

Modernization & Up Gradation of Rice Mills through Cost Effective Technology

Priyanka Tiwari^{1*}, Nivedita Singh¹, Prabhat Kumar Guru²

¹National Institute of Technology, Kurukshetra – 136119, Haryana (India)

²ICAR-National Rice Research Institute, Cuttack- 753006, Odisha (India)



*Corresponding Author

Priyanka Tiwari*

E-mail:

tiwari.priyankatiwari.p2@gmail.com

Article History

Received: 17. 03.2021

Revised: 30. 03.2021

Accepted: 5. 04.2021

This article is published under the terms of the [Creative Commons Attribution License 4.0](https://creativecommons.org/licenses/by/4.0/).

INTRODUCTION

Rice milling is the oldest and the largest agro processing industry of the country. At present it has a turnover of more than 25,500/- crore per annum. It processes about 85 million tonnes of paddy per year and provides staple food grain and other valuable products required by over 60% of the population. Paddy grain is milled either in raw condition or after par-boiling, mostly by single hullers of which over 82,000 are registered in the country. Apart from it there are also a large number of unregistered single hulling units in the country. A good number (60 %) of these are also linked with par-boiling units and sun -drying yards. Most of the tiny hullers of about 250-300 kg/h capacities are employed for custom milling of paddy (NABARD, knowledge bank). Apart from it double hulling units number over 2,600 units, underrun disc shellers cum cone polishers numbering 5,000 units and rubber roll shellers cum friction polishers numbering over 10,000 units are also present in the country. Further over the years there has been a steady growth of improved rice mills in the country. Most of these have capacities ranging from 2 tonnes /h to 10 tonnes/ h.

Description of Rice Milling Operation:

After harvesting of Paddy, it is in raw form and cannot be consumed by humans before necessary processing for obtaining rice. Rice milling is the process followed to remove hulls and barns from paddy grains to produce eatable polished rice. The basic rice milling processes after harvesting are as follows:

Drying	:	To get optimum moisture level before milling
Pre Cleaning	:	Removing all impurities (big stones, soil particle) and unfilled grains from paddy
De-stoning	:	Separating small stones from paddy
Parboiling (Optional)	:	To improve the nutritional quality by gelatinization of starch inside the rice grain. It improves the milling recovery percent during deshelling and polishing / whitening operation
Husking	:	Removing husk from paddy
Husk Aspiration	:	Separating the husk from brown rice/ unhusked paddy
Paddy Separation	:	Separating the unhusked paddy from brown rice
Whitening	:	Removing all or part of the bran layer and germ from brown rice
Polishing	:	Improving the appearance of milled rice by removing the remaining bran particles and by polishing the exterior of the milled kernel
Length Grading	:	Separating small and large brokens from head rice
Blending	:	Mixing head rice with predetermined amount of brokens, as required by the customer
Weighing and bagging	:	Preparing the milled rice for transport to the customer

Rice mills can be widely divided in two groups to serve local and international market

1. Rice mills to serve local market

- Performance parameters are head rice yield and operating cost
- Indian companies making small & large mills to fulfil the domestic need

2. Rice mills to serve export market

- Performance parameters are capacity, utility and appearance
- Many foreign companies are concentrating on manufacturing of highly sophisticated rice mills for producing export quality rice

Traditional rice mill

- Whole grain recovery is less
- Excessive loss in the form of coarse and fine broken
- No paddy dryer used before milling to obtain uniform and suitable moisture limit of grains results in production of inconsistent qualities of rice
- Final product transferred manually add dust particle which deteriorate the quality of rice and increase the moisture content results in less shelf life of rice
- Loss of large portion of endosperm layers
- The machines were non-commercial as the output quality was low
- Use of traditional and locally produced non-standard fabricated items used for milling operation
- Mild steel usage in rice mill machineries and corrosion of mild steel affected the rice quality
- Quality management systems were not employed. There were no testing labs for routine check-ups.

- By product recovery is difficult because of absence of aspiration system
- No proper utilization of by-products of rice
- There wasn't enough investment to buy modern rice mill machinery (automatic and semi-automatic) manufactured and supplied by Japan & Germany.
- It has also been observed that the location of rice mills are confined to a few selected production centres. Their development as a village level agro processing unit is yet to take a proper shape. In the absence of village level rice milling unit, the farmers have to travel great distances for milling the rice. This leads to increased transportation and handling losses.

Modernization and Up gradation of rice mills

Rice mills must modernize to meet global quality standards to meet out the domestic and international demand. Some new technologies need to be popularized in today's milling machines are:

- Modern rice mill having capacity upto 150-330 T/day
- Modern destoner technology completely removes all the impurities of rice
- Pneumatic rubber roll sheller technology decrease 2-3 % broken rice as compare to traditional huller
- Colour shorter technology removes all impurities from rice i.e. black rice, chalky grain, and paddy if any
- Old stone disk hullers, vertical cone polishers have been replaced by emery-coated cylinders, friction-type whitener polisher, and dry & wet mist polishers

- Two-stage whitening process
- Milled rice is now graded
- Equipped with packaging machine results in high quality rice grains with more cleanliness and more shelf life
- Equipped with complete safety for electrical connections provides more comfort to operators
- Skilled operators, good paddy quality, maintenance of machines set the tone for high-quality outputs
- Finish product evenness, silkiness, good appearance with higher shelf life
- Bran oil is one of the healthiest by-product of rice, full recovery add extra income to miller
- Hygiene in rice processing
- Optimum utilization of capacity man-machine-system. If the capacity of rice mill is more it is more economical viable to run
- Automated plants from Germany & Japan are the new market trends

Up-gradation of rice mill by adopting modern processing technology

1. Soft drying for high moisture paddy (Patil & Singh, 2008)

- Soft drying of paddy is quite a new concept in which moisture transfer takes place from raw paddy to dry husk utilizing dry husk's hygroscopic character without heat stress under normal temperature.
- The running cost of soft drying is low because no heat is required, only aeration is done using high capacity blowers.
- The process provides higher head yield because there is no heat stress to grain as in sun drying or mechanical drying.
- There is no cracking of grain during the process. It is energy saving technique because of no heavy mixing of paddy during drying.
- The drying of moistened paddy is relatively simple as there is no quality concern.
- In the process, dry husks are likely to absorb moisture from raw paddy. Gradually, moisture contents of higher and lower get balanced.

2. Bio polishing (Patil & Singh, 2008)

- Bio-polishing of the rice is done with some selected multi-enzymes having the catalytic properties to degrade the bran layer of rice. The enzymes are the selective biocatalysts, which are very specific to their targeted reactants. Thus through such processes the amount of by-product yield is minimum.
 - The salient features of bio-polishing are no loss in head rice yield, nutrient rich than milled rice, fibre content more than milled rice, with benefits of germinated brown rice, softer with less cooking time than brown rice, enzyme treated rice has been found to have better shelf-life as compared to the non-treated rice, enzymatically treated rice possessed higher antioxidant potential, free amino acids, crude fibre and phenolics as compared to the non-treated rice.
 - There are many benefits of bio-polishing, such as mechanical damage to rice kernel can be avoided, parboiling process can be skipped, nutrient loss or weight loss can be avoided, selective bio-polishing has helped to retain the mineral with minor losses in Magnesium, Iron and Zinc, while Calcium content increased by 10%, enzymatic treatment exhibited more positive effect on water uptake ratio and volume expansion ratio, less cooking time, and easier for digestion.
- #### **3. Pneumatic rubber roll sheller technology**
- Dehusking using rubber roll shellers reduces the risk of breaking the grain because husk is pulled off almost at once and pressure is applied by means of resilient surfaces across the width of the grain, where kernels, generally are much more uniform than they are by length.
 - The process does not remove the internal epidermis of the husk. Thus the deshelled grains with their silver skin envelope are protected against scratches and keep longer and better while the silver skin and the germ increases the quantity of bran which is produced while whitening.
 - The improved rice mills have a better husk and rice bran aspiration system. The same prevents mixing of fine brokens with rice bran. Therefore the quality of rice bran obtained is better.

- 4. Energy saving technology** (Goel et al., 2014)
- Paddy cleaner blower operates throughout the year and hence its system efficiency should be analysed and improved
 - The hot water after soaking may be wasted as a drain that represents enthalpy loss
 - The system efficiency of the de-husker, pre-cleaner, dryer blowers should be site specific
 - The polishers are having high rated motors. A motor load survey should be carried out.

Modern rice mill features

1. Pre cleaner

- High separating efficiency.
- Easy alignment of motor with adjustable sieves
- Robust construction with low maintenance requirements.

2. Destoner

- No loss of grains with easy discharge of stones
- Very Low Maintenance with permanent lubrication and easy access to sieves for cleaning or replacement
- Compact design requires less installation space. In place of pulleys, belts, eccentric bearings, etc vibratory drive can be used.

3. Husker

- Advantages of decreased breakage, greater aspiration efficiency and significantly improved rubber roll life.

4. Paddy separator

- Constant and stable separating performance.
- Compact design and large capacity to minimize installation space.
- Special outlets for rice inspection of quality and flow
- Easy Flow Adjustment

5. Rice whitener

- Gentle milling of brown rice over a larger milling surface to ensure a greater Whiteness in a process
- Quicker removal of bran from the screens to improve performance of screens in a continuous operation
- Maintain temperature during milling operation

- This retains the good characteristics of rice while it is milled gently
- Fully automatic plant to maintain quality of produce with minimum human energy expenditure

6. Rice polisher

- The surface of milled rice should be smooth and clean to enhance commercial value.
- Removal of residual bran to gives rice a longer shelf life
- Milling rolls and screens are chosen to minimize breakage of rice kernels
- Suitable of wide varieties of rice

7. Rotary shifter

- Shifting of milled rice efficiently and accurately into 5 to 7 classes: large broken, medium broken, small broken, tips, bran, etc.
- Wide Choice of Sieve Combinations
- Completely Sealed Sieve Frame to prevent dust from escaping the machine, which ensures clean operation and improves plant sanitation.

8. Length grader

- Length graders are indispensable for producing high quality products in rice milling and seed cleaning plants, since the broken or shorter grains that are more than half the length of whole grain are difficult to separate through sieving or thickness / width grading.
- The grains which are longer in length drop out of the indents before they reach the catch trough.

9. Colour Sorter

- Higher Quality Sorting of grains removes all impurities from rice i.e. black rice, chalky grain, and paddy if any
- Simple sorting control makes it easy for operator to achieve maximum sorting performance with minimum training

REFERENCES

- Goyal, S. K., Jogdand, S. V., & Agrawal, A. K. (2014). Energy use pattern in rice milling industries—a critical appraisal. *J Food Sci Technol (November 2014)* 51(11), 2907–2916.
- Patil, R. T., & Singh, K. K. (2008). Innovations in Rice Processing. *Agricultural Engineering Today*. 32(4), 13-18.