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# Assessing the Effect of an Exhaust Fan on the Performance of a Rice Husk Fuelled, Flat Bed Paddy Dryer

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***Abstract:***
*Considering the increasing cost of fossil fuels and its effect on the environment, most countries are turning to using renewable energy sources like Wind, Solar and Biomass. Kenya has abundant sources of Biomass energy in the form of agricultural and forest wastes (Agricultural wastes include, coconut husk, maize cobs, cotton stalks, sawdust, rice husks, etc).These abundant wastes can be utilized with appropriate combustion technologies for drying the grains in order to reduce post harvest losses..*
*A flat bed paddy dryer using rice husks as fuel with the capacity to dry 100 to 250kg paddy was fabricated and its performance assessed at the Kenya Industrial Research and Development Institute (KIRDI).The tests were performed with and without an exhaust fan and paddy being dried at three different depths that is 0.1m ,0.2m and 0.3m. Paddy at a moisture content (MC) of between 25-26% dried to moisture content of between 10% to14%.*
*The results showed that with paddy at 0.1 m it is possible to achieve safe storage Final Moisture Content of below 14% moisture content dried paddy at the top and bottom of the flatbed dryer. But at 0.2m depth of paddy and above the safe storage a uniform Final Moisture Content (FMC) was achieved with the use of an Exhaust Fan*

***Keywords:*** *Biomass, Moisture content, Paddy Dryer, Rice husks.*

## 1. Introduction

There is an essential need to dry grain quickly and effectively after harvest and before storage to retain maximum quality, to attain a moisture content sufficiently low to minimize infestation by insects and microorganisms (bacteria, fungi), and to prevent germination. Natural methods of drying make use of exposure of the wet grain to the sun and wind. Artificial dryers however employ the application of heat from combustion of fossil fuels and biomass resources, directly or indirectly.
Considering that drying process consumes a lot of energy there is need to explore ways of developing and adopting dryers which utilize the abundant agricultural wastes as fuel for drying in Africa. According to the World Bank report (2011) on the Missing food in Sub Saharan Africa (SSA), it is noted that the search for cost-effective drying technologies needs to be a critical element of current and future applied research efforts.
In Kenya rice is currently the third most important cereal crop after maize and wheat. It is grown mainly by small-scale farmers as a commercial and food crop in Mwea, Ahero, West Kano, Bunyala, and Tana delta. About 80% of the rice grown in Kenya is from irrigation schemes established by Government while the remaining 20% is produced under rain-fed conditions, Ministry of Agriculture (2009). Mostly after harvest, the rice is dried under the Sun and then threshed; the rice husks generated is mostly burnt in the fields or dumped by the roadside. Waswa et al (2002) noted that out of the 9,000 to 16,000 Metric Tonnes (MT) of total rice produced in Kenya, about 20% is waste. .
When drying is delayed in the wet season, the value of the grain can fall by between 5- 58% unless it is sold wet to wholesalers with mechanical drying facilities at a discounted price. There are different methods used to dry grain for purpose of reducing the moisture content and extend the shelf life these methods include sun drying in the open, use of solar dryers and mechanical dryers. The safe storage moisture content for paddy is below 13% according to, IRRI (2004)

The main problems with these methods is that open sun drying often leads to contamination and when raining drying can't be achieved well thus leading to high post-harvest losses and solar dryers cannot achieve effective drying when no sunshine. On the other hand mechanical dryers though effective, are expensive due to the high cost of fossil fuels and often emit high percentage of greenhouse gas (GHG). According to Proctor,[4] oil and gas are the conventional fuels employed in heated-air dryers, particularly so for drying operations such as the batch-in-bin dryer. Wherever possible, it is traditional to harvest most grain crops during a dry season and employ simple drying methods e.g. sun drying. However, maturity of the crop does not always coincide with a suitably dry period. Furthermore, the introduction of high-yielding varieties, irrigation, and improved farming practices has led to the need for alternative drying practices to cope with the increased production, and grain harvested during the wet season as a result of multi-cropping.
The use of alternative and renewable energy sources is to become increasingly common as new combustion technologies are developed and conventional fuel cost increase. Some of the most common crop wastes suitable for bio-energy development include sugarcane bagasse, sisal waste, coffee husks, rice husks, maize cobs, and banana leaves. According to Phan (2010) one type of dryer which has been in use for rice drying in the Asia and more specifically Philipines, is the flatbed dryer which utilizes the cheaply available rice husks and also is simple to operate. Though this dryer is effective, it has the problem of non-uniform Final Moisture Content (FMC) on the dried product. It is against this background that the assessment of the dryer utilizing rice husks was done to see on how achieve a uniform moisture content faster and hence reduce on the energy consumption due to extended drying times.

## 2. Materials and Methods

A flat bed dryer was fabricated with a combustor adopted from a model by Phan (2010). The dryer was utilizing rice husks as fuel as in Figure 1 below. In which the flue gases from the combustion of husks was used for drying the paddy
The dryer capacity was 100-250kg of paddy,
Freshly harvested paddy was gotten from Mwea Irrigation Scheme at a moisture content range of between 24-26%
The paddy was dried by the drier at various depth heights that is 0.1m, 0.2m and 0.3m.The Moisture content of the paddy was measured from the top and bottom for five hours. This was done for both with and without an Exhaust fan
The temperature of the of the inlet air to the dryer and the exhaust was monitored by the use of thermocouples.
The relative humidity of the ambient air and the Exhaust air was monitored by the use of an Hygrometer after every 30 minutes.
The moisture content of the Paddy was established by the oven method of Moisture determination

*Figure 1: combustor for rice husk fuel*

## 3. Results and Discussion

| Time | Start 9.30 Am | 10.am | 10.30 am | 11. am | 11.30 am | 12.00 Noon | 12.30 pm | 1.00 pm | 1.30 pm |
|---|---|---|---|---|---|---|---|---|---|
| Moisture Content-%Top | 26.5 | 23.5 | 21.5 | 19 | 16.5 | 15 | 14.5 | 14 | 13 |
| Moisture bottom | 26.5 | 23 | 21 | 18 | 15 | 14 | 13.5 | 13 | 12 |

*Table 1: Result for drying at .1m depth without Fan*

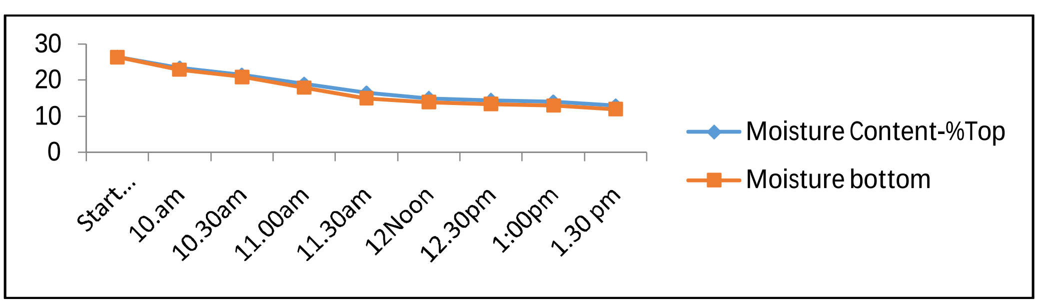


*Figure 2: Drying curve at 0.1 m without Fan*

| Time | Start9.30 am | 10.am | 10.30 am | 11. am | 11.30 am | 12.00 Noon | 12.30 pm | 1.00 pm | 1.30 pm |
|---|---|---|---|---|---|---|---|---|---|
| Moisture Content-Top | 26 | 23 | 19.5 | 17 | 16 | 15 | 14.5 | 14 | 13.5 |
| Moisture bottom | 26 | 26 | 22.5 | 18.5 | 16 | 15.5 | 14 | 13 | 12.5 |

*Table 2: Results for Drying at 0.1m depth-With Exhaust Fan*

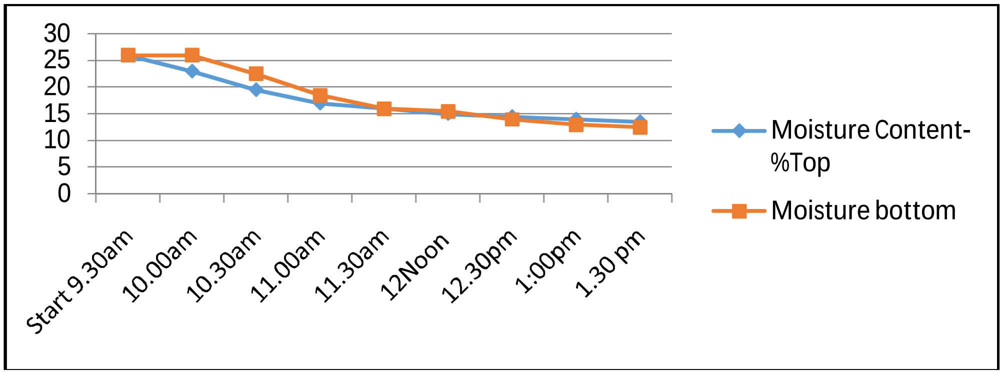


*Figure 3: Drying Curve at 0.1m with Exhaust fan*

From the drying results at 0.1m with an exhaust fan, the Final Moisture Content at the top and bottom of the flatbed dryer was 13 and 12 respectively. Also for the Drying without an Exhaust Fan it was 13.5 and 12.5% respectively. This shows at this depth it is possible to get a safe storage FMC for the Paddy with or without an exhaust fan

| Time | Start9.30 am | 10.am | 10.30 am | 11. am | 11.30 am | 12.00 Noon | 12.30 pm | 1.00 pm | 1.30 pm |
|---|---|---|---|---|---|---|---|---|---|
| Moisture Content-%Top | 25 | 23 | 20 | 18 | 17 | 16 | 15 | 14 | 13.5 |
| Moisture bottom | 26.5 | 23 | 20 | 17.5 | 16.5 | 16 | 14.5 | 13 | 12.5 |

*Table 3: Results for Drying at 0.2m depth-With Exhaust Fan*

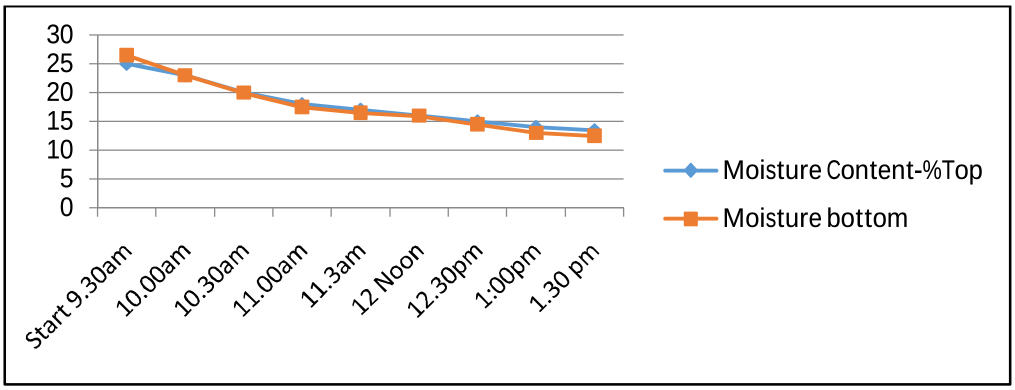


*Figure 4: Drying curve at 0.2 depth with exhaust fan*

| Weight of Paddy | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Time | Start9.30 am | 10.am | 10.30 am | 11. am | 11.30 am | 12.00 Noon | 12.30 pm | 1.00 pm | 1.30 pm |
| Moisture Content-Top | 26 | 25 | 24 | 22 | 21 | 20 | 19.5 | 19 | 18.7 |
| Moisture bottom | 26 | 22.6 | 19.9 | 17.4 | 16 | 15 | 14.5 | 13.8 | 13 |

*Table 4: Results for Drying at 0.2m depth-With 0ut Exhaust Fan*

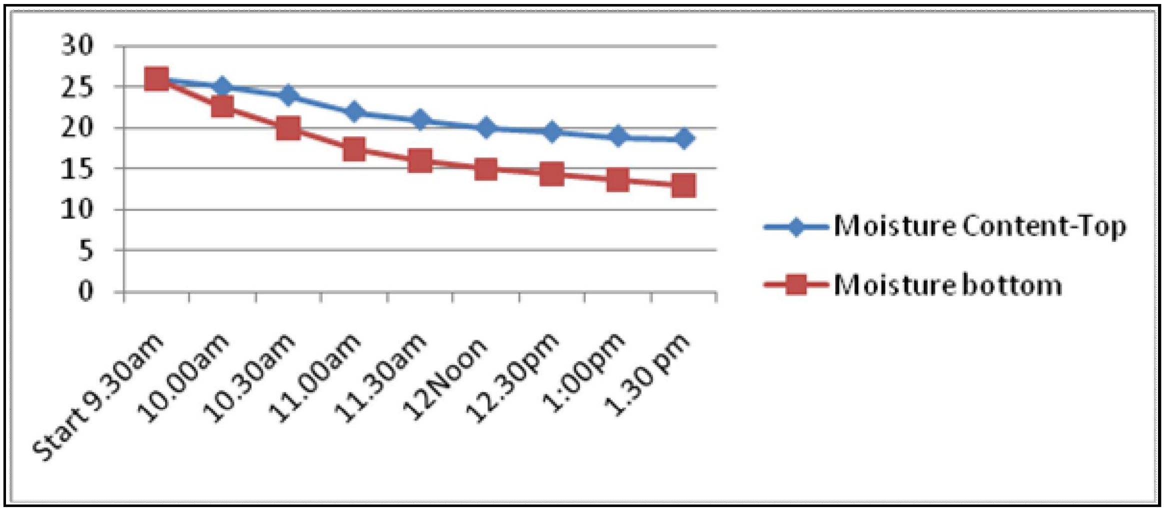


*Figure 5: Drying curve at 0.2m without fan*

| Time | Start9.30 am | 10.am | 10.30 am | 11. am | 11.30 am | 12.00 Noon | 12.30 pm | 1.00 pm | 1.30 pm |
|---|---|---|---|---|---|---|---|---|---|
| Moisture Content-Top | 25.6 | 24 | 21 | 19 | 18 | 17 | 16 | 15.5 | 13.5 |
| Moisture bottom | 26.6 | 23.5 | 20 | 18.5 | 17 | 16.8 | 16 | 15 | 13 |

*Table 5: Results for Drying at 0.3m depth-With an Exhaust Fan*

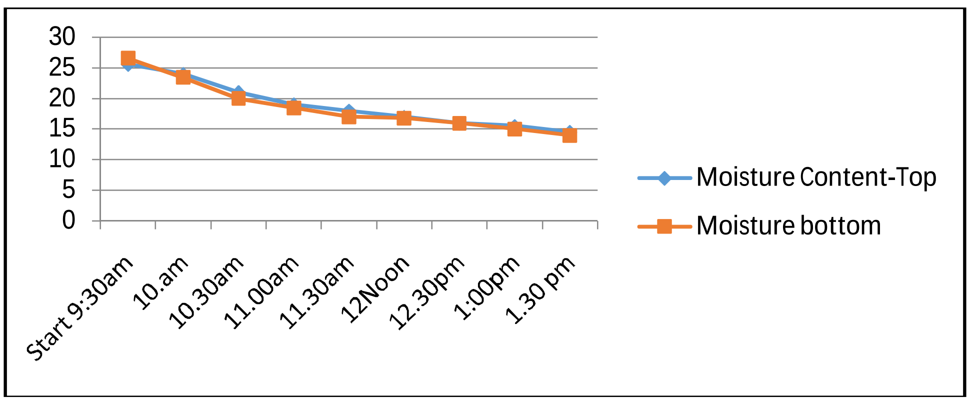


*Figure 6: Drying Curve at 0.3 m with Fan*

| Time | Start9.30 am | 10.am | 10.30 am | 11. am | 11.30 am | 12.00 Noon | 12.30 pm | 1.00 pm | 1.30 pm |
|---|---|---|---|---|---|---|---|---|---|
| Moisture Content-Top | 26 | 25.5 | 24 | 23 | 22 | 21 | 20 | 18.5 | 18 |
| Moisture bottom | 26 | 22 | 19 | 16.5 | 15 | 14 | 13.5 | 13 | 12 |

*Table 6: Results for Drying at 0.3m depth-Without Exhaust Fan*

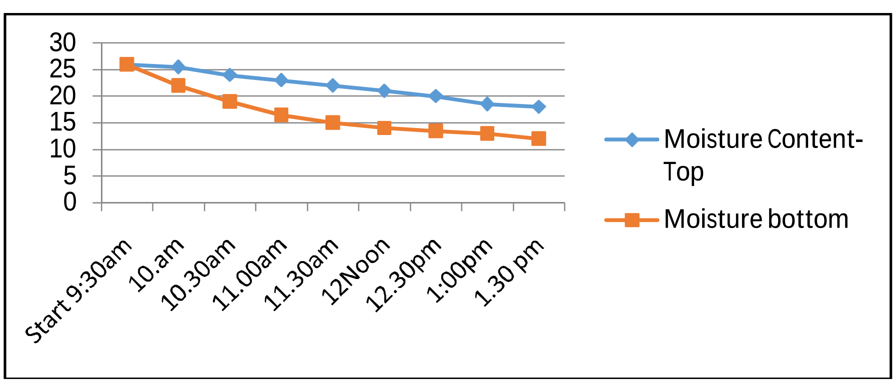


*Figure 7: Drying curve at 0.3 depth without Exhaust fan*

From the results Table 3 and 5 that is when drying the Paddy at .0.2 and 0.3m depths with an exhaust fan it showed that it is possible to attain a Final Moisture Content (FMC) of below 14% at the top and bottom of the drying bed which is the safe storage MC for Paddy But when drying at more than 0.2m depth without an exhaust fan the FMC at the top of the bed was above 18% which is not safe for storing paddy as suggested by IRRI (2004).
The reason for the differential in MC can be explained by the fact that with an exhaust fan air flow at the top of the bed is enhanced and hence removing the moisture which could have deposited at the top which results to non uniform FMC.

**4. Conclusion**

There is great potential for the utilization of biomass wastes like ricehusks as fuel for paddy drying.
Thus in order to achieve this appropriate combustion technologies must be developed in order to achieve quality dried products
From the results it shows that drying of paddy in a flatbed dryer at a depth of more the 0.2 metres and above without an Exhaust Fan results in non uniform Final Moisture Content at the and bottom of the bed.

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