

# Semi-Automated Puffed Rice Machine Using Agricultural Waste Burnt Low Smoke Stove

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**Abstract:** -- Production of puffed rice is still more popular in rural areas at different parts of our country. Till date no mechanized industries developed yet for the production of puffed rice in large scale. Traditionally thousands of people are actively involved to fulfil the production demand. The currently practiced production method is proven inefficient, due to enormous stress experienced by human during production, seeks minimum three human operators who were subjected to work in hazardous environment (i.e. high heat and radiation, work with lot of smoke and dust) during the production process. This results in serious threat to human health and production cost. Thereby, attempts are made to design and fabricate a low cost semi-automated puffed rice machine. The agriculture waste (i.e. dried rice husk, arecanut shells and leaves) is used as energy source for the production of puffed rice. The new semi-automated portable puffed rice machine is capable to operate with single user, low smoke and cost.

**Keywords—** Puffed rice machine, Agriculture waste, and low smoke stove

## INTRODUCTION

The puffed rice and its use as a source of food in our daily lives is well known to all. Puffed rice production is generally carried out in rural areas, by subjecting the paddy to high temperature short time (HTST) treatment [1]. This HTST treatment is conducted generally with the help of heated sand or hot supplied air. The sand grade, and sand-to-paddy ratio do not alter significantly the puffing ability of the rice [1]. The efficiency and production of quality puffed rice is rely mainly on design and fabrication of stove. There are wide variety of possible combinations of stove type (i.e. single or multipot), stove material (sand-clay, concrete, metal and so on) and fabrication method (owner, artisan, factory) [2]. The artisan or factory manufactured stoves cost more, which is not affordable to poor labour who work for daily wages. The sand-clay and concrete built stoves weigh more and cannot be cannot support portability. Further, stoves made up of sand-clay and concrete can sustain high temperature, but life span will be less as they face problem with getting crack in the designed stoves. Sand-clay and concrete stoves are more sensitive to atmosphere. The moisture absorbed by the stove will produce large amount of smoke, which causes serious threat to human health. Traditionally, thousands of people are actively involved to fulfil the large-scale production demand. However, currently practiced method is proven inefficient, due to enormous stress experienced by human during production, require minimum three human labour, labours are subjected to work in hazardous environment (i.e. high heat and radiation, work with lot of smoke and dust) during the production process. Further, traditional production methods cause serious threat to human health is explained as

follows: 1) human labour exposed to continuous heat and radiation cause bone marrow shrinks due to the red blood cells get deoxygenated, 2) Gas mask cannot negate the generated smoke which leads to acquire lung problems, asmonia (a temporary loss of perceiving smell) and presbyosmia (gradual aging-related loss of the sense of smell). Therefore, to limit the said disadvantages much attention required to design and fabricate the portable low-cost stove keeping in view of human health.

Constructing the light weight stove in view of portability for mass production of puffed rice is of practical relevance. Light weight stoves offer logistic advantage for a person who can carry both raw materials and finished (processed) product to home at low cost. Lightweight stoves built with materials (such as, aluminium, steel and so on) can save energy in comparison with clay pots, as they readily conduct heat to fire due to better thermal properties. The significant advantage of lightweight materials must be compensated with the heat loss, when the stove walls are subjected to cold ambient air. Till date no mechanized industries developed yet for the production of puffed rice in large scale. Survey has also been conducted at different places (i.e. Shivamogga, Chitra durga, Belagavi and so on) to know the problems faced during production of puffed rice. The most common problems are identified as follows, working at hazardous environment, stove is heavy and cannot be portable, requires three worker, skilled operator for obtaining quality puffed rice, serious health problems, energy wastage and low productivity. An attempt made in the present work to design and fabricate the semi-automated puffed rice portable machine couple with low or no smoke stove.

***Risk factors of Conventional Puffed Rice Machine***

Traditional practiced method for production of puffed rice are still more popular as they use low cost furnace made up of clay or brick for production of puffed rice. Traditional brick or clay stove widely employed method across India to prepare puffed rice, however this method seen to have many disadvantages, inefficient, not very practical, and large amount of stress for the users. Further, requires three skilled labour and seeks to work in hazardous environment due to intense heat liberated from the burnt fuel during the production of puffed rice. Majority of the fuel currently employed as good fuel wherein they use plastics and vehicle tyres. This liberate huge smoke and cause serious threat to lungs and their body. Chronic exposure to heat can often results in poor health with regard to heart, kidney and liver damage. Chronic exposure to heat could results in heat exhaustion, sleep disturbances and susceptibility to minor injuries and sickness have all been attributed to the possible effects due to prolonged expose to heat [3]. Further, many illnesses are caused due to the prolonged heat exposure are rashes, syncope, cramps and strokes. Moreover, slippery hands due to perspiration could limit the employees to have good control over the loads, which might cause manual handling injuries. Moreover, the perspiration could result with the rice to get contaminated and reduces the puffed quality.

The human labour exposed to high intense heat could always results in high risk for workers safety, health and is not practicable [4]. This also causes the red blood cells to get deoxygenated quickly, bone marrow shrinks and gradual loss of smell perception. The generated smoke due to burnt tyres and plastic, in the moisture contained clay stoves causes air pollution which results in global warming. The polluted air in the atmosphere may contain chemicals, particulates or biological materials that discomforts, or deaths to humans, damage other living organisms namely the food crops, which damage the natural environment. According to world health organization (WHO), air pollution causes a significant risk factor for multiple health conditions including respiratory infections, heart disease, and lung cancer. The air pollution further causes difficulty in breathing, coughing and worsening the respiratory and cardiac conditions. These effects could results in increase medication, emergency, doctors and hospitals and which leads to premature death [5].

***Construction and working principle of stove***

To prevent human efforts working at hazardous environment, reduce human labour, and cost the present work is focussed

to design the ideal system for the production of puffed rice. Specifically, while designing the stove the practical problems collected during the survey is all incorporated. The most interesting feature incorporated while designing the stove is portability and ability to use dry agricultural waste (rice husk, arecanut shells, leaves and so on) as a fuel. Portability help to reduce the logistic cost and the stove is ergonomically designed which favour the operator to sit and work with less effort and not exposed to hazardous environment. Ergonomically designed portable stove help to operate multiple task parallelly, which reduce the requirement of minimum three labour.

The ergonomically designed stove consists of major two parts. The upper part comprises of a drum and bottom part is the stove. In the bottom part the fuel is burnt to supply heat to the drum placed above it. In the stove, the hard (i.e. steel) mesh is provided to support the weight of the solid fuel. Below the mesh, there are two pipes running parallel to the length of the stove which are installed to provide high velocity air to help the fuel burn as much as possible. The pipes are connected to an electric blower which supplies the air at the necessary speed which can be adjusted using a knob. Beneath the mesh a tray is provided to collect the ash formed while burning the fuel. The slot has been provided at one end of the stove to attach and detach the tray and pipes depending on requirements.

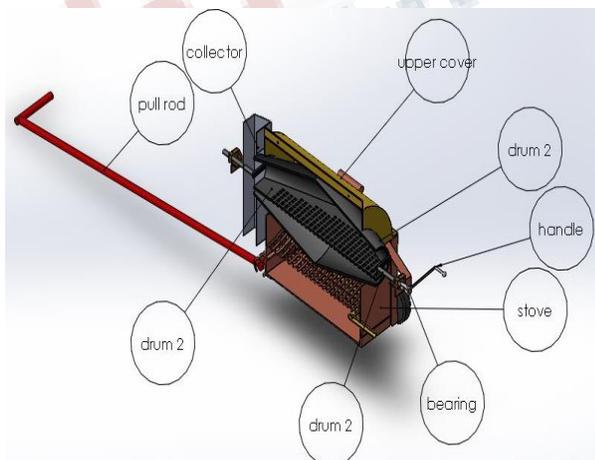
Slot has also been provided towards the longer side of the stove to supply the necessary solid fuel. The plate which is welded to the bottom of the slot at an angle to support the excess fuel which may have been fed. The slot can be closed with the fixed plate to the stove supported by hinges to stop the ash formed being blown out of the stove. An insulation (i.e. heat resistant asbestos cloth) material is bind to the stove that could reduce the radiant heat loss dissipate to the surrounding and also to create healthy environment for operator. For building portable machine, the stove is provided with two wheels for ease of transportation. To attain light weight characteristics in the stove the main body is designed to fabricate with 2 mm steel plates.

Drum is the major part wherein the production of puffed rice is carried out, which is located on the upper portion of the machine. The drum has two steel plates which are attached to the either ends along the diameter. The plates have a solid shaft like extrusion welded perpendicularly to it. The shaft is supported by two bearings, wherein it occupies on the top edges of the stove. The shaft with a longer extrusion is fitted with a handle, so as rotate the drum to any desired angle. To

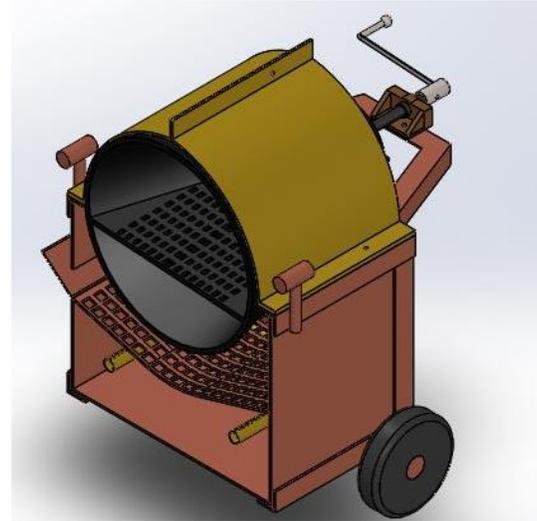
attain uniform heat transfer, the sand is spread across the bottom surface of the drum from inside. The drum is also supported with fine mesh to separate both the rice and sand. The rice is first spread across the mesh as evenly as possible. The handle provided help to rotate the drum to 180°, wherein the rice and the sand get mixed together. The heated sand transfer heat to the rice through conduction to obtain the puffed rice. After ensuring all the rice gets puffed up, the drum is tilted back forth to original position with the help of the handle. The tilting help to separate the bigger size puffed rice from the fine sand while passing through the provided mesh. After ensuring the separation of both puffed rice and sand, the rice is blown out through the space provided from one side that made to collect on the other end of the drum. To achieve this separate collector has been attached at the bottom of the drum.

The major parts and their functions of the designed and fabricated low smoke stove (refer Fig. 1) is described as follows:

1. **Drum:** The drum is considered as the major part wherein the actual production of puffed rice is done.
2. **Handle:** The handle is used to rotate the drum supported by the bearing axis.
3. **Stove:** The stove is designed to burn the solid fuel.
4. **Bearing:** The purpose of bearing is to support and rotate the drum on a certain axis.
5. **Collector:** The collector is used to collect the puffed rice blown from the other end of the drum.
6. **Upper Cover:** The upper cover is used to reduce the radiant heat loss dissipate to surroundings.
7. **Pull Rod:** Pull rod serve the purpose of portability for the stove.



**Fig. 1 Sectional view of Puffed Rice Machine**



**Fig. 2 The semi-automated puffed rice machine.**

The designed and fabricated puffed rice machine work with zero risks (i.e. low smoke, not exposed to heat and radiation, reduce human labour, no health problems). The drum can carry huge amount of sand of approximately 20 kgs, wherein the 3kgs of sand is sufficient to prepare the puffed rice of maximum capacity of 5 kgs. The portability of the designed stove could help to carry anywhere, which reduce the logistic cost of transportation of the stove and raw materials. Although the initial capital investment is comparatively higher compared to conventional clay stove, but that can be compensated with the high quality puffed rice, mass production at low labour cost, free from working at hazardous environment, better health, waste management and environmental protection. Further, the ergonomically designed stove reduces the effective man power required to operate the stove. The conventional clay stove exposed to atmospheric condition during rainy season absorbs the moisture, which requires more time to ignite and results in emission of large amount of smoke that causes poor puffed quality. The prolonged working of conventional stove undergoes formation of crack due to fatigue which reduces the life span of the conventional stove. However, the present stove fabricated with metallic material do not absorb moisture which prevent the above said problem. This could enhance the life span and the performance of the stove.

### CONCLUSION:

The semi-automated puffed rice machine is designed and fabricated to limit the disadvantages of currently used conventional clay stove. The puffed rice machine is designed

ergonomically to operate by a single user who can easily do multiple task simultaneously. The interesting feature of the stove is designed with portability and capability to use dry agricultural waste as fuel. The portability helps the user for ease of transportation of the stove and raw material, which reduces the logistic cost. The insulation (asbestos cloth) covering the stove reduces the radiant heat loss to surroundings and also the risk factor for user. The designed stove limits the accumulation of moisture and its associated risks, which results in good quality puffed rice and increased life span of the stove. The designed and fabricated puffed rice machine work with zero risks (i.e. low smoke, not exposed to heat and radiation, reduce human labour, no health problems) and can be used by any novice user. The stove can also be used with the same working principle for the ground nuts. Thereby, the stove can also be used for multiple products (i.e. coffee, ground nuts and so on) that requires roasting.

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