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Paddy storage status at rice mill and farm household levels of Mymensingh Division in Bangladesh

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ABSTRACT

Long time storage of paddy is a concerning issue at farm households and rice mills of Bangladesh due to inadequate sustainable storage technologies. Hence, paddy storage facilities of 20 rice mills and 40 farm households of Mymensingh division were investigated following semi-structured questionnaires to know the existing paddy storage technologies, problems, and future needs. Traditional gunny bags are used in rice mills for storing consumable paddy whereas 77.5%, 20%, and 2.5% farmers use dole, gunny bag and plastic bag, respectively. About 60%, 17.5%, and 7.5% farmers under the study use GrainPro bag, metal/plastic drum, and motka, respectively for storing paddy seed. Despite using preventive chemicals about 2.4%, 3.4%, and 3.3% paddy loss occurs during storage in automatic, semi-automatic, and major rice mills, respectively. To solve problem, about 80% of rice mill owners demanded for hermetic cocoon.

Keywords: Hermetic storage, paddy, rice mill, storage loss, traditional storage

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1 Introduction

Paddy is one of the most strategic commodities for the world and is closely connected with food security and financial solvency of rural communities. More than 90% of world's paddy is consumed in Asia (IRRI, 2013). Paddy is the staple food crop of Bangladesh and is grown on about 10.5 million ha of land (about 75% of the total cropped area and over 80% of the total irrigated area). Almost all of the 13 million farm families of the country grow paddy. Paddy farming provides nearly 48% of rural employment (BRRI, 2011). Currently, Bangladesh possesses over 167 million people with an annual growth rate of 0.98% (WPR, 2022). If the current population growth rate continues, population will reach up to 215.4 million in 2050, and the country will face enormous problem for feeding the estimated population. Thus, Bangladesh will require about 44.6 million tons of white rice by the year 2050. But, it is estimated that, cultivation area of paddy will shrink to 10.28 million ha by this time (Kabir et al., 2016). Paddy yield therefore needs to be increased from the present 2.74 to 3.74 t ha^{-1} (BBS, 2008). So, to attain self-sufficiency in paddy production, postharvest loss reduction of paddy can be an efficient solution for facing the upcoming food demanding challenges. Storage is one of the most critical postharvest operation. Amongst the total 14% postharvest loss about 6% loss occur in storage (Awal et al., 2017). Traditional methods of storing are attributed for this huge loss. Warm temperatures (10 °C to 37 °C) and high ranges of relative humidity (43% to 89%) of Bangladesh favor rapid insect infestation unless properly dried and stored (Hossain et al., 2017). Farmers of Bangladesh usually store paddy and seed

paddy in traditional storage structures/containers like dole, steel drum and motka from one harvest season to the next for a maximum of one year (Hossain et al., 2019) to meet their own consumption, facing emergency financial needs through selling and fulfilling seed requirement for the next sowing season. A portion of paddy in the storage structures/containers at farmer's level is subjected to damages or rotten by the various biotic and abiotic factors. A study covering 1360 farmers from 96 villages across all the divisions of Bangladesh found that average in-store losses occurred for *Aus*, *Aman*, and *Boro* paddy were 3.68%, 3.80% and 4.12%, respectively (Abedin et al., 2012). Significant qualitative and quantitative loss of paddy and seed paddy occur due to the uncontrollable activities of microorganisms, insects, mites, and rodents in traditional storage structures. About 56% of storage loss occurs due to rodents, 41% due to insects and only 3% due to birds in case of traditional storing methods (Saha et al., 1996). A comparative study on traditional storage technologies and improved hermetic technologies in Bangladesh found that, hermetic storage technologies are more suitable than traditional storage technologies. Paddy stored in GrainPro and PICS bag were found better than traditional technologies such as dole, motka, plastic drum, and plastic bag considering storage period, weight loss, and minimum damage caused by insects (Hossain, 2020). Highest insect infestation of stored paddy was found in motka (157 insects/250 g paddy) followed by dole (137), plastic bag (48) and plastic drum (20), whereas no insect infestation was observed in GrainPro and PICS bag (Awal et al., 2017).

Quality seed is essential for desirable production of paddy. Bangladesh require about 0.35 million metric ton of seed paddy in a year. Of the total demand about 75.6% is produced and stored by rural farmers and only 24.4% is supplied by Bangladesh Agricultural Development Corporation (BADC) - a national seed production, processing and storage center (IRRI, 2020). Actually, during storage at farmers house seed paddy affected by pest and molds which hampers seed viability resulting in less production (Mia et al., 2000). Seed with high germination power can contribute in producing more crop. But traditional way of seed storage is inappropriate for seed health and vigor. Germination percentage of paddy seed in PICS bag, GrainPro bag, plastic drum, plastic bag, motka, and dole were found 93%, 91%, 81%, 67%, 54%, and 42%, respectively. Germination rate of seed paddy stored in traditional methods was unsatisfactory compared to hermetic technologies and standard acceptable range ($\geq$80%) (Awal et al., 2017). Paddy yield largely depends on seed quality. Therefore, seed paddy should be stored properly for sustainable crop production.

Wet basis moisture content of paddy at harvest time ranges from 18 to 30% (Brooker et al., 1982) and depending on the purpose of use and storage period harvested paddy should be dried to 12-14% moisture content prior to storage (Ullah and Abedin, 1991; RKB, 2022). Farmers cannot store paddy for longer period of time in their houses due to the lack of proper storage systems. For this reason, farmers are bound to sell their paddy immediately after harvesting either to the traders or directly to the rice mills. Thus, they usually deprived from the colossal price of paddy during off season. Rice mills usually convert paddy into white rice. 17000 rice mills of Bangladesh are also a crucial actor in maintaining rice supply chain throughout the country (Saha and Sarkar, 2021). Rice mill owners along with their commission agents and arotder try to procure paddy during harvesting time at a flat rate and store the paddy for processing up to the next few months. But, they face problem in managing ample quantity of paddy due to the unavailability of proper storage facilities. Though few researchers have previously worked on hermetic storage technology but market demand of improved storage technology has not been studied yet. Hence, the study was conducted at rice mills and at farm households to know the existing paddy storage practice and identify the future need for further intervention.

2 Methodology

2.1 Location, sample size, and duration of the study

This study was conducted in Mymensingh, Sherpur and Netrokona districts of Bangladesh. Rice mills of the study area were divided into 3 groups such as automatic rice mills, semi-automatic rice mills, and major rice mills, following stratified random sampling technique to have a meaningful insight about storage technology of rice mills in Bangladesh. Actually, information about the total number of rice mill in Mymensingh division is scarce in literature. Therefore, the study selected 20 rice mills (Automatic: 07, Semi-automatic: 07, and Major: 06) following snowball sampling technique for collecting necessary data related to the storage system. Each rice mill will be represented by a unique code number (Table 1). In addition, data were collected from 40 farm households of Phulpur and Shyamganj upazilas of Mymensingh and Netrokona districts, respectively. The timeframe of the study was November 2020 to November 2021.

2.2 Interview schedule and key informants

Separate semi-structured questionnaires were prepared for collecting data at rice mills and at farm household. The interview schedules were finalized through pre-testing. The owner, manager and work-

Table 1. Rice mills under study area with code number

Rice mill type	Name of rice mill	Code number
Automatic (A)	Wahed Auto Rice mill	A1
	Chandan Auto Rice Mill	A2
	Phulpur Agro industries	A3
	Millers Limited	A4
	Kakoli Agro Industries Limited	A5
	Akbar Auto Rice mill	A6
	New Arafat Auto Rice mill	A7
Semi-automatic (S)	Jamuna Auto Rice mill	S1
	Jaker Auto Rice mill	S2
	Sakhina Mini Auto rice mill	S3
	Fakir Auto Rice mill	S4
	Pachvai Auto Rice mill	S5
	Shampa Auto Rice mill	S6
	Moti Auto Rice mill	S7
Major (M)	S R rice and flour mill	M1
	Munshi Rice mill	M2
	Talukdar Rice mill	M3
	Juminar Rice mill	M4
	Cheragali Rice mill	M5
	Pachtara Rice mill	M6

ers of storage section of rice mills were selected as the key informants in case of rice mill survey whereas, female/male farmers who had the experience of storing paddy at least one year were selected for collecting data related to paddy storage at farm household level.

2.3 Storage practices at rice mills and at farm household

Present storage status such as storing method, structure, capacity, duration, loss of paddy during storage, management practices during paddy storage, ventilation system of warehouse, and frequency of pesticide application during storage was collected from the respective key informants. The storage structures were also inspected physically. The respondents were also interviewed about the problems of paddy storing that they actually face. Moreover, existing paddy management pathway was also investigated.

2.3.1 Storage facility

Existing paddy storage methods at rice mills and at farmers' level were investigated and represented as percentage using following Equation 1.

$$\text{Storage methods (\%)} = \frac{N_s}{T_n} \times 100 \qquad (1)$$

where, N_s = number of respondents used similar storage method, and T_n = total number of respondents of the same category.

2.3.2 Postharvest loss of paddy during storage

Postharvest loss occurs in one ton paddy for one week storage period was measured (Equation 2) from the weight of paddy before and after storage and expressed as percentage (FAO, 1980; Basavaraja et al., 2007; Gangwar et al., 2007).

$$\text{Loss (\%)} = \frac{W_b - W_a}{W_b} \times 100 \qquad (2)$$

where, W_b = weight of paddy before storage (kg), and W_a = weight of paddy after storage (kg).

2.4 Perception about improved storage technology

Hermetic Cocoon (capacity: 5 metric ton), GrainPro bag (capacity: 50 kg) and silo (capacity: 3 metric ton) are considered as improved storage technologies as they can store products for longer period of time in good condition (Alam et al., 2022; Awal et al., 2017; Tefera and Mendesil, 2020). Opinion of respondents about improved storage technology is important to assess market demand. Hence, opinion was taken from the rice mill owners and farmers about improved storage technology and represented as percentage using following Equations 3 and 4.

$$\text{Perception of rice mill owner (\%)} = \frac{N_{rm}}{T_r} \times 100 \qquad (3)$$

$$\text{Perception of farmers (\%)} = \frac{N_f}{T_f} \times 100 \qquad (4)$$

where, N_{rm} = number of rice mill owners agreed, N_f = number of farmers agreed, T_r = total number of rice mills, and T_f = total number of farmers.

3 Results and Discussion

3.1 Existing storage technologies at rice mills

Entire processing operations of rice mills were investigated in particular focus on the storage system. Rice mills procure paddy from the farm house/foria/arotder and produce either parboiled or aromatic rice (Fig. 1). They also store paddy in a traditional storage structure and in gunny bag following drying operation. Storage structures of almost all rice mills are semi-concrete. Even, they do not monitor temperature, grain moisture and humidity of the storage house. Here, moisture content of paddy stored in traditional storage changes with time and for that reason second time drying operation is needed before milling operation. Second time drying means additional cost of paddy processing. Rice mills usually sell rice to the dealer, trader, government rice procuring bodies or at the local open market. About 90% of rice mills use pesticides to protect the paddy from insect, rodent and fungus attack.About 10% of rice mills had modern storage facilities such as hermetic cocoon and improved ventilation system in godown.

3.2 Existing storage technologies at farm households

Farmers more often sell their harvested paddy from field at a flat rate during peak harvesting time. They store only a little quantity of paddy necessary for own consumption purpose or fulfilling personal need up to the next season or will be used as paddy seed in the next season (Fig. 2). They use only rodent repellent during storage of paddy. Farmers under the study area had also the provision of mechanical drying and improved storage facility along with sun drying and traditional storage systems. They were found to dry paddy using BAU-STR dryer before storing paddy. Six different storage technologies i.e. Dole (cylindrical or oval shaped wattle made container of capacity 180-1000 kg), Gunny bag (jute bag of capacity 40-50 kg), Plastic bag (poly propylene bag of capacity 40-50 kg), GrinPro bag (hermetic bag of capacity 40-50 kg), Metal/Plastic drum (cylindrical shaped structure made of steel/plastic of capacity 50-100 kg), and Motka (earthen container of capacity 80-200 kg) were found at farm household level. Among these, Dole and gunny bag were used for short time storage of paddy. On the other hand, plastic bag, motka and steel/plastic drum were used for long time storage. About 77.5% of farmers used dole, 20% used gunny bags and 2.5% used plastic bags for storing consumable paddy. But in case of paddy seed storage, about 60% of farmers used GrainPro bags, 17.5% used metal/plastic drum, 7.5% used motka and 15% of respondents usually bought paddy seed from market whenever required (Table 2).

3.3 Storage capacity of rice mills

All the rice mill owners usually procure paddy from arotder and sometimes from local market. The arotder are trustworthy to the millers and supply paddy on demand. According to the rice mill owners, they get paddy from the arotders whenever necessary and they did not face any shortage of paddy for operating rice mill. Owing to this reason, now they do not store paddy for longer period of time. They store paddy only for 7-15 days and only those quantity of paddy is stored which is necessary for running the mills during those time. From the Table 3, it is seen that the storage capacity of automatic and semi-automatic rice mill is quite good but they store only a meager quantity of paddy. The major rice mill is a traditional mill and they actually had very poor storage facility. However, they actually utilized their potential storage capacity.

3.4 Postharvest loss of paddy during storage at rice mill

Rice mill owners do their best for keeping the storage facility in good condition. They usually apply Aluminum Phosphide on 7-15 days interval, Phostoxin and Ponder on 15 days interval as a regular maintenance of their storage structures. Automatic, semi-automatic, and major rice mill owners expressed that on an average, they expend on preventive chemicals about BDT 346, BDT 389, and BDT 400, respectively to store 1 ton of paddy for a week. Despite this preventive measure, the percent losses of paddy were as follows: 2.4% in automatic, 3.4% in semi-automatic and 3.3% in major rice mills (Table 4). About 90% of rice mill owners said that, rodent attack is the most common reason for this loss. Rice mills process about 70% of total paddy per annum in Bangladesh (Ahamed et al., 2023) and so storage loss is a concerning issue for national food security. Therefore, this existing storage system is inefficient for paddy storage and there is a need for improved storage systems in rice mills.

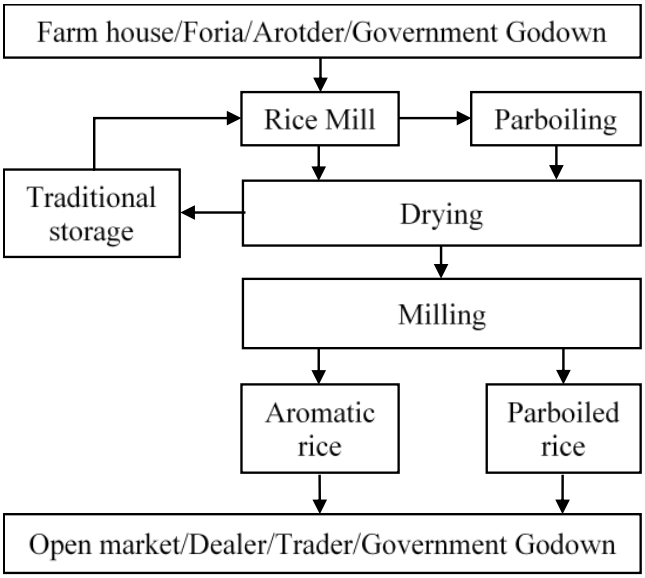

Figure 1. Existing paddy management system of rice mills

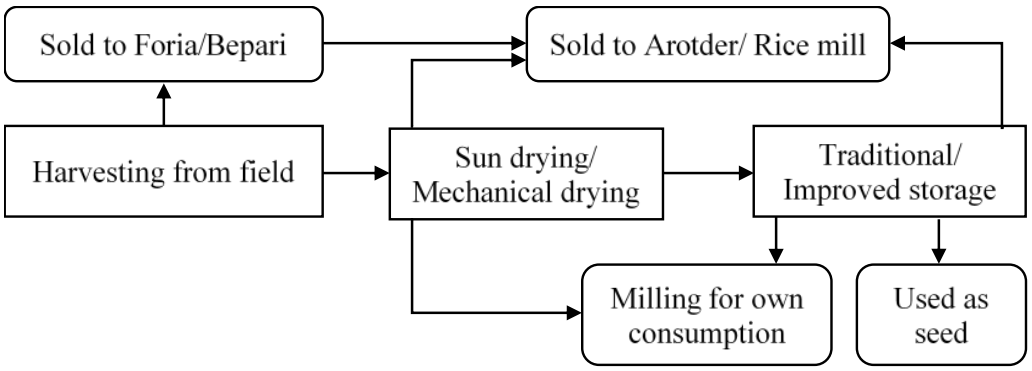

Figure 2. Existing paddy management system of farm household

Table 2. Paddy storing methods at farm household

Grain type	Storing methods	Number of farmers used	Farmers used (%)
Paddy	Dole	31	77.5
	Gunny bag	8	20
	Plastic bag	1	2.5
Paddy seed	GrainPro bag	24	60
	Metal/plastic drum	7	17.5
	Motka	3	7.5
	Buy seed	6	15

Table 3. Storage capacity of automatic, semi-automatic and major rice mills

Rice mill type	Rice mill	Storage capacity (t)	Maximum stored (t)
Automatic	A1	2000	160
	A2	15000	300
	A3	2000	400
	A4	1000	–
	A5	1840	144
	A6	2400	800
	A7	1600	200
Semi-automatic	S1	3000	-
	S2	200	240
	S3	350	200
	S4	2400	40
	S5	720	32
	S6	2000	64
	S7	200	12
Major	M1	120	18
	M2	200	168
	M3	48	240
	M4	192	48
	M5	*	–
	M6	48	24

Have no storage facility (*); does not store (–)

Table 4. Postharvest loss of paddy during storage in rice mills

Rice mill type	Rice mill	Storage duration	loss (kg t^{-1} wk^{-1})	Avg. loss (kg t^{-1})	Avg. loss in (%)
Automatic	A1	7	37.5	24	2.4
	A2	7	25		
	A3	7	12.5		
	A4	–	–		
	A5	5	52.5		
	A6	7	12.5		
	A7	10	4.5		
Semi-automatic	S1	–	–	34	3.4
	S2	7	37.5		
	S3	7	37.5		
	S4	7	25		
	S5	10	26.55		
	S6	7	37.5		
	S7	7	37.5		
Major	M1	7	50	33	3.3
	M2	10	26.5		
	M3	15	14.5		
	M4	7	37.5		
	M5	–	–		
	M6	7	37.5		

Does not store (–)

Table 5. Perception of rice mill owners about improved storage technology

Improved storage technology	Number of rice mill owners opined	Rice mill owners opined (%)
Hermetic Cocoon	16	80
GrainPro bag	1	5
Silo	1	5
No reply	2	10

3.5 Perception of rice mill owners about improved storage technologies

Amongst the 20 rice mill owners about 80% respondents opined for Hermetic Cocoon to solve the existing paddy storing problem. GrainPro bag and silo were demanded by 10% respondents. About 10% respondents did not provide any response regarding to the improved storage technology (Table 5). However, unavailability of hermetic cocoon in local market is a concerning issue for widespread adoption of this improved technology.

4 Conclusion

The traditional paddy storage system in the rice mills and farm households are ineffective for long term storage of paddy. The rice mill owners are now aware about improved storage technology and 80% of them are willing to adopt hermetic cocoon for bulk storage of paddy. However, availability of hermetic cocoon should be ensured in local market at low price for widespread adoption of this technology and to reduce postharvest loss of paddy during storage.

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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