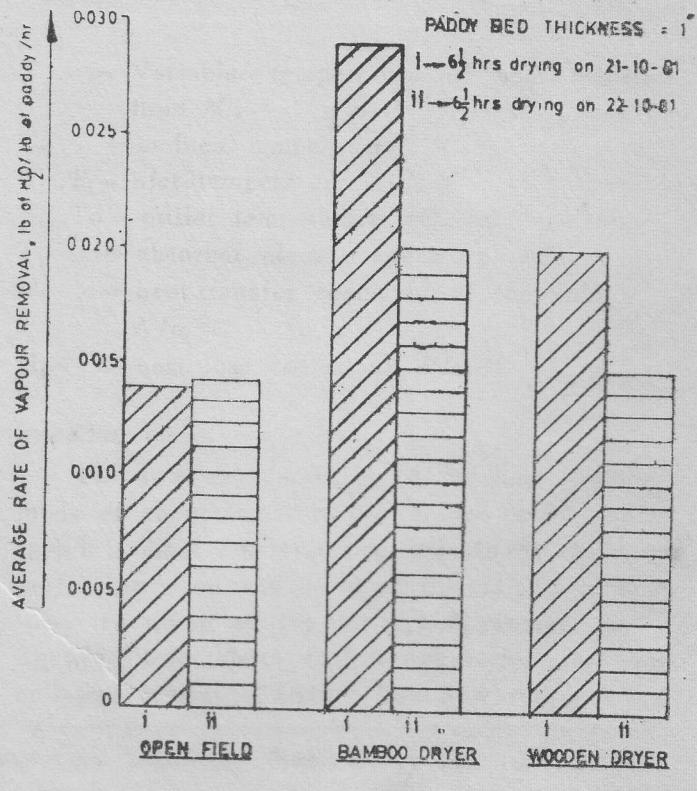


FIG.5 COMPARISON OF AVERAGE RATES OF VAPOUR REMOVAL FROM THE PADDY (21-10-81 and 22-10-81)

the basis of the paddy charged at the begining of each day. The moisture removal rate decreases on the subsequent day for bamboo and wooden dryers while it remains more or less same in the case of open drying.

Extensive tests should be carried out with various combination of air vent opening for wooden dryer and different bed thickness in all the devices before making any concluding remark. However, some tests with higher bed thickness indicate somewhat lower moisture removal rate. Simplicity and cost should also be taken into consideration in recommending a device. The cost of the bamboo dryer is about Tk. 250.00 whereas the wooden dryer costs about Tk. 400.00. Therefore, at this stage of development, the bamboo dryer may be tried in the rural areas for drying purposes.

Acknowledgement

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Reference

1. Report on the project entitled "Solar Drying and Manually Operated Shallow Tubewells" sponsored and conducted jointly by M.E. Department, BUET and UNICEF, Dhaka. (Under preparation)