TECHNICAL BULLETIN

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Two-Stage Drying Technique for High-Moisture Grains

Quick and efficient drying of high-moisture grains, especially those of Maize, is a critical post-harvest processing issue in Bangladesh as Maize production has increased significantly from 1.5 to 2.8 million tons in the recent years. Efficient management of the influx of freshly harvested grains, especially during rainy seasons, is an important factor to the growers and processors for maintaining grain quality. At the industry level, only the LSU (Louisiana State University) type dryer is used for rice grain drying. In case of Maize, the sun drying method is the common practice in Bangladesh, but there is a high risk of grain quality deterioration, microbial infestation and wastage in this traditional grain drying method.

Huge amounts of freshly harvested paddy and maize go to waste due to lack of appropriate and rapid drying techniques at the farm level. This problem becomes severe during the peak harvesting season in May –June due to heavy and continuous rainfall. To date, the two-stage drying practice using high temperature fluidized bed dryer followed by any low temperature dryer has not been in use in the commercial grain drying sector of Bangladesh. Besides single stage, two-stage paddy drying is being practiced at the industry level in many humid countries such as Thailand, the Philippines, Indonesia, Taiwan and Malaysia. The use of high temperature between 100 and 150^{o}C in the first stage drying by fluidized bed dryer may result in reducing microbial hazards in grains. This project was implemented by the Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur to develop and evaluate an efficient two-stage drying technique for quick drying of high-moisture Paddy and Maize grains.

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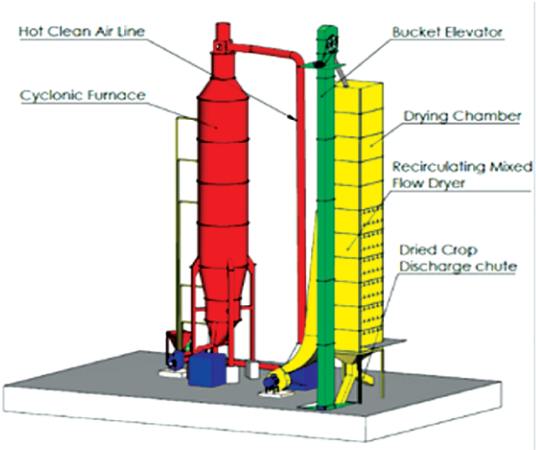

Methodology

This was a collaborative research work carried out jointly by researchers from public (HSTU) and private sectors. The major activities of the project comprised:

- Baseline survey to evaluate the status of existing Paddy and Maize drying systems in selected areas of Bangladesh
- Mathematical modeling and computer simulation program were developed for fluidized bed drying of grain (Paddy and Maize)
- Design and fabrication of lab scale fluidized bed dryer for drying of Paddy and Maize in first stage drying
- Design and fabrication of lab scale Louisiana State University (LSU) dryer for drying of Paddy and Maize in second stage
- Design and fabrication of lab scale fixed bed dryer for drying of Paddy and Maize in second stage
- Design and fabrication of prototype to commercial scale dryers

- Extensive experiments were conducted using laboratory dryers to investigate the effect of drying parameters on quality of dried products
- Commercialization of the developed drying techniques in the country.

Specific energy consumption analysis

For each drying method, the specific electrical energy consumption (SPEEC) in kWh/t was calculated as follows:

$$SPEEC = \frac{R_T}{W_P}$$

where, W_p = amount of moist paddy dried (t) in a batch

$E_T = E_m + E_b$, E_T = total electrical energy, kWh

Total thermal energy was calculated using the following equation:

Eth- Hw x Ch x t

E_{th} = thermal energy, MJ; H_w is the rice husk consumption rate, kg/h; C_h is the heat value of rice husk, MJ/kg (the value of Ch was considered 13.4 MJ/kg)

The specific thermal energy consumption (SPTEC) in MJ/t was also calculated as follows:

$$SFTEC = \frac{E_{th}}{W_P}$$

Quality assessment for dried rice

Milling of dried paddy was carried out using the SATAKE de-husker and polisher in the laboratory of the Dept. of Food Engineering and Technology. After polishing, head rice and broken rice were separated manually from the total milled rice in the laboratory. Finally, % head rice yield and % milling recovery were calculated as follows:

Head Rice Yield (HRY)

Head rice yield was determined by the following relationship:

$$\%\text{Head rice yield} = \frac{\text{Weight of head rice}}{\text{Weight of dried paddy sample}} \times 100$$

Milling recovery

Milling recovery was calculated as follows:

$$\%\text{Milling recovery} = \frac{\text{Amount of milled rice (head rice and broken rice)}}{\text{Weight of dried paddy sample}} \times 100$$

Results and Outputs

- Lab scale fluidized bed, LSU and fixed bed dryers and equipment are available and fully ready for use in grain drying experiments and other research in the laboratory of the Department of Food Engineering and Technology, HSTU
- New drying technologies have been developed: High-moisture paddy and maize can be dried quickly (in only 4-6 hrs) by the developed drying techniques in contrast to existing drying practices where drying time is usually10 to 20 hrs

Grain	Amount of grain dried in a batch (kg)	Drying time (hr)	Drying cost (Tk/kg)	% HRY
Fresh paddy	6000	5-6	0.5 to 0.7	61±0.2
Parboiled paddy	6000	6-7	0.6 to 0.7	63±0.40
Maize	7200	5-6	0.4 to 0.60	-

The proposed "HSTU Multi-Crop Dryer" comprising two types of dryer namely, fluidized bed dryer and recirculating mixed flow dryer associated with innovative grain conditioner employed with zigzag free falling and cooling system is a novel drying plant that is capable of drying 14-21 t/day in two/three batches of grain reducing moisture content of 22-27 % to 13 to 14% in only 4 to 6 hrs at a reasonable level of energy consumption

- Better quality dried grain is obtained.

Benefits and Outcomes

- Two students graduated with the Master's degree having practical knowledge in the design, fabrication and operation of fluidized bed, LSU type and fixed bed dryers who can contribute to the grain drying sector of the country; private sector workers developed skill and gained experience in the design and fabrication of grain dryers
- Skill and confidence in fabricating commercial scale dryers using locally available materials have been built with the prospect of substantially reducing fabrication time and costs
- Research facilities have been developed at HSTU for further R&D work on grain drying; use of environment friendly and energy efficient heating unit will reduce environmental pollution caused by rice mills in Bangladesh
- Two units of the "HSTU Multi-Crop Dryer" have already been commercialized.

Expected Impact

The present labor intensive and sun-dependent grain drying method in Bangladesh is not safe and profitable. The newly developed drying technique is not dependent on the sun, is energy efficient, eco-friendly and cost-effective. Moreover, grain producers and processors will need a much smaller space for grain drying. Finally, grain producers, traders and consumers will be

highly benefited by the substantial improvement in the quality of grains due to a shift from traditional grain drying methods to that of machine drying.

Recommendations

- The developed dryers need to be made available to the farmers and millers by ensuring subsidies under the Farm Mechanization through Integrated Management projects.
- New mechanization and motivation programs should be undertaken through government pilot projects to introduce the grain drying technology in the country for quick post-harvest processing of freshly harvested high-moisture Paddy and Maize especially in the rainy season.
- Further research is needed to develop the technology of using solar energy
- CHP (combined heat power) in grain drying to make the process more energy efficient and environment friendly needs to be developed.

This technical bulletin has been prepared on the basis of technical information available from a completed CGP project of KGF, the details of which are given below:

Project Code and Title: TF 29-AM/15. Design and development of two-stage drying technique for drying high moisture grains

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