

Indigenous storage structures for paddy in North East region

Reema Kshetrimayum¹ and Ngankham Joykumar Singh^{2#}



Summary

The effect of different indigenous storage methods on the quality of rice during the storage period was studied. Four different varieties of paddy were stored in different storage structures as indigenous types, such as *Kot* (small bamboo structures), *Kei* (large size storage structure), wooden structures and metal bins separately, and the total head rice recovery of rice during storage period was studied. The maximum head rice yield was found in the KD cultivar and the minimum in the Huikap cultivar. The different physical dimensions and characteristics of paddy influenced the breakage of paddy, affecting the total head rice recovery during storage. Long, slender grains are more susceptible to breakage, affecting the head yield.

JAE 2022, Vol 14

Received: 22 October 2022

Accepted: 20 November 2022

Published: 25 December 2022

<https://doi.org/10.58628/JAE-2214-226>

Associated Editor: Dr. Anita Meena

Copyright © 2022 The Author(s). Published by Society for Agriculture and Arid Ecology Research (SAAER). This is an Open Access article under the Creative Commons Attribution License 4.0 (CC BY-NC-SA).



Keywords: Paddy, storage structure, Indigenous, NEH region

Introduction

Rice is a major crop in the North-eastern states of India, especially Manipur, Assam, Bihar and West Bengal. Out of 28 million ha. of paddy land, some 20 million ha. belong to the most fragile rainfed ecosystem. This region's average paddy productivity (1.2 to 1.4 tonnes per ha.) has always been below that of the national average (1.9 tonnes per ha.) mainly due to biotic, abiotic and socioeconomic constraints. The irrigated ecosystem's high yield is now plateauing or showing a declining trend. The region experiences medium to heavy rainfall ranging from 1600 to 2800 mm annual rainfall. Land holding of the majority of the farmers is either small to medium, ranging from 1.5 to 3 ha. The availability of modern warehouse and godown are very scanty. Farmers store their food grains about 70% of their produce in a traditional way and are not very much aware of the quantum of losses. A novel technology is developed to polish rice with the help of cellulosic enzymes of microbial sources (Kothakota et al 2015). The storage of paddy is practised in indigenous types such as *Kot* (small bamboo structures) and *Kei* (large-size storage structure), which is known to encounter quantitative storage losses of about 7-10%, thereby losses the germination capacity of seeds. The percentage of germination capacity was extensively determined by Singh et al 2014 and Agrawal et al 1973. The capacity of *kot* ranges from 1.5 to 5 tonnes. The major storage loss is caused due to rates, mites, birds and moist grains. The storage loss in this type is about 5-9%. *Keis* are semi-permanent structures. The capacity of *kei* varies from 10 to 25 tones. These two bulk storage methods do not have the provision for fumigation and other rodent protective measures. Besides, the rice millers in Manipur

still use the traditional hullers, and in some conditions, huge loss in the form of broken (20-30%) and total rice yield (5-10%) is caused. It is a matter of concern now to bridge the gap between rice productivity and its availability to farmers for consumption and marketing. This is possible only through loss prevention and value addition by adopting improved techniques of processing and preservation of rice at post-production stage (Dash et al.1997). Such an approach further ensures additional income to the farmers, thereby making rice farming profitable and sustainable.

The rice obtained from the freshly harvested paddy is less suitable both for processing and culinary utilization, whereas adequate ageing brings about desirable properties for the purpose. Freshly harvested grains of all varieties of paddy exhibit poor milling and cooking characteristics (Peredon et al. 1997). Thus, post-harvest technology plays an important role in improving the availability of rice in the state. After harvest and threshing of rice, a series of operations such as cleaning, drying, storage and milling are undertaken. It is during these operations as substantial amount (10-15%) of the grain is lost due to improper handling, thereby affecting the rice availability for consumption and for marketing (Ojha 1978).

Several attempts have been made in the past to study and develop farm-level storage systems for food and seeds. Bhatnagar (1969) reported a replicated study on the Punjab Agricultural University (PAU) steel buns, indigenous mud bins and polyethylene-lined mud bins for storage of wheat seed for a year. The grain stored in mud bins displayed higher moisture levels, higher incidence of infestation and germination values. Basnet & Jindal (1982) reported the changes in quality in terms of moisture content, bulk density, per cent germination, milling yield and breakage strength of stored paddy in traditional bamboo bins and two ferro-cement bins of conical and cylindrical shape. The bamboo bin was

¹Ph.D Scholar, BCKV, Nadia

²College of Food Technology, Central Agricultural University, Imphal - 795004

[#]Corresponding author NJ Singh, E-mail: joyngang@gmail.com

reported to be superior in maintaining an overall better quality of paddy during the four-month of storage period. Bala et al. (1993) reported a replicated study on the storage of paddy in three types of traditional bamboo storage bins of different sizes. They concluded that all these bins can be used for storage of paddy seeds from harvesting to sowing season. Basunia & Takemi (1997) reported the changes of quality rough rice stored in bamboo bins and modern thick paper bags. This study aimed to demonstrate the changes in the physical properties of paddy stored in bamboo storage structures with different treatments using cheap and locally available materials over a period of storage. Considering the above problems, a case study was carried out to introduce improved indigenous storage structures for storing four local paddy cultivars.

Materials and Methods

The improved structures were i) polythene lined bamboo storage structure, ii) metal bin, iii) bamboo storage structure plastered with mud and cow-dung mix and iv) wooden storage structure. These structures were constructed with locally available materials. Effect of different storage structures on quality; milling recoveries (%) on four local cultivars of paddy, viz; KD, Huikap, Leimaphou and RCM-9 were investigated. These cultivars were selected based on their high yield and consumer preference. These paddy cultivars were the origin of the place and have superior quality to or on at par with basmati rice cultivars in quality traits grains at an initial moisture content of 12.5% (d.b.) were stored and changes in its quality parameters were observed for 10 months with an interval of two months.

The physical properties of paddy (length, width, and thickness), moisture content and head rice yield are the major factors responsible for rice's milling and cooking quality. For storage study the freshly harvested four local varieties viz; KD, Huikap, Leimaphou and RCM-9 were collected from paddy breeders in C.A.U. to maintain genetic purity. Collected samples were cleaned off the foreign material such as dust, dirt, chaff etc. using winnower. Paddy loads were sundried for 2-3 days to bring the moisture content to 12-13±0.5% (d.b.) and later on loaded in the different storage structures. These storage structures were set up at farmer's houses and actual observations were recorded at every two months to check the changes in quality characteristics. The effect of different storage structures on moisture content, milling recoveries for four different paddy varieties were studied. Changes in moisture content inside the grain mass were recorded by inserting the digital moisture probe at different depths of the storage structure every month starting from Nov, 2013 to September, 2014 kept under natural environmental conditions in farmer's house (AOAC, 1984)

Milling experiments were also carried to find out the milling quality such as head rice recovery. A sample

size of 200 g of different varieties of paddy was taken out from the storage structures for every two months. The milling process was carried in two operations, dehusking and polishing. Dehusking was carried out in 'Satake' laboratory sheller. The output of the sheller consisted of the brown rice, husk and unhusked paddy which were collected separately in polythene bags. The unshelled paddy and broken in the brown rice were separated manually and weighed using an electronic balance. The samples of brown rice were then milled in a 'Satake' rice polisher. The milled rice and bran were collected separately and weighed. The broken (less than 3/4th the length of the whole rice) were separated manually as well as mechanically and then weighed. Later on percentage head rice recovery was calculated. The experiments were repeated for three replications for all the four varieties.

Results and Discussion

Experiments were conducted on four local paddy varieties of Manipur (KD, Huikap, Leimaphou and RCM-9) at a moisture content 12.5±0.5% (w.b.) to study the effect of different storage structures on quality characteristics of paddy grain such as change in moisture content and head rice recovery. The variation in moisture content of the paddy stored in different storage structures/bins was recorded during the storage period and graphically presented in Fig.1 to 4. The figures depicted that the moisture content of stored paddy initially decreased up to 3 first months of storage, which later increased as the storage period was extended. The decrease in moisture content initially was due to an increase in the atmospheric temperature and decrease in relative humidity, which caused the drying of stored paddy, and the increase in moisture content of paddy beyond 3 months of storage was due to the increase in relative humidity and decrease in the temperature of atmospheric air which was obvious due occurrence of rains. It can also be seen from the figures that the increase or decrease in the moisture content of stored paddy was not equal in all the bins. This was due to the variable moisture transmission capacity of the different storage structures. The structure wall having higher water vapour transmission rate facilitated a higher increase or decrease in the moisture content of the stored paddy. However highest changes in grain moisture content were observed in bamboo mat structures plastered with mud-cow dung mix in all paddy cultivars (16.10-16.50%) except in KD (15.20%) and the lowest changes were observed in wooden storage structures ranging from 13.75 to 14.22% (w.b.). First shower rainfall usually occurs in the month of April in Manipur. Humidity in the atmosphere during this period starts rising upto 60-70%. The storage structures were found to vary the moisture content depending upon the climatic conditions and rainfall (Shobha, 2006).

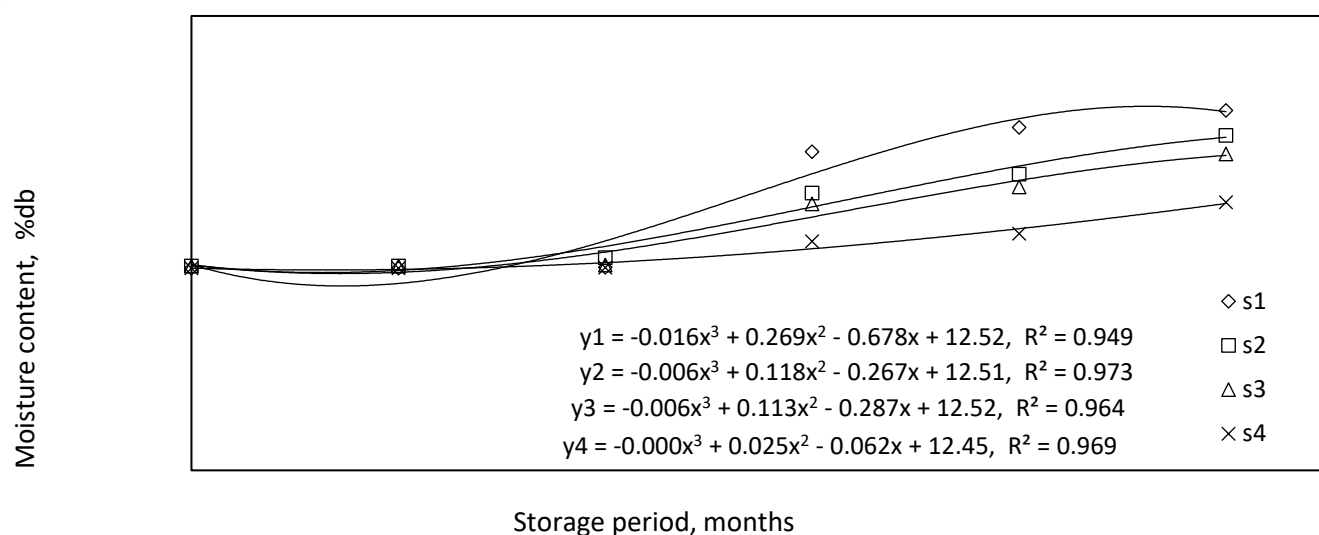


Figure 1. Effect of different storage methods on the moisture content of KD variety

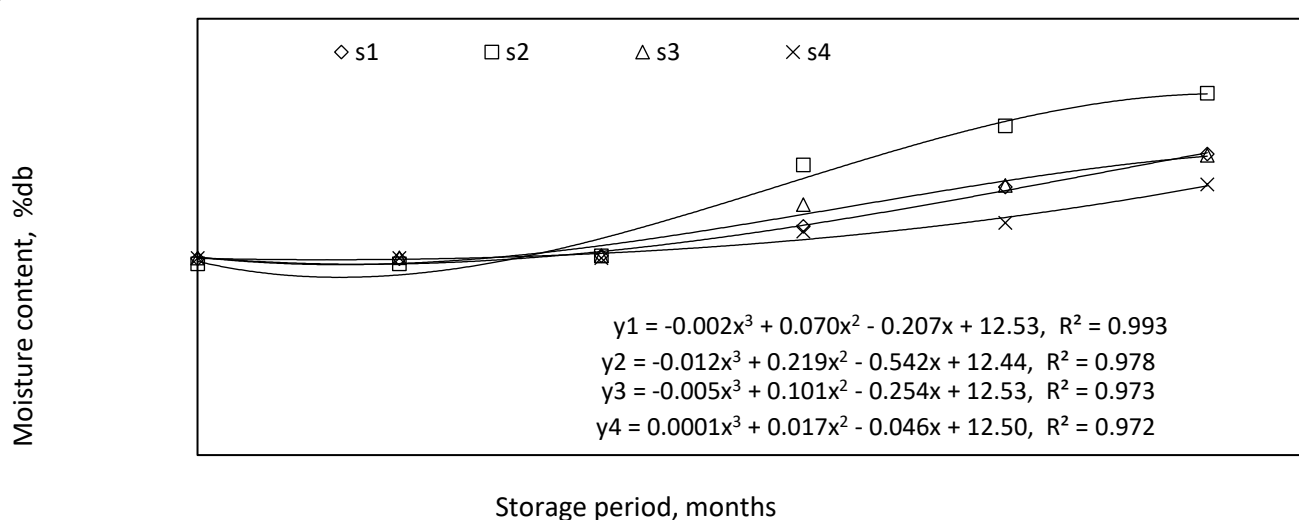


Figure 2. Effect of different storage methods on the moisture content of Huikap variety

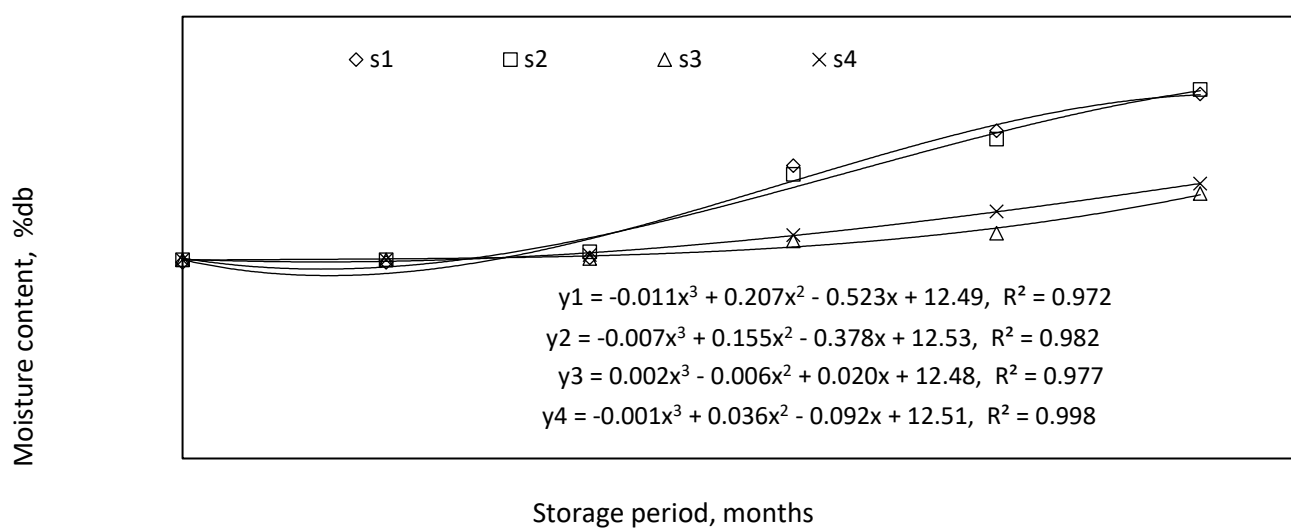


Figure 3. Effect of different storage methods on moisture content of Leimaphou variety

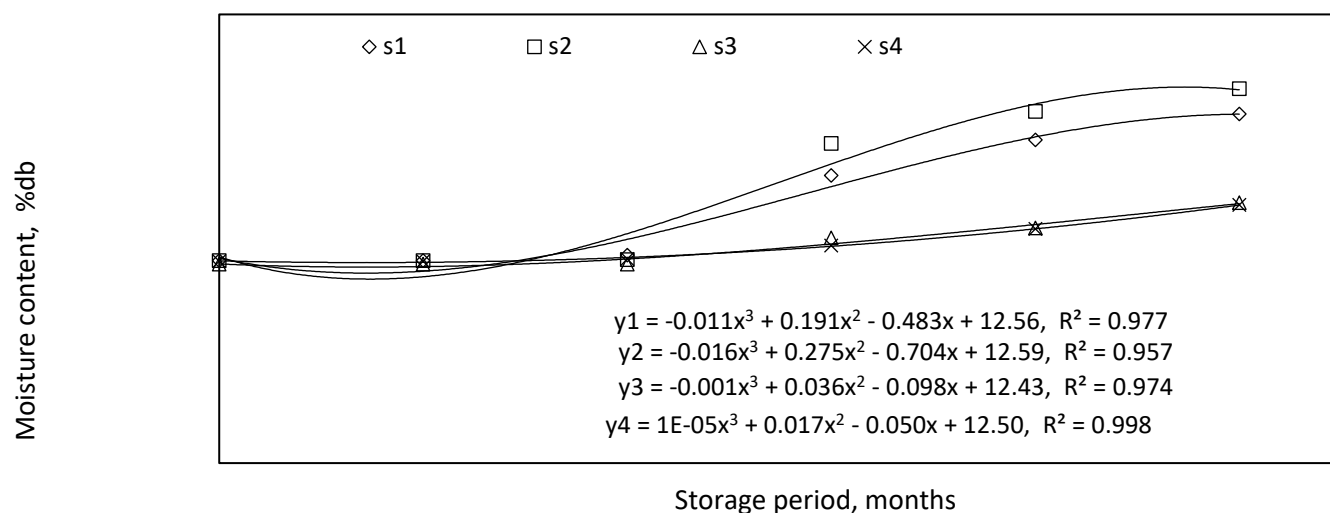


Figure 4. Effect of different storage methods on the moisture content of RCM-9 variety

S1=Polythene lined bamboo mat structure, S2= Bamboo mat structure plastered with mud cowdung mix, S3 = Metal bin & S4 = Wooden storage structure

Table 1. Physical characteristics and head rice recovery of different rice varieties of Manipur (mean values)

Variety	Length, mm	Width, mm	Thick, mm	HRY, %
KD	5.62±1.12	1.85±1.02	1.43±1.16	59.08±2.41
Huikap	7.42±1.35	1.56±1.41	1.25±2.10	55.28±3.49
Leimaphou	5.86±1.05	1.82±1.01	1.35±1.05	58.34±1.74
RCM-9	6.13±1.52	1.64±1.22	1.38±1.35	56.88±3.94

The maximum length of 5.62±1.12 mm, width; 1.85±1.02 and thickness; 1.43±1.16 mm of the grain was observed in Huikap, KD and KD respectively while the minimum value of 5.62±1.12, 1.56±1.41 and 1.25±2.10 mm were observed in KD, Huikap and Huikap respectively. KD and Leimaphou cultivars were slender and medium whereas Huikap and RCM-9 were elongated type. The average value of head rice yield of the cultivars prior to storage are presented in Table 1. The maximum head rice yield was found in KD cultivar and minimum in Huikap cultivar. The physical characteristics of paddy such as length, width and thickness also influenced the breakage of paddy head and thereby affecting the total head rice recovery. Long slender grains are more susceptible to breakage affecting the head yield. This is in agreement with Sun and Siebenmorgen *et al* (1993) and Sahay *et al* (1980). The effects of storage methods on the total head rice recovery of rice during storage period are presented in Table 2. Various mathematical models (linear, exponential and power series) were used to describe the head rice yield with storage period. The following interrelation was developed to correlate the total head rice recovery (HRY) with storage period (ST).

The correlation between the head rice yield (HRY) and storage period (ST) in non-linear relation was found which was with agreement with Rayguru and Pandey (2002) reporting non-linear (exponential model) expression for polishing of aromatic rice. Table 3 lists the statistical parameters of the models. From this, it is observed that equation (1) is more appropriate as its associated error (standard error of estimates, SEE) is less (0.0559-0.1924) and it has a higher correlation coefficient. The final graph also reveals that the

correlation between the head rice recovery and storage period is more significant in the case of KD and Leimaphou cultivars, as indicated by the higher correlation coefficient value (r). Similarly higher value of correlation coefficient ($r > 0.990$) is also observed in the storage structure; wooden bin, resulting in the superior quality rice stored in this method.

Conclusion

Indigenous storage methods based on local resources, at the producer level, are usually well adapted to all the types of grain and the environment in which they are employed. These eco-friendly and safe storage structures in use since very long periods and have withstood the test of time. The introduction of wooden storage bin structures was very much accepted by the farmers. It reduces insect damage and moisture losses and increases the safe storage life of grain and head rice recovery. The highest change in grain moisture content was observed in bamboo mat structures plastered with mud-cowdung mix in all paddy cultivars (16.1-16.5%) except in KD (15.2%) after 10 months and the lowest change was observed in wooden storage structures ranging from 13.8 to 14.2% (w.b.). The highest head rice yield of 65.9% in KD and lowest of 57.0% in Huikap cultivar were observed in wooden structure and bamboo mat structure, respectively. Hence, the improved indigenous storage methods had effects on the quality of different paddy cultivars under study.

Declarations of interests

All authors of this manuscript declare that they have no conflict of interest.

Data sharing

All relevant data are within the manuscript.

References

1. Agarawal PK, Karihaloo JL, Ahmad SMM & Gupta PC. 1973. Predicting germinability in maize, wheat and paddy seeds on the basis of tetrazolium test. *Seed Research*, 1(1): 83-85.
2. AOAC. 1984. Official Methods of Analysis. (14th ed). Association of Official Analytical Chemists. Washington, DC, USA.
3. Bala BK, Zaman MA, Biswas BK & Hussain MI. 1993. Studies of storage paddy in three different types of traditional storage systems. *Journal of Agriculture Engineering, ISAE*, 2(3): 121-137.
4. Basunia MA & Takemi A. 1997. Studies on storage of rough rice in traditional bamboo bin and modern paper bag storage systems. *Journal of Japanese Society of Agriculture Machinery*, 59 (1): 69-76.
5. Basnet PB & Jindal VK. 1982. A comparative study of the quality of paddy stored in tradition and ferrocement bins. *Journal of Ferrocement*, 12 (1): 13-24.
6. Bhatnagar AP. 1969. Performance study of grain storage bins. *Journal of Agriculture Engineering, ISAE*, 6 (2): 48-55.
7. Dash SK, Mohanty SN & Sahoo TB. 1997. Rice postharvest practices in Orissa, India. *Agricultural Mechanisation in Asia, Africa and Latin America*, 28(2): 30-40.
8. Kothakota A, Pandey JP, Ahmed AH, Singh A & Kumar A. 2015. Optimization of Process parameters for enhancing the cooking characteristics of enzymatic ally pretreated brown rice (PSD-15), 9 (1&2): 397-402.
9. Ojha TP. 1978. "Role of Harvest and Post Harvest Technology of Rice Production, Harvesting, Drying and Storage of Rice." *National Symposium on Increasing Rice Yield in Kharif, held at CRRRI*, from 8-11 Feb. *Cuttack*.
10. Peredon A Al, Marks BP, Siebenmorgen TJ & Reid NB. 1997. Effects of rough rice storage conditions on the amylograph cooking properties of medium grain rice. *Cereal Chem.* 74 (6): 864-867.
11. Rayaguru K & Pandey JP. 2002. The influence of extended milling on the head yield profile of aromatic rice. *Int. Rice Research Notes*, 27.2
12. Sahay MN, Dash, AB & Lodh SB. 1980. Effect of polishing time on head rice yield. *Oryza Journal*, 17: 235-237.
13. Singh S, Sinha A, Kumar S & Yadav SM. 2014. Determination of seed germination per cent and effect of *Trichoderma harzianum* Fafai on fresh and stored Seed by different methods. *The Ecoscan*, VI: 181-185.
14. Shobha N, Geeta Channal & Channamma N. 2006. Indigenous grain structures and methods of storage. *Indian Journal of Traditional Knowledge*, 5 (1): 114-117.
15. Sun H & Siebenmorgen TJ. 1993. Milling characteristics of various rough rice kernel thickness fractions. *Cereal Chem*, 70: 727-733.