RICE HULLER

SECTOR: AGRI - PROCESSING

MODEL BANKABLE DOCUMENT

SELCO FOUNDATION

NABARD

TABLE OF CONTENT

1. Introduction……..…….2
2. The need for solution……..……2
3. Schematic Design ……..…….3
4. Technical specification of components……..3
5. Key features……..…….4
6. Installations ……..……5
7. Maintenance……..…….7
8. Safety……..…….7
9. Troubleshooting……..……..…...8
10. Cost & Economics ……..……9
11. Case study ……..……..11
12. Impact……..……...15

1. INTRODUCTION

Rice is grown in more than 100 countries. Among the 156 million hectares of land being used for rice farming, 900 million tonnes of residue is being produced. More than 95% of rice is grown by small farmers (0.5 – 3h). Several grains have an unpalatable husk or shell that needs to be removed by a decorticator. A range of specialised machines are available for this task. A range of small rice hullers (both manual and powered) is available. But less rice is broken during hulling if the rice is parboiled first. So, rice polishers are available for removing the rice bran after hulling. The entire process needs to be decentralised to add value for the miller and the farmer(s). Millers usually get more than 50% of the value gain upon processing of rice, this value needs to be captured by the farmer either directly or indirectly.

Rice is the staple food of billions across the world. Among the 156 million hectares of land being used for rice farming, 900 million tonnes of residue is being produced.There are several thousands of varieties grown across the world. It is estimated that India is home to more than 6000 varieties. Rice feeds about 60 % of the world population and it plays an important role in the life and culture of people who cultivate it.

In India 104.8 million tonnes of rice is grown in 43.86 million ha of land. 90% of this land is owned and farmed by small and marginal farmers. These farmers have a land holding of less than 2 ha. More than 95% of rice is grown by small farmers (0.5 – 3h). Most of the rice grown and consumed by them. They have a small amount of surplus rice which is sold to traders and rice mills.

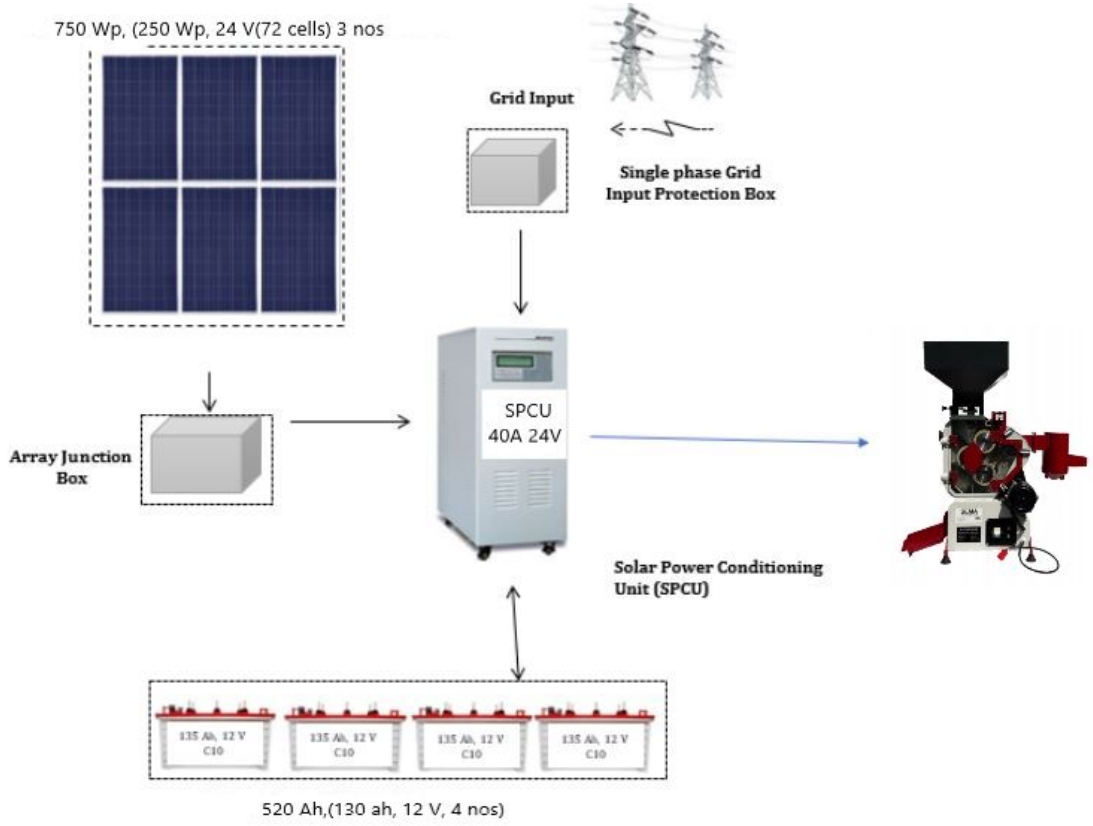
The post harvest processing of rice involves drying and cleaning of paddy. After this the rice is hulled and polished. Hulling removes the protective coating around the grain called the husk and polishing removes the brown layer coating the grain to produce the white grains that are more appealing for human consumption. The grains having these husk or shell needs to be removed by a decorticator. A range of specialised machines are available for this task. A range of small rice hullers (both manual and powered) is available. But less rice is broken during hulling if the rice is parboiled first. So, rice polishers are available for removing the rice bran after hulling. In India most the paddy is subjected to a process called parboiling. Parboiling is the process of partially boiling of the rice. This changes the characteristics of the paddy making it easier to hull rice. It also improves the hulling efficiency and the recovery rate.The white rice that is produced is called raw rice.

2.NEED FOR SOLUTION

For small and marginal paddy farmers, husking their paddy is a laborious process if done manually and an expensive one if taken to rice mills. Manual hulling is either done by pounding the paddy with a long wooden rod or by laying the paddy on roads so that big rolling stones or vehicles can drive over it.

Farmers who take their paddy to mills have to incur high transportation costs and are also deprived of the byproducts like bran and husk, which the mill owner keeps for him. Since rice is hulled a maximum of 1-2 months a year, any sort of large investment is not feasible. Currently, farmers rely on diesel-fed/grid high power machines. Farmers with erratic power supply usually get their products hulled at a mobile diesel rice huller, which requires travelling from one village to another. Within India, the production capacity and the energy requirement of the existing rice mill technology is too large.

3. SCHEMATIC DESIGN



4. TECHNICAL SPECIFICATION

The table below provides the system designs and details of the components and devices with specifications required for a solar powered rice hulling machine with 1.5HP motor size. The systems design will provide autonomy to the machine for 4 hours per day.

Sl.No.	Products	Capacity	Qty
1	**Solar Module (72 cells) - 3 Panels in series**	**250 Wp, 24 V**	**8**
2	**Module Mounting Structure**	**250 Wp, 1M**	**8**
3	**Solar battery**	**135 Ah, 12 V**	**8**

4	Cable red+black (M-B, B-L)	10 sq.mm.	30
5	Cable red+black (B-B)	25 sq.mm.	12
6	Cable red+black (M-M)	4 sq.mm.	30
7	Earthing Cable	10 sq.mm.	20
8	AJB with MCB & SPD (Greensol)	4 IN, 1 OUT	1
9	Single pole MCB (Load side)	64 A, 48 Vdc	1
10	Battery Rack	135 Ah X 8 Nos. (2 stacks of 4 batteries)	1
11	Earthing Kit		2
12	Consumables		1

5. KEY FEATURE

- The solar powered rice huller has many advantages compared to the conventional diesel powered rice huller.
- The huller is capable of running entirely on solar power thereby bringing down the cost of fuel and grid electricity to zero.
- A highly efficient dc motor is used to power the device. These motors are capable of running non stop for 8 hours without overheating.
- Rubberised wheels used in the mill are harder and larger than the ones used conventional mills. This ensures longer running periods with lower downtime with increased productivity.
- The wheels also reduces the percentage of broken grains increasing the profits for the miller.
- There are three wheels in the mill that hulls the rice. The middle wheel is adjustable in x axis and is equidistant between the other two wheels at the ends. The gap between the wheels can be adjusted between 0.1 mm and 1 mm to accommodate different varieties of rice.
- Grains are hulled between two different pairs of wheels which gives better hulling efficiency and reduces the percentage of broken rice produced.
- An aspirator is used to separate the husk and grains. The aspirator sucks out the husk and deposits it in the collector which can be disposed easily.
- The metal casing and the plates used are laser cut, zinc plated and powder coated to prevent rust formation. This ensures that the machine will be rust free during its working lifetime.
- The shafts are made from EN8 hardened steel.

- All moving components have been machined to 50 micron tolerance. This ensures there is less friction and increases energy efficiency.

6. INSTALLATION GUIDE

6.1. Rice huller machine

- As set-up considerations, a leveled floor (pedestal or table) is required for optimum efficiency of the machine. The pedestal and table should be fixed and not undergo shaking under operation.
- Remove the top panel of the wood box.
- Remove bottom bolts to unpack the machine.
- Mount the rubber feet in order to adjust the final leveling of the machine.
- Check for any damage due to transportation by manually operating the pulleys.
- Connect plugs. Wait for power light signal. Close the door and switch on the huller.
- The machine should be allowed to run at no load condition for 10 minutes and the absence of the following should be ensured.
    - Marked vibration during running.
    - Undue noise in the huller.
    - Heating on window and motor.
    - Belt slippage.
    - Vibration in fan.
    - Unusual wear or slackness in components.

6.2. Module:

- While unboxing module to install two people should care handle module instead of one person.
- Identify shadow-free location on roof top for installation and clean the area. Mark points to place RCC (Reinforced Cement Concrete) on the floor.
- Depending upon geography and type of roof it will be decided whether MMS has to be customized or not.
- If needed with the help of local fabricators it has to be made possible.
- Identify south with the help of magnetic compass and mount the panel facing South.
- Please maintain the optimum tilt angle of the solar panel so as to maintain the efficiency and increase the life of the panels.
- Depending upon the type of footing Roof mounting and ground mounting, configuration of tilting angle in particular angle- Summer Tilt and winter tilt
- The type of footing will depend on the type and angle of roof for rooftop mounting. In case of ground mounting, it depends on the type of soil.

- Isolated footings are most commonly used footings for Reinforced cement concrete column because it is simple and most economical.
- Combined footing: the aim is to get uniform pressure distribution under the footing.
- Earthing of panels: in order to protect the entire solar system and people using it has to be connected to earth.
- Panels are interconnected such that the voltage of the system is achieved. They are connected to the Array Junction Box by MC4 Connectors. Panels are interconnected such that the voltage of the system is achieved.

6.3. Charge controllers:

- Fuse has to be removed prior to installation.
- First connect positive and negative terminal of the battery to the charge controller.
- Then connect the positive and negative terminal of the load to the charge controller.
- Then fuse has to be reinstalled.
- Finally connect the positive & negative terminal of the panels to the charge controller.

6.4. Batteries:

- For ventilation holes are made in the rack to give space for air to pass through.
- Batteries should not stacked one above the other.
- Keep polarities of all the batteries adjacent to each other on the same side.
- Batteries should be stored in a cool, dry and shaded area free from sunlight.
- Best room temperature for storing batteries is 20°C.
- In DC systems, while making connections, always connect negative wire first and then positive wire.
- While disconnecting, disconnect positive wire first and then negative wire. This is for safety reasons and to avoid sparks at the battery terminals while doing connections
- Keep air safety distance between batteries of at least 20mm.
- Use wire lugs at battery terminals to avoid loose connections.
- Do not use grease on battery lugs as it has a high melting point and is a bad conductor of electricity. Use petroleum gel instead.
- Lugs should be dry and should not be hot. Lugs get hot due to loose connections, improper wire size or poor quality of lugs
- Always keep top of batteries clean and keep the lids sealed to avoid contamination by dust.
- To measure battery voltage, first disconnect electric load and solar input
- To get more accurate current readings, connect ammeter in series to the battery and load.
- Battery Connections: Do the battery interconnections such that the system voltage is achieved. Keep them well in the battery box.

7. MAINTENANCE GUIDE

7.1. Rice huller machine

- Machine should be cleaned everyday after operation.
- At the end of the operation,remove any stuck grains between the rollers.
- Ensure that the gap between the wheels are uniform before starting the machine.

7.2. Module:

- Clean the panels at least once a month.
- Do not displace the panels from the mounting structure.
- Tilt angle has to be checked.
- Check if there is any deformation in the panels.
- Check if there are any wire/ wires directly exposed to sunlight.
- Do not drop, allow objects to fall on, stand or step on solar modules.
- Do not walk, lean, sit or rest heavy objects on solar panels.
- Prevent the direct contact of the positive and negative terminals of Panels.
- Solar modules have a protective glass front. Broken solar module glass is an electrical safety hazard (electric shock and fire). These modules cannot be repaired and must be replaced.

7.3. Charge controllers:

- Care has to be taken to frequently check the indicators to ensure proper functioning of the system
- Do not place any metallic or fire prone object close to the charge regulator. A minimum of 12” space should be maintained all around for free air circulation.

7.4. Battery:

- Check the acid level in the battery at regular intervals. Fill with distilled water if the acid level is low.
- Do not overuse the system.
- Apply Petroleum Gel on both terminals of the battery.
- Prevent the direct contact of the positive and negative terminals of batteries.
- Batteries store a large amount of energy. Never short circuit the external contacts of battery under any circumstances

8. SAFETY

8.1 Rice huller machine

- Ensure that the base frame is sturdy and does not shake during operation as it can affect the efficiency of the machine.
- Ensure that the door is closed during operation to prevent grains flying out.
- Before starting the machine ensure alignment of rollers.

8.2. Module:

- If wiring line voltage is higher than 70 Volts it will be Hazardous.
- Wear insulated safety gloves, industrial shoes while working on the system
- Do not touch the panels junction box during day time, as DC voltage is always present when solar modules are exposed to sunlight
- MCB has to be turned off in solar combiner box of the Solar Array before you work on them.
- Always check positive or negative polarity of any wire with multimeter before connecting it to any device
- Do not leave any wire open, it can touch other terminals causing short-circuit.

8.3. Charge controllers:

- Do not allow water to drip or splash on the charge regulator.
- Avoid children touching the charge controller.
- Keep the machine and other parts clean and free from dust & water.

8.4. Battery:

- Provide a ventilation in the battery room for the hydrogen gasses generated to move out.
- Do not allow water to drip or splash on the battery.
- Avoid children touching the charge controller.
- No Smoking warning sign has to be hanged if needed outside.
- Wear safety glasses for protecting the eyes from the acid.
- If acid comes in contact with eyes, wash for 15 minutes and report to a doctor immediately
- If acid comes in contact with skin or clothing, rinse off for several minutes and try not to spread the electrolyte. Report to a medic/doctor after rinsing

9. TROUBLESHOOTING

9.1. Rice huller machine

problem	Possible cause	Corrective action
High amount of unhulled paddy	1) Incorrect gap between the rollers 2) very high flow rate	1) Adjust the roller gap in increments of 0.1 mm until optimum efficiency is obtained. 2) decrease the flow rate
Poor husk aspiration	Suction power is limited	Open the door and increase the gap by moving the bottom plate down.

Extra husk aspiration	Suction power is excessive	Open the door and decrease the gap by moving the bottom plate up

9.2. Module :

- Disconnect the fuse
- Cover solar modules with thick blanket or cardboard
- Check the interconnection polarity between the modules
- Check the bypass and reverse blocking diodes for correct polarity
- Check for any loose connection
- Replace the fuse.
- Uncover the solar modules
- Check the output voltage of individual modules using clamp meter /Multimeter
- Check the output voltage of solar array at terminal blocks.

9.3. Charge controllers:

- Check for Fuse if the wire inside the fuse is shot, replace with new fuse.
- Check for series charging, if not then there might be complaint with the circuit.
- Check for panel, battery and load voltage

9.4. Battery:

- Check specific gravity of the battery if the specific gravity is low then send it
- Check the terminal voltage after the load is disconnected from the battery terminal.
- Remove corrosion on the terminal posts
- Use self-leveling filler that automatically fills the battery to a predetermined level.
- While topping take care not to splash from the cell opening

10. COST & ECONOMICS

Methodology: The cost economics based on the service demand translating to profits per month which is required to service the EMI cost of acquisition of the system. The business case in based on entrepreneur model where paddy is bought, after hulling the product is repackaged and sold in the market.

The cost and economic of rice huller business is based on the following assumptions:

- Cost of System (includes solar component): Rs 200,000/-
- Interest rate is fixed at an average of 12%
- Payment tenure translate to 60 monthly EMIs

- Based on the calculation, the EMI cost coming to Rs 6673
- No. of working day considered: 25 days
- No. of working hours: 6 hours
- The entrepreneur avails loan amount of Rs 3,00,000 for both capex and opex.

Approximate revenue per year

Paddy Hulling	kg/hour	60
Rice Production	kg/hour	38
Working hours	hours/day	6
Working days	days/month	25
Market price of Rice	Per Kg	42
Total Selling Revenue	Per year	28,72, 800

Approximate expenses per year

CAPEX		OPEX	
Items	One-time cost	Items	Annual cost
Rice huller	50,000 ₹	Operator + 1 Labourer	168,000 ₹
Solar system	150,000 ₹	Transport & Maintenance	100,000 ₹
		Packing	100,000 ₹
		Paddy	2,160,000 ₹
Total	200,000 ₹	Total	2,528,000 ₹

EMI Calculation

EMI	
LOAN AMOUNT	300,000 ₹
RATE OF INTEREST PER ANNUM	12.00%
RATE OF INTEREST PER MONTH	1%
TENURE IN MONTH	60
EMI	6,673 ₹

Expected increasing profit from Solar rice huller machine

1	Rice Production cost	Rp/year	2,528,000 ₹
2	Total selling revenue	Per Year	2,872,800 ₹
3	Yearly EMI expense	Per year	80,076
	Total operating income (Profit) (2-(1+3))	Per Year	₹ 264,724
		Per Month	22,060 ₹

The intervention is expected to increase the entrepreneurs income by Rs 22,060 on an average.

11. CASE STUDY

a) Anand - Halliberu Village, Karnataka

Haliberu village is situated near Kolluru, Kundapura Taluk, Udupi District. This village is 75 km away from district headquarters. This village has 71 households. All 71 households are involved in agriculture. Major crops of this village are Arecanut, Cashew, and Paddy. All families involved in paddy farming. Each farmer/family grows 10 to 15 quintal paddy in 1 to 3 acre land per year which is close to 78 tons per year. Most of the paddy is used for the self-consumption of each family and very few farmers are selling paddy to local contacts or market. All farmers are taking paddy to the rice mill which is located 4 to 5 km away from the village. This is the present practice of paddy hulling in this village. Rice mills charge Rs.3/- per kg rice. Road access to the villages is very poor, because of this transportation is very difficult in this village. After seeing this opportunity, the potential of doing solar-powered rice huller in this village was identified and found Mr. Anand a micro-entrepreneur in this village.

Mr. Anand is a farmer from Haliberu village, Kolluru. He is involved in agriculture for the past 15 years. He has 1.5 acre of paddy farming land, 1-acre areca nut farm, and 5 cashew trees. In this he is growing around 15 quintal paddy per year, 3 to 4 quintal Arecanut and around 50 Kg cashew. Along with agriculture, he is also running rickshaw. This is his secondary income source. In his family, a total of 7 members include 5 adults and 2 children. Along with him, his family member is going for agri-labor work. On an average monthly family income is approximately Rs.15000/- to Rs.20000/-.

Mr. Anand showed interest in the project and he gave his consent to install solar-powered rice huller and polisher. The technical detail of machine mentioned below.

Machine specification:
Rice Huller – 0.5 HP – 100kg per hour and 400kg per day
Polisher – 1.5HP – 65kg per hour and 260kg per day

Solar-powered rice huller and polisher was installed on this site in Aug 2019. The entrepreneur is working on the rice mill. Slowly villagers have come to know about the solar-powered rice mill project installed in the village and they are coming to hull their paddy to Mr. Anand. Since it is new for them they are comparing and trying both hulling methods. As of now, the entrepreneur is able to hull around 200 kg to 400kg per week. As per him, he is earning:-

Weekly			
#	Paddy in KG	Charges	Total Earnings
1	400	3	1200
Monthly			
#	Paddy in KG	Charges	Total Earnings
1	1600	3	4800


And this is because of offseason most of the farmer had done hulling and sold paddy. Now paddy is coming for hulling which they have kept for family consumption.

b) Harsha Trust FPO

There are many FPOs in and around Odisha that engage in different types of processing - rice, millet, chilly, turmeric and dal. One among them is Danteswari women producer CO.LTD, an agri producer - a rice processing Farmer Producer Organisation (FPO) under Harsha Trust

initiative, that operates in the Kosagumada block of Nowrangpur district, Odisha. The FPO is a collective consisting of 520 farmers. Among the 520 members, 53 have been elected as board members who take various decisions related to the functioning of an FPO. The FPO is responsible to supply the material for cultivation - including seed, fertilizer and also training on product harvesting and marketing of the products. The paddy being hulled are of various types - aromatic and black jeera rice. Even today, 20% of paddy is still manually hulled because of the distance and transportation issues.

The Kosagumada block is an off-grid area and the primary occupation of all households is farming and are engaged in other agri related livelihoods. There are about 20,000 households in this block, all of whom are involved in cultivation and having an average of half to 2 acres of farming land. The major crop that is cultivated by all households especially in the rainy season is paddy, 20% is dal and another 20% would be vegetables for self consumption purposes only. Those having 1 - 2 acre of land use 40% of their crops for consumption and the rest goes to the market, whereas those with half acre of land use their entire produce for self consumption purpose. Suppose 1 acre of paddy cultivation is done, it gives 20 bags of paddy, 1 bag being 50-60 kg of paddy - amongst which 10 bags are kept for self as a counter act for food security issues and 10 bags given to the nearest FPO.

Tech details: The rice mill consists of a machine that hulls and polishes rice. It is a 5 hp machine that can hull to produce 2 quintals or 200 kg of rice per hour. It is a 5 hours system.

Post installation of the solar powered rice huller and polisher in May 2018, the paddy cultivated by the villagers now goes entirely to the FPO, which is then hulled and sold by the FPO in the market. The villagers choose the FPO over the market as they are paid INR 2 more than the market price for paddy. Milling for self consumption is only by those villagers who are closer to the block, say 10-12 kms, while those who are at a distance may just mill locally. On a daily basis, 700 kg (6-7 quintal) of rice is milled in the FPO, so 25 days*700kg = 17,500 kg is milled in a month. The procurement of paddy by the FPO from the villagers is standard across the year so there is no seasonal effect on the output being milled and produced for the market. The crops being cultivated changes with the seasons - during the rainy season, cash crops like paddy is grown, 10% of vegetables is grown during summers as per water available and dal and other vegetables are grown in the winters. Thus, paddy has to be usually stored by the FPO across the year and processed according to the capacities of the machine and demand of the market. The market for the processed rice has yet to scale and mature as the demand, quality checks and market linkage and players are yet being explored and innovated upon.

For servicing: Mukti solar, an incubatee, offers any type of service regarding the machine and solar if any service request is received.
Utilisation: The FPO utilises the machine for 4-5 hours, and operates it only in the day time.

Packaging, storage and distribution

As the FPO has to store the paddy over the year, it ensures adequate storage space. It has allocated a big space, a house of 1000 sq ft, and uses gunny bags to store them. The paddy is usually stored not more than a period of one and a half month. The rice hulled is packed in

cotton bags and sold to the market within a weeks time. The FPO has a 6-wheeler truck for facilitating the input-output mechanism - which includes collection - where paddy is collected from the villagers at a 30-35 km radius and distribution - where the polished rice is sold to the nearest market 25-30 km away. They also take the required steps to prevent damage to the crop and infestations. This can include adopting traditional methods and using the adequate materials for flooring, walls, etc.

Market and costs

The nearest market is 25-30 km away. There are no market fluctuations experienced yet as a standard output is processed and sold in the market. The state government has an agency, Odisha Rural Development and Marketing Society(ORMAS), that helps establish market linkages and provides training and support.

Cost of inputs bought from the market: The FPO pays the villagers INR 1000 per quintal for paddy and sells the rice as ration for INR 10/kg and in the market for INR 12/KG.

Finance

There are national and rural banks like SBI, Axis bank and a huge presence of non-banking financial company (NBFC) in the block. As part of technology research and innovation, the machine was installed as a demo and the costs are as follows:

Total cost of the machine = 17.66 lakh
Solar cost = 6.9 lakh
Machine cost = 9.66 lakh
Installation cost = 1.1 lakh

Hygiene and safety

A separate space is used for running the machine and measures are taken to ensure the hygiene and safety inside the room. As the temperature is usually really high, ventilation and temperature control needs to be ensured. Further work is being looked at, especially to improve the ventilation.

12. IMPACT

1. Zero fuel costs for the machine to run.
2. Reduction in drudgery involved in labor intensive manual rice hulling process.
3. Very low maintenance with ease of operation results in long machinery life.
4. Decentralized models can be a one-time investment at the community level but benefiting in the long run.
5. Areas with limited accessibility such as hilly terrains, rural areas can have their own hullers thus reducing the transportation cost.
6. Farmers can keep the byproducts (husk).

7. This innovation has given scope for production of brown rice at domestic level at low cost, cottage scaled value addition business for farmers.