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FIELD PERFORMANCE OF BAU-STR DRYER IN RURAL AREA OF BANGLADESH

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ABSTRACT

Paddy drying after harvest is important for reducing loss and storing long term. High moisture promotes the development of insects and molds that are harmful to the grain. It is necessary to adapt technology for drying paddy at small scale traders and farmers' level as an alternative to traditional sun drying. The low cost BAU-STR dryer would be one of the alternative effective drying technologies. Therefore, the objective of this study was to investigate technical and financial performance of BAU-STR dryer at the field level. The study of BAU-STR dryer was conducted during Boro Season, 2016 at selected areas of Mymensingh and Jessore districts. Air temperature inside grain bin was recorded using 3 ACR Smart Button data logger. Ambient air temperature was recorded using TRH-1000 sensor. Moisture content of the grain was measured at five locations in the BAU-STR dryer during drying operation. The dryer was evaluated with three verities: T_1-SL 8, T_2-Hybrid Taj, T_3-BRRI dhan28 which consider as three treatments. The dryer capacity was 500 kg per batch. The results showed that the temperature and moisture distributions in BAU-STR dryer were uniform. Paddy was dried from moisture content 22.8 to 12.2% uniformly in between 2.5 to 4.8 hours for 500 kg dryer capacity in different treatments. The drying time for larger grain (T_1-SL8) was less compared to other two varieties. The drying efficiency was about 52%, 65% and 52% for T_1, T_2, and T_3, respectively. The operating cost of drying was found Tk. 0.87 per kg (diesel engine operated blower) for BAU-STR dryer. The benefit-cost ratio and payback period were found 1.9 and 0.28 yr for diesel engine operated BAU-STR dryer from the experiments at field level of Bangladesh.

Keywords: *drying, BAU-STR dryer, field, paddy, Bangladesh*

INTRODUCTION

Paddy is the main staple crop of Bangladesh accounting for 76% of total cropped area and 95% of cereals production. Bangladesh is now producing about 51.9 million ton of paddy (FAO, 2015) to feed about 161 million of people (UN, 2015). Bangladesh ranks 4th in terms of rice production due to use high yield variety (HYV) and modern paddy production technology. Drying of agricultural products in Bangladesh is normally carried out by traditional sun drying method. It is a traditional practice where paddy is exposed to sun and wind in the yard or field. But there is no control on drying rate. The drying rate is very slow and it often results poor interior quality due to dependence of weather conditions. Climate change makes weather very unpredictable and unexpected rainfall can result in delayed drying, re-wetted grains and quality deterioration. Paddy has a high respiration rate and is susceptible to attacks by micro-organisms, insects and other pests at harvesting time. High moisture promotes the development of insects and molds that are harmful to the grain. High moisture in grain also lowers the germination rate of rice. Therefore, drying of rice is critical to prevent insect infestation and quality deterioration of rice grain and seed. Drying of paddy is a major problem in Bangladesh due to rain and gloomy weather in Boro (April – June) and short day and foggy weather in Aman (October – December) season. Improper or delayed drying leads to loss in grain quality, in addition to the estimated 14% loss from cutting through storage (Bala *et al.*, 2010).

To reduce post-harvest losses especially in drying operation and increasing quality of storage paddy, it is necessary to adapt drying technologies for paddy at small scale traders and farmers' level.

The low cost STR dryer were modified after testing at Boro 2015 season and the modified version was given the name BAU-STR dryer and tested again in Aman 2015 season. From the lab test and economic analysis, it was found that BAU-STR dryer was better than open field sun drying. Therefore, it is necessary to test this modified version at the field level to investigate technical performance and cross-check the economic parameters. The specific objectives of the research are to study spatial distribution of drying air temperature in BAU-STR dryer, and also to investigate the technical and financial performance of BAU-STR dryer at field level of Bangladesh.

RESEARCH METHOD

Experimental site and Materials

The field performance of modified BAU-STR dryer was conducted at three villages in each district of Jessore and Mymensingh during 23 April to 7 May 2016 in Boro season.

BAU-STR Dryer

The BAU-STR dryer consists of inner bin, outer bin, hot air pipe, blower and stove (chula). The diameter of outer bin is adjustable to hold desired volume of paddy sample. The dryer is made of two perforated concentric cylinders with grains inside the annular space. Air is passed from the inner cylinder through walls with bottom and top closed to dry the grains inside the annular space. An axial flow blower is used to suck the hot air from the stove (Chula) through steel pipe and force the air radially through perforated bins (Fig. 1a and b). In BAU-STR dryer, diesel generator was used for running the blower. Locally available rice husk briquette is used as fuel in a portable locally made stove.

Dryer installation procedure

The BAU-STR dryer was installed in paddy field at Jessore and farmers house-holds at Mymensingh. At first, a hard polythene sheet was set up in the paddy field. The inner bin was placed in a suitable position of polythene sheet.The outer grain bin was fixing up for 500 kg paddy and placed around the inner bin in such that the distances of outer bin remain same from inner bin in all sides. After half of the grain bin fill up, three temperature sensors (Model-ACR SmartButton) were placed to determine temperature distribution inside the dryer maintaining 29, 38 and 47 cm distance from the center line of inner bin namely $T_{m,1,}$ $T_{m,2}$ and$T_{m,3,}$ respectively (Fig. 1c). Then the rest of volume of grain bin was filled by paddy. The axial flow blower was set up on the top of the inner bin of the dryer and a polythene cover was used to protect hot air leaking from

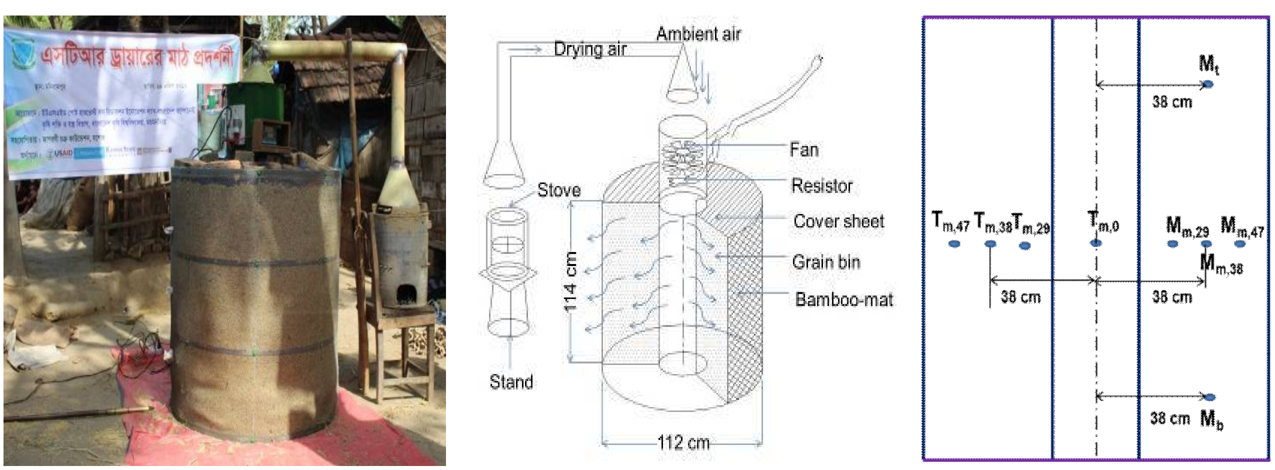


Fig. 1. (a) Photographic view, (b) Schematic view and (c) Temperature & Moisture sensor set up locations of the dryer (T=Temperature, M=Moisture, m=middle, t=top, Number in the subscript indicate distance from the center in cm)

the paddy of the dryer using bricks. A stove (chula) was placed in one side of the grain bin and firing was done using rice husk briquette. Then the hot air supply pipe was fixed with the help of bamboo stand which was tied by GI wire whereas suction face of hot air pipe attached with stove and other face attached with blower.

There were three treatments (T_1=SL 8, T_2=Hybrid Taj and T_3=BRRI dhan28) with three replications for drying experiments. The treatments were taken as bold and medium grain to evaluate grain size effect of dried paddy. The ambient air temperature (T_{air}) and relative humidity were recorded by using a data logger (Model-TRH 1000, temperature accuracy: ±0.6°C @ 25°C, ±2°C from -40°C to 70°C and ±4% RH between 20 to 80% RH).

Moisture content was measured at the five locations of grain bin. Among the five locations, three horizontal locations were named $M_{m,29}$, $M_{m,38}$ and $M_{m,47}$ maintaining 29, 38 and 47 cm distance from the center line of inner bin during drying operation and other two locations were named $M_{t,38}$ and $M_{b,38}$ which were 13 cm distance from the top and bottom layer of grain bin.The moisture content of paddy was measured using a digital moisture meter (Model-RiceterL, accuracy: ± 0.2% 105°C, measurement range 11-30% for paddy rice). Moisture content of paddy was measured in every half an hour interval. Drying rate, drying capacity and efficiency of the dryer were calculated. Financial parameters like dryer operating cost, pay-back period and internal rate of return were calculated using standard formula.

RESULTS AND DISCUSSION

Spatial distribution of temperature and moisture content

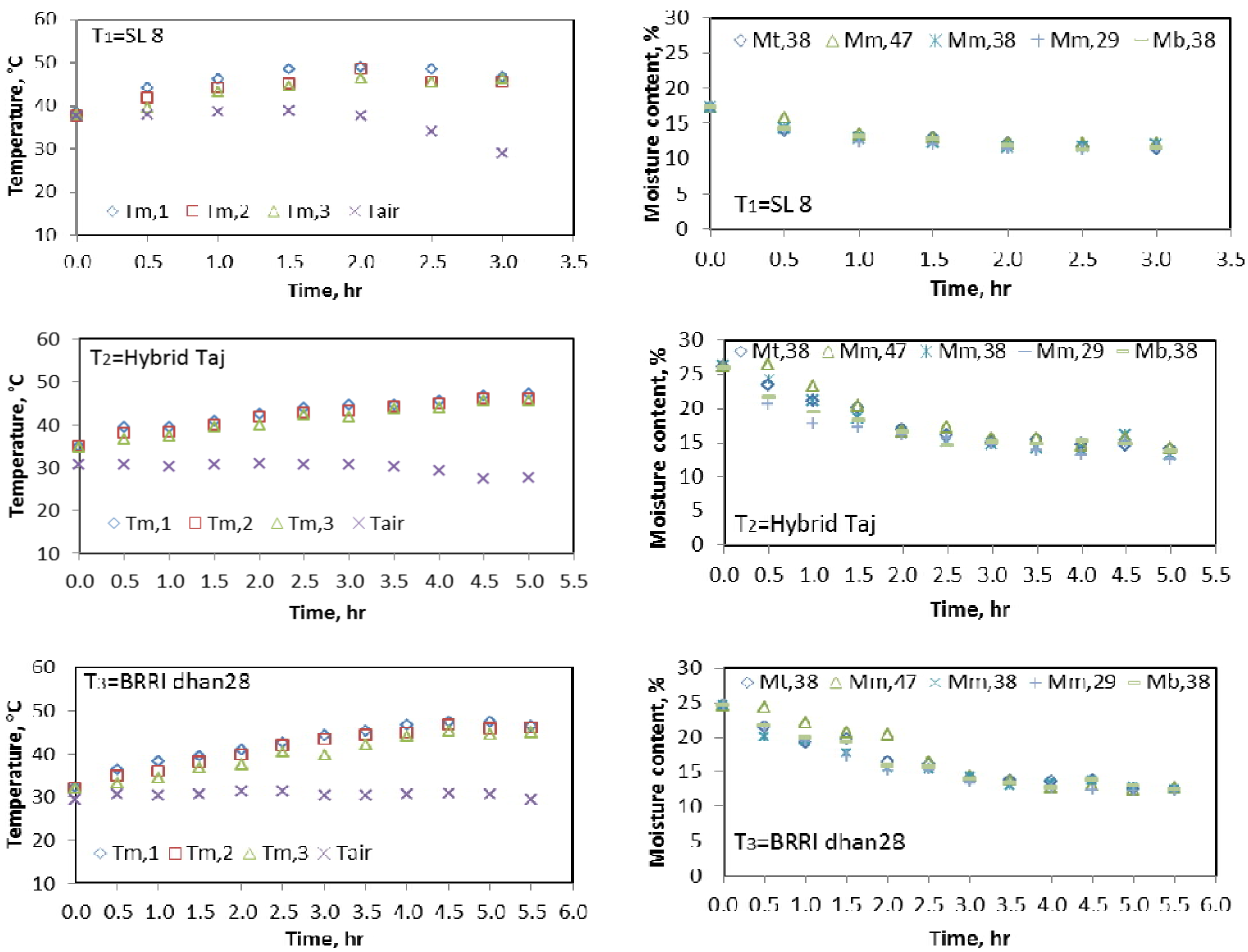
The field evaluation of BAU-STR dryer was conducted in terms of drying capacity and efficiency to adopt in farmers and small traders' level for proper drying and safe storage of paddy in Bangladesh.The temperature profile proved that the drying air uniformly distributed inside the dryer (Fig. 2a). The figure shows that temperature was around 38 ^{o}C in first treatment and about 30^{o}C in second and third treatment at the starting time of the dryer in all locations in all cases and then increased above 40^{o}C in every location after 1.5 hour. The temperature sensors were set at the different distance from the center line of the inner bin from where hot air was entering into grain pile. Temperature was varied initially among the horizontal locations because distances from the center of the inner bin were different. Temperature at $T_{m,3}$ location was much lower than temperature at $T_{m,1}$ after half an hour of starting drying operation (Fig.2a).

After certain time, temperature distribution of all horizontal sensors location became almost same. The drying temperature increased rapidly within two hours and then increasing rate was nearly steady or slowed down till the completion of drying. It proves that hot air temperature uniformly distributed to all over the drying section of the dryer. Similar results have been reported for paddy seed drying in hybrid dryer (Hossain *et al.* 2012). However, variations of the temperature over the time depend on the efficiency of steady fuel supply for producing same hot air temperature which needs to be taken care of. The drying time varied with the variation of grain size. In first treatment, the drying time is lower than that of other treatments because of bold grain size. The spore space is much higher in bold grain compared to other medium grains. Drying air can easily pass through the big spore space from inner part to outer part of grain bin which directly affect temperature distribution and drying time.

The initial moisture content of sample and drying air temperature directly affect the drying time. The typical drying curves for three treatments (T_1=SL 8, T_2=Hybrid Taj and T_3=BRRI dhan28) at middle layer of dryer are shown in Fig. 2b. The general trend, moisture level of grain was decreased with the drying time. The initial moisture content was lower in treatment T_1 than the other two treatments. As a result, the drying time reduced to 2.5 hrs in first treatment. The drying time was significantly lower in T_1 than that of other treatments. The grain was dried uniformly and reached same and desired moisture level (about 12%) in all part of the dryer in 2.5 to 4.8 hours depending on the initial moisture content of paddy and drying air temperature.

Performance of dryer

The field performance of modified BAU-STR dryer was satisfactory in terms of drying capacity, drying efficiency and milling recovery of dried paddy. The paddy was dried from 17.8% to 11.4%, 26% to 13.1% and 24.6% to 12.2% in three treatments within the range of 2.5 to 4.8 hrs, respectively (Table 1). The



(a) (b)

Fig. 2: Temperature distribution and change of moisture content at different distance at middle layer from the center of the dryer during Boro 2016 season for three treatments (a) Temperature distribution and (b) Moisture variation

Table 1: Field performance of BAU-STR dryer in the Boro, 2016 season

Treatment	Hot air temp., °C mean±std	Relative humidity, % mean±std	Initial moisture content, (%)	Final moisture Content, (%)	Drying time, (hr)	Drying rate, (% moisture content/hr)	Drying efficiency, (%)
T_1 (SL 8)	44.3±3.5	65.8±18.3	17.8	11.4	2.5	2.6	51.5
T_2(Hybrid Taj)	42.5±3.0	61.1±16.3	26.0	13.1	4.7	2.7	64.8
T_3(BRRI dhan28)	41.8±4.2	68.4±10.4	24.6	12.2	4.8	2.6	51.9

results showed that freshly harvested paddy drying took 2.5 to 4.8 hours for a moisture content reduction from 22.8 to 12.2%. The drying time depends on initial moisture content, drying air temperature and relative humidity. The drying air temperature (44.3°C) was high and initial moisture content (17.8%) was low in first treatment compared to other treatments. Therefore, the drying time reduce to 2.5 hrs in first treatment. The drying efficiency was 51.5, 64.8 and 51.9 for three treatments. The drying efficiency of treatment T_2 is much higher compared to other treatments because of higher energy use efficiency.

Economic analysis

The purchase price of BAU-STR dryer (diesel generator operated) was Tk. 60000 with economic service life 10 years. Economic analysis for BAU-STR dryer in field level showed that the operating cost of paddy dryer was found Tk. 0.87 per kg whereas in traditional sun drying methods the operating cost was 1.0 Tk. per kg. The benefit cost ratio (BCR) was 1.9. The payback period of the dryer was 0.28 year. Payback period of BAU-STR dryer was less than one year which was very encouraging for farmers in rural area of Bangladesh. It is evident from the economic analysis that BAU-STR dryer is economically viable in terms of technical and financial analysis and suitable for Bangladesh conditions. It would be more economical, if the dryer could be used for other crops such as maize and paddy seeds.

CONCLUSION

Temperature distribution and moisture removal rate of BAU-STR dryer were uniform throughout the dryer. Half ton (500 kg) paddy could be dried in 2.5 to 4.8 hours depending on initial moisture content. Drying cost was 0.87 kg with pay-back period of less than a year. Therefore, it can be an effective means of drying paddy in the farmers and traders'level of Bangladesh. During field experiment, it was found that the farmers and small traders are very interested to use BAU-STR dryer in rainy season and cloudy weather because BAU-STR dryer can be used for drying paddy in their limited space in every households.

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