Electricity Generation by using Conventional Ceiling Fan

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Abstract— The agricultural sector is the backbone of Indian Economy contributing majorly to the country's GDP. India's food grain production reached around 275.88 million tonnes in the year 2017-18 and is estimated to reach 278.55 million tonnes in 2018-19. As on February 2018, it is estimated that over 58% of rural Indians depends on agriculture for their livelihood and this sector contributes around 17-18% to the country's GDP. As per the 2014 FAO , world agriculture statistics India is the world's largest producer of many fresh fruits like banana, mango, guava, papaya, lemon and vegetables like chickpea, okra and milk, major spices like chili pepper, ginger, fibrous crops such as jute, staples such as millets and castor oil seed. India is standing as a largest producer of wheat and rice and contributes 20% of the world total rice needs. In spite of these large numbers, food production still does not meet the needs of population. The successful operation of pre and post-harvest technologies is essential towards the food availability and security worldwide. The grain harvesting is a combined process which incorporates the various harvesting processes such as gathering, drying, threshing, separation and cleaning, etc., particularly drying and threshing are the most important function. Countries like India are blessed with abundant solar energy and it is a large sources for meeting energy demand without putting adverse impact of environment. Biomass energy is also employed as auxiliary heating source due to its availability and cost effectiveness in rural areas. This paper describes about the design and performance assessment of a low cost solar powered grain dryer with dehusking system for post harvesting technologies. In the proposed prototype model, drying chamber serves as the first stage with a solar collector to convert the energy of the sun rays into heat with the help of transparent top of the drying tunnel, which increases the temperature of the drying air, blower will move the air through the drying tunnel, inflate the tunnel, and take out the moisture content from the grains placed inside the chamber. The whole dehusking mechanism consists of a solar panel, a rechargeable battery and a charge controller to generate electricity that drives a worm gear motor. The complete system was designed for small to medium scale agro-processors in a way to reduce post-harvest expenditures and also to improve the product quality.

Keywords: Post Harvest Technologies, Open Sun Drying and Solar Dryer, Biomass Energy, Dehusking System

I. Background

Energy - demand is the foremost threat to all the parts of the world. The energy sector has a direct impact on the economic development of any country and India is facing an acute energy scarcity which is hampering its industrial growth and economic progress.85-90% of the world's primary energy is produced from fossil fuels. There is a limited storage of fossil fuels and one of the important reasons for recession in world's economy is the continuously increasing prices of these fuels. Finding solutions, to meet the Energy - demand is the great challenge for Social Scientists, Engineers, Entrepreneurs and Industrialists of our Country. According to them, applications of Non-conventional energy Resources are the only alternate solution to solve the problem of the decreasing economy and the energy sector's related issues. Now-a days the Concept and Technology employing this Nonconventional energy becomes very popular for all kinds of development activities, especially in the solar sector. India has a great potential to generate electricity from solar energy and the Country is on course to emerge as a solar energy hub. The techno-commercial potential of photovoltaic in India is enormous. With GDP growing in excess of 8%, the energy 'gap' between supply and demand will only widen. Solar PV is a renewable energy resource capable of bridging this 'gap'. Most parts of India have 300 – 330 sunny days in a year, which is equivalent to over 5000 trillion kWh per year – more than India's total energy consumption per year. Average solar incidence stands at a robust 4 – 7 kWh/sq. meter/day. With around 300 sunny days a year nationwide, solar energy's potential in India is immense and its applications in various sectors are wide. One of the major area, which finds number applications are in Agriculture Sectors. Applications of renewable energy also include generation of power to do a number of farm works like pumping water for irrigation, for keeping livestock, or for domestic use; lighting farm buildings; powering processing operations, and other uses. Solar technology offers farmers an opportunity to stabilize their energy costs, to become less reliant on the electrical grid and potential power outages. Solar Photovoltaic cells (SPV) directly convert the light energy from the sun into electricity. Taking into consideration the importance of solar energy and the increased attention humans are paying to renewable energy in agro sector, this paper investigates about the design and performance assessment of a low cost solar powered grain dryer with dehusking system integrated with inverter circuit.

II. Solar Drying System

A large amount of food and grains are spoiled due to the lack of proper storage systems. Drying is one of the most important means for the preservation of many kinds of agricultural products. It means moisture removal from the product and helpful in preserving food product for long time and prevent product from contamination. Drying of food is an effective means of extending shelf life, improving quality and minimizing losses during storage since most of the water is taken out of the product during this process. Various drying techniques are employed to dry different food products such as open sun drying, industrial drying based on fossil fuel and solar-based drying system. Open Sun drying is economical, but the dried product quality is poor due to micro-organisms growth, contamination by dust, insects, birds, pets and spoilage due to sudden and unpredicted rain, loss of vitamins, nutrients, and color changes. It requires large area,

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dependency on natural weather control over drying condition, UV radiation, Ununiform drying. Industrial drying offers quality drying, whereas its high cost limits its use. In many rural locations and villages of countries, grid-connected electricity and supplies of other non-renewable sources of energy are either unavailable, unreliable or, for many farmers, too expensive. Sometimes, they employ motorized fans and/or electrical heating, leads to large initial and running costs barrier that they are rarely adopted by small scale farmers. As per MNRE report, most of the energy requirement for drying is fulfilled by fossil fuels such as coal and natural gas. India spends annually around 160 million tonnes of coal, 90 million tonnes of petroleum products and 240 million tonnes of other traditional conventional energy to meet its industrial, agro and domestic requirements. The use of solar energy in drying is becoming an important and viable alternative since it decreases consumption of conventional energy, and improves production efficiency. There is a significant potential for solar dryer in the agricultural sector also to dry agricultural products such as food grains, vegetables, fruits and medicinal plants, thereby eliminating dependency on open sun drying and industrial drying, while saving huge quantities of fossil fuels. It also has a high potential of diffusion in the domestic and industrial sector. It has advantages like low running cost and superior quality of food.Solar dryer is a low-cost device, operated by solar energy. Solar dryers are available in a range of size and design such as tunnel dryers, hybrid dryers, horizontal- and vertical-type dryers, multi-pass dryers and active and passive dryers Based on the heating modes and solar heat utilization, solar dryers are classified forced air circulation or active solar dryers and natural air circulation or passive solar dryers. But the solar dryer is less reliable due to the intermittent nature of solar energy. It has the interruption during the night time, cloudy days and rainy weather. The reliability issue of solar dryer can be improved by the provision of auxiliary heating source powered by biomass energy. Since, biomass is the most widely used due to its availability and cost effectiveness in rural areas. This paper deals with the integration techniques of solar and biomass in mixed mode configuration for crop dryer to enhance the performance of the dryer and dried products.

III. RICE MILLING PROCESS

Rice Milling is an energy intensive industry that is located all over India and is a major contributor national export earnings. There are about 93000 rice hullers which produce150 million tons of rice annually. Out of them, 43000 rice hullers are raw and parboiled rice producers. These energy intensive traditional mills are facing an acute shortage of power due to frequent power cuts leading to inefficient operations and lower use of production capacity which leads to lower margins. Although some of the mills have started using captive power plants from the rice husk produced by them as fuel, there is a huge gap which is met by Diesel Generators. In the post harvesting process, rice is soaked in hot water for 6-8hrs, after which steam is bubbled though the soak tank for 15 minutes and then the paddy moisture is dried by solar crop dryer unit. This is followed by de husking, polishing and screening. Huge amount of power is required at every stage. More than 1 % or the turnover of the rice mills is spent on power costs. A rice kernel is covered by two layers. The outer layer is called the husk or hull and the inner layer is the bran. The whole rice kernel, including these two layers, is called paddy (rough rice). Husk is not edible and bran reduces the rice luster; therefore, they must be removed from the paddy. The husk is not tightly attached to the kernel and is easily removed. Rice dehusking is a process of removing the husk and bran from the paddy rice and producing head white rice grains that are sufficiently milled, free from impurities and contains minimum number of broken grains.

IV. HARDWARE DESCRIPTION

A. *Solar Drying Chamber*

Solar drying is classified into direct and indirect solar dryer. In direct solar dryers, the air heater contains the grains and solar energy which passes through a transparent cover and is absorbed by the grains. Essentially, the heat required for drying is provided by radiation to the upper layers and subsequent conduction into the grain bed. However, in indirect dryers, solar energy is collected in a separate solar collector (air heater) and the heated air then passes through the grain bed, while in the mixed mode type of dryer, the heated air from a separate solar collector is passed through a grain bed, and at the same time, the drying cabinet absorbs solar energy directly through the transparent walls or the roof. The objective of this paper is to design a mixed-mode solar dryer in which the grains are dried simultaneously by both direct radiation through the transparent walls and roof of the cabinet and by the heated air from the solar collector. The materials used for the construction of the mixed-mode solar dryer are cheap and easily obtainable in the local market.

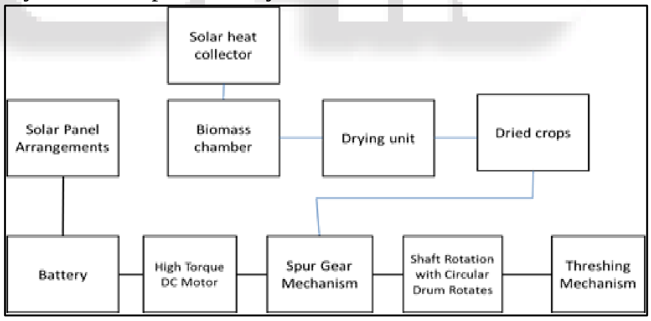

Fig. 1: Basic block diagram of solar crop dryer with Dehusking unit

The design concept of the solar grain dryer is to collect the solar energy through a solar collector and use it to heat up a mass of air and then pass it through a drying chamber by natural convection. Hence the heat supply to the grain is by indirect absorption of solar radiation. The solar crop dryer was developed, constructed and assembled as shown in Figure 1. The dryer consist of the heat collector, drying chamber, air vents and biomass burner. Considering the husking unit, As solar panel observe the solar energy from sun and convert into electrical energy. This electrical energy is stored in battery which will further used for various applications. As battery is charged it utilized to dive the high torque dc motor. Switch on The button DC motor starts rotating, with the help of which it also drive the Belt and pulley mechanism. This pulley is attached to long shaft

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through which whole thresher mechanism is attached. After continuous rotation of drum / thresher mechanism the rice is separate out form rice crop, and collects into container.

B. Solar Heat absorber and Collector

Sunlight passes through the glazing and strikes the absorber plate, which heats up, changing solar energy into heat energy. The heat is passing through pipes attached to the absorber plate. Absorber plates are commonly painted with "selective coatings," which absorb and retain heat better than ordinary black paint. Absorber plates are usually made of metal—typically copper or aluminum—because the metal is a good heat conductor. The heat collector was constructed using 2 mm thick aluminum plate, painted black, is mounted in an outer box built. The space between the inner box and outer box is filled with foam material of about 35 mm thickness and thermal conductivity of 0.05 Wm–1 K–1 .The top of the collector is made of one layer of 0.5 Inch thickness of double walled UV stabilized polycarbonate sheet material with dimension of 24 Inches*48 Inches*6 Inches, which is more efficient than other materials. The advantages of PC sheets are High impact strength, Easy to fabricate, good electrical insulation properties, excellent toughness, Very good heat resistance, easily replaceable, easily bent and cannot be easily broken and more flexible and 200 times stronger than glass. The heat absorber is constructed of 12 Inches distance from the ground. It has 7 No's of heat absorber pipes inside the collector box with length of 48 Inches and diameter of 1 Inch. There are two air-vents generally referred to as inlet air vent and outlet air vent. The air intake into the collector is through a 3.5 Inches slot made through the collector casing between the absorber plate and the bottom of the collector, which forms the airflow duct. The flat-plate solar collector is always tilted and oriented in such a way that it receives maximum solar radiation during the desired season. The best stationary orientation is due south in the northern hemisphere and due north in southern hemisphere. Therefore, heat collector in this work is oriented facing south and tilted at 45o to the horizontal. This inclination is also to allow easy run off of water and enhance air circulation.

C. The Drying Chamber

The hot air from the heat absorber and biomass burner is acting as the heat source to the drying chamber. The drying chamber was built from aluminum material. An outlet vent was provided toward the upper end at the back of the cabinet to facilitate and control the convection flow of air through the dryer. Access door to the drying chamber for loading and off-loading of the grains is positioned at the front side of the cabinet. This consists of four removable trays made of 13 mm aluminum, which placed with the distance of 5 Inches each other. The roof and the walls of the cabinet are covered with polycarbonate sheets of 4 mm thick, which provides additional heating. The outlet air vent is the chimney which is situated on the top of the drying chamber. It is made of metal tube and ridged roofing sheet painted black which serve the exhaust of flue gas. It is circular in shape measuring 3 Inches high and of diameter of 1 Inche.

D. Drying Trays

4 No of trays each measuring 24 Inches*28 Inches are placed inside the drying chamber and were constructed from a double layer of fine wire mesh with a fairly open structure to allow drying air to pass through the items. The distance between each tray unit is 5 Inches.

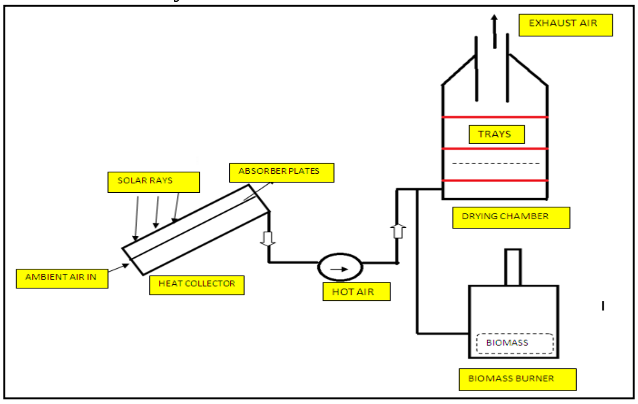

Fig. 2: Working of Solar& biomass integrated crop dryer

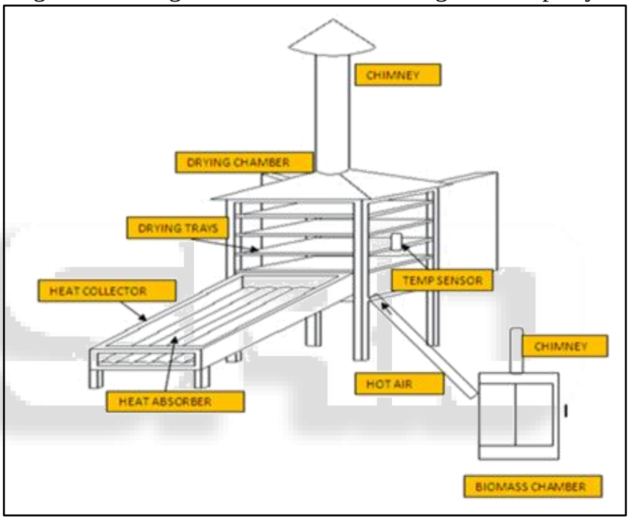

Fig. 3: Solar& biomass integrated crop dryer layout

Fig 2& 3 shows the main components of the dryer, consisting of the solar collector (air heater), the drying cabinet and drying trays.

E. Biomass Burner

India being a large agrarian economy, biomass – wood, agricultural residues, animal dung, etc. – is available in enormous quantities and biomass contributes over a third of primary energy source in India. And, hence, over 40% of India's total energy requirement is met through biomass burning. Biomass-based dryer systems for rural applications could effectively make up for the absence of grid electricity supply in many remote areas and village electrification. Bio-mass includes all water- and land-based organisms, vegetation, and trees, and all dead and waste biomass such as municipal solid waste (MSW), bio solids (sewage) and animal wastes (manures)and residues, forestry and agricultural residues, and certain types of industrial wastes. Biomass has been a major energy source, prior to the discovery of fossil fuels like coal and Petroleum. Bio mass burner is constructed using aluminum plates. The dimensions of the burner are 18*18*18 Inches. The biomass products are feed into the burner through the opening window. The hot

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flue gas is collected from the burner and fed to the drying chamber. As solar panel observe the solar energy from sun and convert into electrical energy. This electrical energy is stored in battery which will further used for various applications. As battery is charged it utilized to dive the high torque dc motor. Switch on The button DC motor starts rotating, with the help of which it also drive the Belt and pulley mechanism. This pulley is attached to long shaft through which whole thresher mechanism is attached. After continuous rotation of drum / thresher mechanism the rice is separate out form rice crop, and collects into container.

F. Rice Husking Machine

Various steps involved in the post harvesting process of crop grains are soaking paddy in water to increase the moisture content, steaming paddy to achieve partial gelatinization, drying paddy to save the moisture content for storage and milling, husking to remove paddy husk from paddy kernel and milling to remove bran from brown kernel. The bran is more difficult to remove because it is tightly attached to the kernel. The process of removing the bran is called whitening or pearling. During this process, rice kernels are subjected to intensive mechanical and thermal stresses which might damage or break some of the kernels. Most part of the rice dehusker is made up of steel. Inside the casing is the steel roller, sieve and the blade which was sandwiched between to plates welded into the casing using the clamps. The roller was made from iron steel. The diameters of the steel roller and the shaft were 4 inches and 1.5 inch respectively. Steel square bar of 0.5 inch is welded 60 degrees around on one fourth part of the roller that will serve as screw conveyor which conveys the paddy inside the huller. Another set of steel square bar of 0.5 inch is welded horizontally on the remaining length of the roller. The length of the steel roller is 14 inches. The hopper serves as an entrance to the rice huller. A thin plate is placed on the lower part of the hopper neck than can be opened or closed. The main function of the adjuster plate is to regulate the feed or paddy that will enter the rice huller. The hopper has a square upper and base area which is 7 inches and 1.5 inches on one side respectively. This dimension for a hopper will hold 1 kilo of paddy when full. It also has steel plate installed at the bottom that will serve as the feed regulator. The vacuum is a 600kW fan which operates at 220 V, 2.7 A, 16000 rev/min and 50-60Hz. Its main function is to suck the leftover husk at the exhaust of the rice huller. The developed rice husking machine will took almost one hour to husk 12 kg of rice.

Calculation of husking rate is shown in Equation-1.

Husking rate by solar power = 0.2 kg/minute (1)

= 0.2*60 kg/hour

= 12 kg/hour

Daily 6 hours of running:

= 12 *6 kg/day

= 72 kg/day

= 72*30 kg/month

= 21, 60 kg/month

Therefore, running the proposed solar powered rice husking system for 6 hours daily can husk 2160 Kg/month of rice

V. HARDWARE SETUP

The physical properties such as density, specific gravity, weight, size of the impurities and rice grains were considered. These properties form the basic information for the design of the machine. Parameters such as capacity (quantity of feed), axial dimension of rice grain, coefficient of friction and sphericity of the rice were determined in other to have a comprehensive and effective design of the machine.

S.No	Physical structure	Dimensions
Dryer Unit		
1	No of trays	4
2	Trays	Aluminum and Iron
3	Max temperature Limit	65°Deg
4	Height from the ground	5 Inches
5	Height of the dryer	24 Inches
6	Width	26 Inches
7	Distance between trays	5 Inches
8	Thermostat model	EG01/2
9	Display SELECT	TC 513
Fan		
1	Flow rate	$300m^3/hr$
2	Voltage	12 V DC
3	Power	12 W
Heat Collector		
1	Outer dimension	24*48*6 Inches
2	Width	24 Inches
3	Length	48 Inches
4	Height from Ground	12 Inches
5	Thickness	6 Inches
6	Air Hole diameter	3.5 Inches
7	Heat Absorber pipes	7 Nos
8	Heat Absorber pipe length	48 Inches
9	Heat collector distance from surface	2.5 Inches
10	Air hole distance from end point	0.5 Inches
11	Inclination angle	45 Deg
12	Cover	double walled UV stabilized polycarbonate material
13	Collector insulation	0.3 Inches
14	Absorber thickness	1 Inch
15	cover thickness	0.5 Inch
16	Distance between absorber and glass cover	3.5 Inches
Biomass burner		
1	Height from the ground	6 Inches
2	Height	18 Inches
3	Width	18 Inches
4	Chimney Height	3 Inches
5	Fuel door dimensions	10*10 inches

Table 1: Specifications of Hardware Unit

Rice dehusking unit		
1.	Solar Panel	Monocrystalline Power : 37W, Voltage : 12V Size: 83cm x45cm
2.	Charge Controller	-
3.	Battery	Lead-acid,(12V, 7Ah)
4.	D.C. Motor (12 V, 90W,60 rpm) Permanent magnet worm gear motor	Aluminium
5.	Hopper	Capacity: 10 kg GI Sheet Size =40 x 40 x20 G.I.Sheet
6.	Spur Gear	1:4, 25mm, 100mm
7.	Roller	-
8.	Shaft	M.S
9.	Connecting Wire	Cu
10.	Blower(12V, 0.25A, brushless dc motor)	-
11.	Frame Stand	5 Inches
12.	switch	1 No
13.	Centrifugal Blower	RPM :2800

Fig. 4: Hardware model of drying chamber


Fig. 5: Hardware setup Heat collector system

A. Specific uniqueness of the crop dryer unit

- It's a hybrid system, since heat from solar and biomass is utilized for heating, which improves it heating efficiency.
- The dryer unit is covered with polycarbonate sheet, so it retains the heat for a long time.
- Bio mass burning furnace will supply heat during the night time, So the system gives drying heat 24/7.
- It restricts the growth of microorganisms in the products.
- It's operated from solar and biomass, so no need for Electrical supply. Best suitable in remote places also.
- Affordable price.
- Occupying less area, since physical structure is small.
- It improves quality of the dried product, since uniform spread of heat through circulating fan.
- Thermostat setup available for temperature monitor and control.
- Wood and other wastes are used as fuel in biomass furnace.

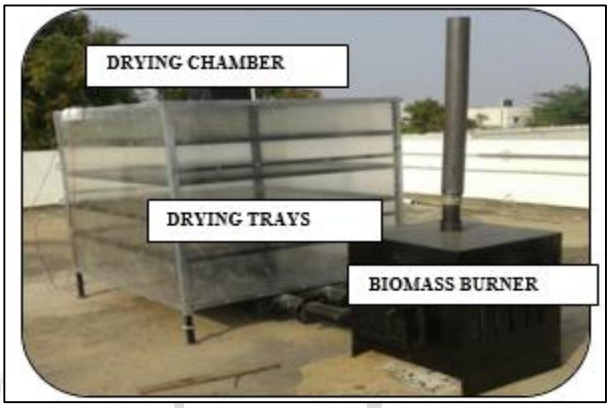

Fig. 6: Hardware model of drying chamber with biomass burner

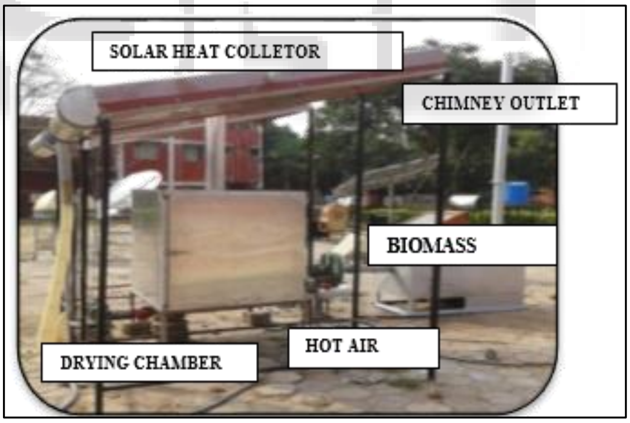

Fig. 7: Hardware setup of crop dryer unit

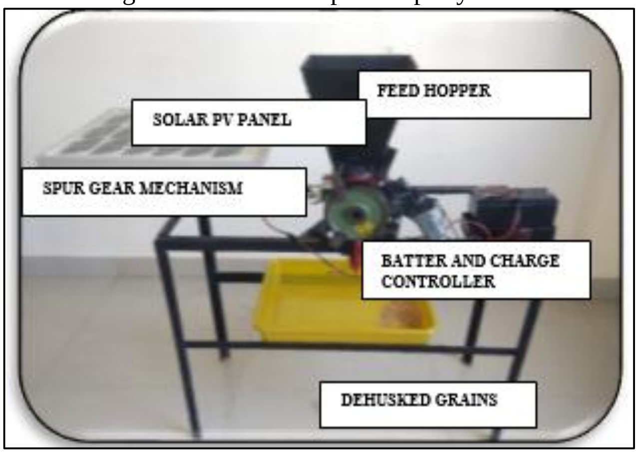

Fig. 8: Hardware setup of solar dehusking unit

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VI. RESULTS

The hardware system was placed over the roof top of a building based on the design. Axial flow fan was fixed at the top of the drying chamber and tested. The experiments were conducted in the month of March, from daily 9 am to 5 pm. The solar radiation was measured using pyranometer. The K-type thermocouples were used for the measurement of temperature in the collector assembly. The temperature was measured for each hour from 9 am to 5 pm at three points, namely entry, middle and exit of the glass cover, absorber plate and bottom insulation. The temperature of the air in the drying chamber and the atmosphere were measured by the thermometer. A vane-type anemometer is used to measure the air velocity.

A. Grapes

Initial moisture content	80 to 90%
Final moisture content	15 to 20%
Max temperature	70ºC
Storage	Sealed bags
Required drying time	3 days 4 hours /day
Required drying temperature	45 º C

B. Groundnuts

Initial moisture content	40 %
Final moisture content	9 %
Max temperature	70 º C
Storage	Containers
Required drying time	3 days 4 hours /day
Required drying temperature	45 º C

C. Green Chilies

Initial moisture content	80 to 90%
Final moisture content	15 to 20%
Max temperature	70 º C
Storage	Sealed bags
Required drying time	3 days 4 hours /day
Required drying temperature	45ºC

D. Tulsi and Medicinal Leafs:

Initial moisture content	60 to 70%
Final moisture content	15 %
Max temperature	65 º C
Storage	Sealed bags
Required drying time	3 days 4 hours /day
Required drying temperature	45 º C

Fig. 8: Dried Products samples

E. Feeding rate and percentage of husking process

S.No	PaddyFeed rate	Milled grains	Unmilled grains	Broken grains	Percentage milled
	500	400	30	70	80
	1000	650	100	250	65
	1500	850	150	500	56.7
	2000	900	300	800	45
	Average	700	145	405	61.7

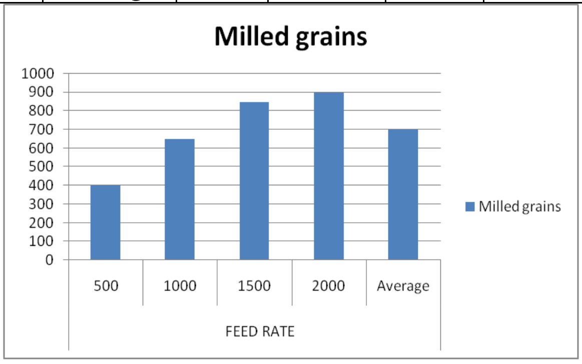

Fig. 8: Milled paddy crop drains Vs feedrate in dehusking unit

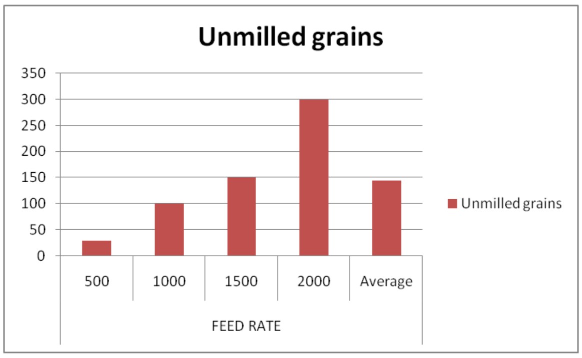

Fig. 9: Unmilled paddy crop drains Vs feedrate in dehusking unit

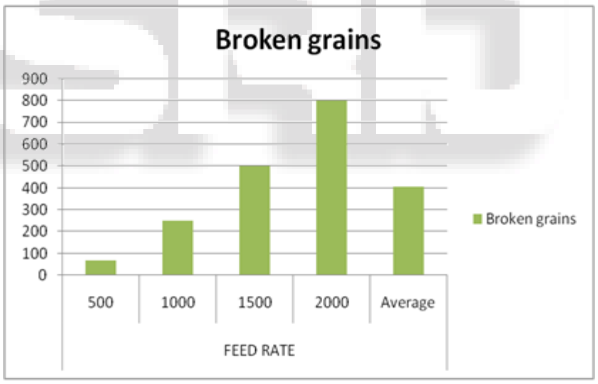

Fig. 10: Broken crop drains Vs federate in dehusking unit

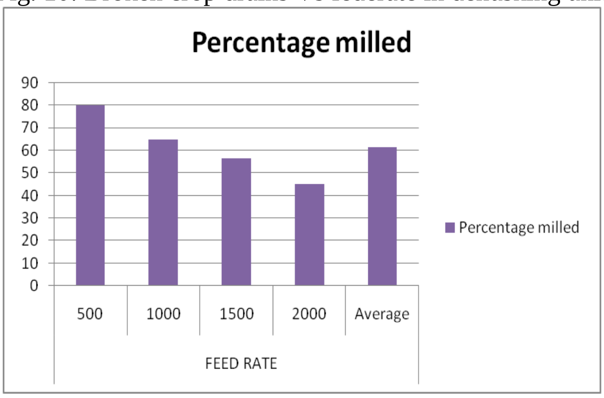

Fig. 11: Percentage of Milled paddy crop drains Vs feederate in dehusking unit

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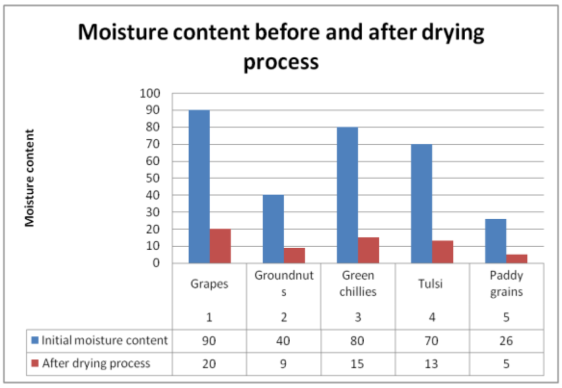

Fig. 12: Moisture content before and after drying process of crop dryer unit

 Dried chilies	 Dried grapes	 Soaked Grains
 Dried mint leaves	 Dried bitterguard	 Dried paddy Grains

Fig. 13: Sample output of dried crops under crop dryer

VII. Conclusion

The use of solar energy for drying and husking applications for agricultural products has a large potential from the technical and energy-saving point of view. A low cost solar powered grain dryer with dehusking system solar powered rice husking system has been designed, implemented and tested for husking rice and the performances have been evaluated. This model has good prospects in both rural and urban areas of a developing country like India. The partial availability of solar energy in the day and the transient nature of solar energy are compensated by integration with biomass resources. The results are encouraging and it is recommended to further investigate various integrations and back up technologies to enhance the performance of the solar thermal systems.

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