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Moisture content variations in stacks of paddy, rice (*Oryza sativa*) and wheat (*Triticum aestivum*): A case study

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ABSTRACT

This study depicts the variation of m.c. in stored wheat (*Triticum aestivum* L.), rice (*Oryza sativa* L.) and paddy food grains. The experiment was conducted at the Central Warehousing Corporation Karnal III, Rev. Distt. Karnal, FCI Dist. Karnal, FSD (Food Storage Depot) - Barwala, Rev. Distt. – Hisar, FCI Distt.-Hisar and FSD Naraina, Rev. Distt.-South/west, Delhi, FCI (Food Corporation of India) Distt.-Mayapuri, Delhi, for determining storage losses of food grains. It was observed that wheat stocks gained the weight and was found to be maximum gain of 0.60% (godown) and 0.87% cover and plinth. Rice stacks showed loss in weight, being 2.99% as maximum, while for the paddy stacks the maximum loss was found to be 3.07% (CAP) over 1 year of storage study.Wheat stacks gained weight was less in godown storage than CAP storage structure.

Key words: CAP, Food grains, Godowns, Sampling, Weight gain, Weight loss

Food grains form an important part of the Indian diet. Grain production has been steadily increasing because of advancement in production technology. However, improper storage results in high losses in grains. According to World Bank Report (1999), post-harvest losses in India amount to 12 to 16 million tonnes of food grains each year, an amount that the World Bank stipulates could feed one-third of India's poor. The monetary value of these losses amounts to more than ₹ 50,000 crore per year (Singh, 2010). Thus, the post-harvest losses have impact at both the micro and macro levels of the economy. Natural contamination of food grains is greatly influenced by environmental factors such as type of storage structure, temperature, *p*H, moisture (Sashidhar et al., 1992). Types of structure used, length and purpose of storage, grain treatment (e.g. parboiling) and pre-storage practices are all important variables affecting storage losses. The importance of these regional and crop variations immediately determines certain necessary characteristics of crop storage research (Greeley, 1978). During storage, quantitative as well as qualitative losses occur due to insects, rodents, and micro-organisms. A large number of insect pests have been reported to be associated with stored grains. The occurrence and numbers of stored grain insect pests are directly related to geographical and climatic conditions. Almost all species have remarkably high rates of multiplication and, within one season, may destroy 10-15% of the grain and contaminate the rest with undesirable odours and flavours. Insect pests also play a pivotal role in transportation of storage fungi (Sinha and Sinha, 1990).The storage methods range from mud structures to modern bins. The containers are made from a variety of locally available materials differing in design, shape, size and functions. The materials used include paddy straw, wheat straw, wood, bamboo, reeds, mud, bricks, cowdung etc. Grains can be stored indoors, outdoor or at underground level (Channal et al., 2004). Bulk storage of produce is done mainly in warehouses. Warehouses are scientific storage structures especially constructed for the protection of the quantity and quality of stored products. In India, the warehouses are owned by the Food Corporation of India (FCI), Central Warehousing Corporation (CWC), or the State Warehousing Corporation. The

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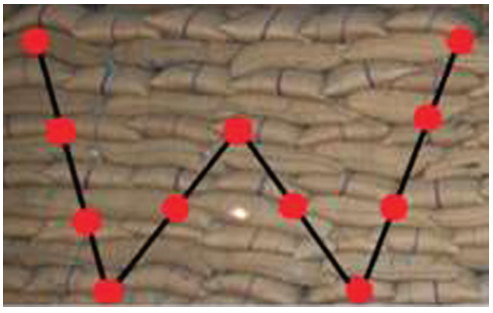

Fig. 1. W form of sample collection

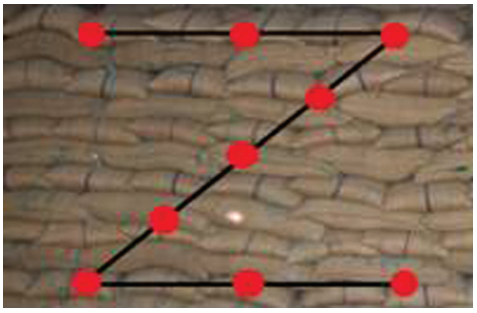

Fig. 2. Z form of sample collection

Fig. 3. Sample collection from subsamples

Food Corporation of India is the single largest agency which store food grains in the warehouses.

At any given time 60-70% of grains is stored on the farm in traditional structures like *kanaja, kothi, Sanduka*, earthern pots, *gummi* and *kacheri*. However, indigenous storage structures are not suitable for storing grains for very long periods. Here in lies the significance of improved storage structures and scientific storage of grains in form of warehouses. These provide safe and economical means of grain storage for long durations (Gaur, 2015).The perennial problem of the National Food Authority is weight loss of cereal stocks in its warehouses. Though warehouses are one of the best storage structures, there are storage losses in the stored grains. An RTI reply has revealed that at least 17,546 tonnes of food grains was damaged between 2009–10 and July 2012 in Food Corporation of India (FCI) godowns (Times of India, 2013). If this is the situation of the India's best storage facilities then the situation of other storages can be thought of. So, it is needed to check the grains randomly to check the infestation and to do whatever is suitable to protect the grains from further damage.

MATERIALS AND METHODS

The stacking of the wheat (*Triticum aestivum* L.), rice (*Oryza sativa* L.) and paddy food grains was carried out in the FCI/CWC warehouses/CAP. The samples were collected from the stacks time to time for further analysis. The experiment on the stored grains was carried out with the collaboration of CWC, Karnal III, Rev. Karnal, FCI Dist. Karnal, Food Storge Depot (FSD)-Barwala, Rev. Dist.- Hisar, FCI Dist.- Hisar and FSD-Naraina, Rev. Dist.-South/West, Delhi, FCI Dist.- Mayapuri, Delhi, India. Weight loss/ gain (weight and m.c. of the stacks from stacking to liquidation) of stored grains were determined as per prescribed performa.

Sampling procedure of grains

The samples were collected fortnightly, from all the four lateral sides and from the top of the stack. The samples were taken in W or Z form (Figs 1, 2) from the stacks. Two kilogram samples of each stack were mixed thoroughly. The 2 kg sample was then divided into four subsamples of 500 g with the help of sample divider. The m.c. of the each subsample was determined. The subsample of 500 g grains were spread on a plate and then the sample were taken from the nine random places (Fig. 3). The total 20 g sample was taken for analysis from the subsamples.

Selection and liquidation of stacks

The two numbers of chambers/CAP were selected each for wheat, rice and paddy, thus storing 8 stacks in each selected depot for 4 spells of storage periods for selected commodity. Two stacks for each spell of 3, 6, 9 and 12 months were weighed and liquidated.

RESULTS AND DISCUSSION

The experiment was conducted at FSD-Barwala, CWC Karnal and FSD Naraina, New Delhi, for the determining storage losses of food grains in FCI. Present status of storage study of food grains (Table 1) for the commodities like wheat, rice and paddy are as follows:

The wheat and rice food grains were stored in

Table 1. Commodities-wise stacks position at different sites

Name of Depots	Storage type	Comm-odities	No. of stacked stacks (72)	No. of liquidated stacks (72)
CWC, Karnal	Warehouse	Wheat	4+4	16
		Rice	4+4	
FSD-FCI, Barwala	Warehouse	Wheat	4+4	32
		Rice	4+4	
	CAP	Wheat	4+4	
		Paddy	4+4	
FSD-FCI, Mayapuri	Warehouse	Wheat	4+4	24
		Rice	4+4	
	CAP	Wheat	4+4	

Table 2. Weight loss/gain (%) after months during storage of food grains

Warehouse location	Commodity	Stacking month	Loss/gain, % after months			
			3	6	9	12
CWC, Karnal	Wheat	Oct. 2013	+0.21	+0.01	+0.60	+0.46
	Rice	Aug. 2013	–1.00	–0.90	–0.92	–0.54
FSD, Barwala	Wheat	Dec. 2013	+0.22	+0.13	+0.33	+0.44
	Rice	Jan. 2014	–0.45	–0.78	–0.98	–1.20
	Wheat (CAP)	Jan. 2014	+0.09	+0.46	+0.87	+0.22
	Paddy (CAP)	Jan. 2014	–1.72	–3.07	–2.89	–2.38
FSD, Naraina	Wheat	Sep. 2014	–1.10	–1.95	+0.24	–0.30
	Rice	Jan. 2014	–0.88	–1.73	–2.48	–2.99
	Wheat (CAP)	Aug. 2014	–1.52	+0.19	–0.16	+0.27

chambers at CWC Karnal III, Rev. Dist. Karnal, FCI Dist. Karnal in October 2013 and August 2013 respectively (Table 2). The maximum weight gain was found 0.60% in July 2014, followed by 0.46% (October 2014), 0.21% (May 2014) and 0.01% (May 2014) during 12 months storage period of wheat grains. Similarly, maximum weight loss was found 1.0% (May 2014) followed by 0.92% (May 2014), 0.90% (May 2014) and 0.54% (August 2014) during 12 months storage period of rice.

The wheat, rice and paddy food grains were stored chambers/CAP at the FSD Depot - Barwala, Rev. Dist. - Hisar, FCI Dist.- Hisar in December 2013, and January 2014 for wheat and rice in covered godown and January 2014 for wheat and paddy in CAP. In covered godowns, the maximum weight gain was found 0.44% (December 2014), followed by 0.33% (September 2014), 0.22% (April 2014) and 0.13% (June 2014) during 12 months storage of wheat. Similarly, the maximum weight loss was found 1.20% in February 2015, followed by 0.98% (November 2014), 0.78% (July 2014), and 0.45% (June 2014) during 12 months storage period of rice. In CAP, the maximum weight gain was found 0.87% in October 2014, followed by 0.46% in July 2014, 0.22% in January 2015 and 0.09% in April 2014 during the 12 months storage period of wheat. Similarly, maximum weight loss was found 3.07% in July 2014, followed by 2.89% in October 2014, 2.38% February 2015 and 1.72% in April 2014 during 12 months storage period of paddy.

The wheat and rice food grains were stored in chambers/CAP at FSD, Naraina, Rev. Dist. South/ West, Delhi, FCI Dist. Mayapuri, Delhi, in September 2014 and January 2014 for wheat and rice in covered godown and August 2014 for wheat CAP. In covered godowns, the maximum weight gain was found 0.24% May 2015 and the maximum weight loss of 1.95% in February 2015, followed by 1.10% (November 2014), and 0.30% (August 2015) during 12 month storage period of wheat. Similarly, the maximum weight loss was found 2.99% in January 2015, followed by 2.48% (November 2014), 1.73% (July 2014) and 0.88 (April 2014) during 12 months storage storage period of rice.

In CAP, the maximum weight gain was found 0.27% during August 2015, followed by 0.19% (February 2015) and the maximum weight loss of 1.52% was recorded in November 2014, followed by 0.16% (May 2015) during the 12 months storage period of wheat.

CONCLUSION

The present study was carried out at CWC (Central Warehousing Corporation) Karnal III, Rev. Dist. Karnal, FCI Dist. Karnal, FSD (Food Storage Depot) - Barwala, Rev. Dist. – Hissar, FCI Dist.-Hissar and FSD Naraina, Rev. Dist.-South/west, Delhi, FCI (Food Corporation of India) Dist.-Mayapuri, Delhi for the determining the moisture variation in stored wheat, rice and paddy food grains. The major findings observed during the 12 months storage study of food grains are: wheat stacks gained the weight (0.60% in godown and 0.87% in CAP) as maximum gain; rice stacks lost weight, being 2.99% as maximum loss; paddy stacks lost the weight, being 3.07% (CAP) as maximum loss; and wheat stacks gained weight, being less in godown storage as compared to CAP storage structure.

REFERENCES

Channal G, Nagnur S, Nanjayyanamath C (2004) Indigenous grain storage structures. L E I S A.

Gaur M (2015) Traditional v/s modern methods of storage in India. Indian Journal of Research **5**(3): 406–407.

Greeley M (1978) Recent Indian experience with farm-level food grain storage research. Food Policy, pp 39–49.

Sashidhar RB, Ramakrishna Y, Bhat RV (1992) Moulds and mycotoxins in sorghum stored in traditional containers in India. Journal of Stored Products Research **28**(4): 257–260.

Singh PK (2010) A decentralized and holistic approach for grain management in India. Current Science **99(9, 10)**: 1179–1180.

Sinha AK, Sinha KK (1990) Insect pests, *Aspergillus flavus* and aflatoxin contamination in stored wheat: A survey at north Bihar (India). Journal of Stored Products Research **26**(4): 223–236.

Times of India. 2013. Over 17,000 tonnes of grains wasted in 3 years.

World Bank Report (1999). Post-harvest Management – Fights hunger with FAO India Grains, March 2002, **4**(3): 20–22.