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Economic analysis of storage losses & its efficiency

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Abstract

Onion is an important commercial vegetable crop in Maharashtra, where proper storage is essential for minimizing post-harvest losses and improving farmers returns. The present study was undertaken in Akola district during 2025-26 to assess storage losses, storage efficiency and the factors influencing storage efficiency under different onion storage structures. A multistage random sampling method was followed, and 120 onion growers were selected from Patur, Balapur and Barshitakli tehsils. The farmers used four major storage structures, namely Kanda Chawl, Traditional structure, Pucca floor and PDKV Low-cost portable structure. The findings showed substantial variation in storage losses among the different structures. The highest overall storage loss was observed in the Traditional structure (11.50%), followed by Pucca floor (9.70%) and Kanda Chawl (5.60%), while the PDKV Low-cost portable structure recorded the lowest loss (0.71%) in the sale-wise analysis. Physiological loss in weight was the main contributor to quantitative losses, whereas sprouting accounted for a major share of qualitative losses. In terms of absolute quantity, losses were highest in Pucca floor storage (22.48 quintals) and lowest in PDKV storage (0.54 quintals). Despite differences in physical losses, storage efficiency was highest for the Traditional structure (90.94%), followed by Kanda Chawl (90.76%), PDKV Low-cost portable structure (90.50%) and Pucca floor (89.29%), with an overall average efficiency of 90.37%. Regression analysis showed that enclosed storage capacity had a negative and significant influence on storage efficiency, whereas total quantity sold had a positive and significant effect. The models explained 81.70-97.80% of the variation in storage efficiency. The study emphasizes that appropriate storage design, effective capacity utilization and proper management practices are important for reducing onion storage losses and improving storage performance.

Keywords: Storage losses, storage efficiency, determinants, PDKV Low-cost portable structure, Kanda chawl, Pucca floor, Traditional structure

1. Introduction

Onion is an important commercial vegetable crop and an important source of income for farmers. However, the economic benefits from onion production are affected by substantial post-harvest losses during storage. The extent of loss depends not only on the duration of storage but also on the type and design of storage structure, ventilation, handling practices and management of the stored produce.

Storage enables farmers to hold onion after harvest and sell it according to market conditions rather than immediately disposing of the produce. However, prolonged storage can result in physiological loss of weight, rotting, scale loss, sprouting and black mould. These losses reduce the quantity and quality of marketable onion and consequently affect farm income.

Akola district of the Vidarbha region of Maharashtra was selected for the present study because of the availability of onion growers and different types of onion storage structures. The study area included farmers using Kanda Chawl, Traditional structures, Pucca floor and PDKV Low-cost portable structures. These structures differ in their physical characteristics and storage conditions, which may result in differences in storage losses and storage efficiency.

Therefore, a comparative assessment of storage losses and efficiency under different structures is important for identifying suitable storage practices.

The specific objectives of the present study titled “Structure wise storage losses and its storage efficiency of selected onion storage structures” are to estimate structure-wise storage losses and storage efficiency of onion and to analyse the determinants of storage efficiency under different storage structures.

2. Materials and Methods

2.1 Study Area: The study was conducted in Akola district of Maharashtra. The district was selected purposively on the basis of the availability of onion growers. A multistage random sampling technique was adopted for the selection of

respondents. Three tehsils, namely Patur, Balapur and Barshitakli, were selected from Akola district. Patur and Balapur were selected on the basis of onion area, whereas Barshitakli was selected on the basis of the availability of a larger number of storage structures. Four villages from each selected tehsil were selected, and ten farmers were randomly selected from each village. Thus, The primary data was collected from 120 farmers for accomplishment of objectives. Among the 120 selected farmers, 67 farmers used Kanda Chawl while 19 used Traditional storage structures. Similarly, 11 used Pucca floor structures and 23 used PDKV Low-cost portable structures.

Table 2.1: Distribution of Sample Farmers by Storage Structure

Storage Structure	Number of Farmers	Percentage
Kanda Chawl	67	55.83
Traditional structure	19	15.83
Pucca floor	11	9.17
PDKV Low-cost portable structure	23	19.17
Total	120	100.00

Maximum number of farmers used Kanda chawl while Pucca floor used by smallest number of farmers.

2.2 Data Collection and Analysis: Primary data were collected through personal interviews using a specially designed and pre-tested interview schedule. The collected data was analysed using simple tabular analysis and multiple regression analysis.

2.2.1 Storage losses of onion: Storage losses were classified into quantitative and qualitative losses. Quantitative losses included physiological loss of weight (PLW), rotting and scale loss, whereas qualitative losses included sprouting and black mould. Losses in physical quantity of onion during the storage period were converted into monetary terms by considering the price of onion for that particular period of month. Simple tabular analysis was used to estimate structure-wise storage losses of onion storage structures.

2.2.2 Storage efficiency: Storage efficiency was estimated by comparing the quantity of onion stored with the available storage capacity. The formula used was:

$$\text{Storage Efficiency} = \frac{\text{Quantity stored}}{\text{Storage capacity}} \times 100$$

2.2.3 Determinants of Storage Efficiency: Multiple regression analysis was used to examine the determinants of storage efficiency. Storage efficiency was considered the dependent variable.

The independent variables included

- X_1 = Enclosed storage capacity (quintals)
- X_2 = Storage cost (Rs. per quintal)
- X_3 = Value at harvest period price (Rs. per quintal)
- X_4 = Average number of days between two consecutive sales of stock (Days)
- X_5 = Total quantity sold (quintals)
- X_6 = Total storage loss (quintals)
- X_7 = Profit per quintal of onion stored (Rs. per quintal)
- X_8 = Average price received from storage (Rs.)

The multiple regression model was specified as

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8$$

where Y represents storage efficiency, a represents Intercept and b_1 to b_8 represents Coefficient.

3. Results and Discussion

3.1 Structure-wise Storage Losses and Storage Efficiency of Onion

3.1.1 Sale-wise storage losses in selected structures

Sale-wise storage losses in selected structures are presented in Table 3.1.1

Table 3.1.1: Sale-wise storage losses in selected structures

Sr. No	Particulars	Kanda chawl	Traditional storage	Pucca floor	PDKV developed low cost portable
A.	Structure-wise storage				
1.	Quantity of onion stored (Qtls.)	203.7	191.10	231.80	73.50
2.	No. of days of storage	64.30	105.50	112.70	31.70
3.	No. of sales	1.90	1.90	2.10	1.30
4.	Rate (Rs.)	754.30	805.30	860.00	741.70
B.	Structure-wise losses				
I.	1 st Sale				

1.	PLW (%)	0.80	1.30	1.20	0.10
2.	Rotting (%)	0.30	1.00	1.20	0.10
3.	Scale (%)	0.30	1.00	0.80	0.10
4.	Sprouting (%)	0.40	1.10	1.00	0.02
5.	Black mould (%)	0.40	0.90	0.80	0.01
	Total loss during 1 st sale in%	2.20	5.30	5.00	0.33
	Total loss during 1 st sale in Qtls	4.40	10.30	9.20	0.43
	Total loss during 1 st sale in Rs.	3470.30	10932.70	7641.20	367.00
II.	2nd sale				
1.	PLW (%)	1.00	1.60	0.80	0.10
2.	Rotting (%)	0.50	0.90	0.50	0.03
3.	Scale (%)	0.30	0.70	0.40	0.02
4.	Sprouting (%)	0.30	0.80	0.50	0.10
5.	Black mould (%)	0.20	0.70	0.30	0.10
	Total loss during 2 nd sale in%	2.30	4.70	2.50	0.35
	Total loss during 2 nd sale in Qtls	6.30	10.50	7.30	0.30
	Total loss during 2 nd sale in Rs.	4667.10	7580.90	6123.40	279.70
III.	3rd sale				
1.	PLW (%)	0.50	0.70	0.90	0.01
2.	Rotting (%)	0.20	0.20	0.40	0.00
3.	Scale (%)	0.20	0.20	0.40	0.00
4.	Sprouting (%)	0.10	0.20	0.30	0.03
5.	Black mould (%)	0.10	0.20	0.20	0.01
	Total loss during 3 rd sale in%	1.10	1.60	2.20	0.04
	Total loss during 3 rd sale in Qtls.	4.00	5.30	6.40	0.05
	Total loss during 3 rd sale in Rs.	2763.60	3569.40	5283.50	30.70
C.	Overall loss				
1.	Total loss in%	5.60	11.50	9.70	0.71
2.	Total loss in Qtls	11.41	21.98	22.48	0.54
3.	Total loss in Rs.	8604.45	17697.68	19336.76	397.96

It is revealed from Table 3.1.1 that, the Pucca floor stored the highest quantity of onion (231.80 quintals) for the longest period (112.70 days), while the PDKV low-cost portable structure handled the lowest quantity (73.50 quintals) for the shortest period (31.70 days). Storage losses were generally higher during the first sale and declined in subsequent sales. The Traditional structure recorded the highest overall loss (11.50%), followed by the Pucca floor (9.70%) and Kanda Chawl (5.60%). In contrast, the PDKV structure recorded the lowest loss of only 0.71%. Monetary loss was also lowest in the PDKV structure (Rs. 397.96), compared with Rs. 19,336.76 in the Pucca floor and Rs.

17,697.68 in the Traditional structure. Overall, the findings indicate that the PDKV low-cost portable structure was more effective in reducing onion storage losses and improving economic efficiency than the other storage structures.

3.1.2 Structure-wise percent of quantitative and qualitative losses in onion during storage

Structure-wise percent of quantitative and qualitative losses in onion during storage is presented in Table 3.1.2

Table 3.1.2: Structure-wise percent of quantitative and qualitative losses in onion during storage (Per cent)

Sr.no.	Particular	Kanda Chawl	Traditional structure	Pucca floor	PDKV Low-cost portable structure
Quantitative					
1	Physiological loss	2.30 (56.10)	3.60 (47.37)	2.90 (43.94)	0.21 (55.36)
2	Rotting	1.00 (24.39)	2.10 (27.63)	2.10 (31.82)	0.13 (23.21)
3	Scale	0.80 (19.51)	1.90 (25.00)	1.60 (24.24)	0.12 (21.43)
	Total loss	4.10 (100.00)	7.60 (100.00)	6.60 (100.00)	0.46 (100.00)
Qualitative					
1	Sprouting	0.80 (53.33)	2.10 (56.41)	1.80 (58.06)	0.15 (52.02)
2	Black mould	0.70	1.80	1.30	0.12

		(46.67)	(46.15)	(41.94)	(47.98)
3	Total loss	1.50 (100.00)	3.90 (100.00)	3.10 (100.00)	0.27 (100.00)
	Overall loss	5.60	11.50	9.70	0.73

(Figures in parenthesis indicate the percentage to total loss)

It represented from Table 3.1.2 that, physiological loss was the major source of quantitative loss, while sprouting was the main contributor to qualitative loss. The Traditional structure recorded the highest quantitative (7.60%), qualitative (3.90%) and overall loss (11.50%), followed by the Pucca floor (6.60%, 3.10% and 9.70%) and Kanda Chawl (4.10%, 1.50% and 5.60%). Rotting was relatively high in the Pucca floor (31.82%). In contrast, the PDKV low-cost portable structure showed the lowest quantitative

(0.46%), qualitative (0.27%) and overall loss (0.73%). Overall, the results highlight the role of proper ventilation and suitable storage design in reducing onion losses.

3.1.3 Structure-wise quantity of quantitative and qualitative losses in onion during storage

Structure-wise quantity of quantitative and qualitative losses in onion during storage is presented in Table 3.1.3

Table 3.1.3: Structure-wise quantity of quantitative and qualitative losses in onion during storage (Qtls.)

Sr.no.	Particular	Kanda Chawl	Traditional structure	Pucca floor	PDKV Low-cost portable structure
Quantitative					
1	Physiological loss	4.69 (56.10)	6.88 (47.37)	6.72 (43.94)	0.15 (45.65)
2	Rotting	2.04 (24.39)	4.01 (27.63)	4.87 (31.82)	0.10 (28.26)
3	Scale	1.63 (19.51)	3.63 (25.00)	3.71 (24.24)	0.09 (26.09)
	Total loss	8.35 (100.00)	14.52 (100.00)	15.30 (100.00)	0.34 (100.00)
Qualitative					
1	Sprouting	1.63 (53.33)	4.01 (53.85)	4.17 (58.06)	0.11 (55.56)
2	Black mould	1.43 (46.67)	3.44 (46.15)	3.01 (41.94)	0.09 (44.44)
3	Total loss	3.06 (100.00)	7.45 (100.00)	7.19 (100.00)	0.20 (100.00)
	Overall loss	11.41	21.98	22.48	0.54

(Figures in parenthesis indicate the percentage to total loss)

It is revealed from Table 3.1.3 that, physiological loss was the major component of quantitative loss, with the highest losses in the Traditional structure (6.88 quintals) and Pucca floor (6.72 quintals), compared with only 0.15 quintals in the PDKV structure. Total quantitative loss was highest in the Pucca floor (15.30 quintals), followed by the Traditional structure (14.52 quintals). Sprouting was the major qualitative loss, particularly in the Pucca floor (4.17 quintals) and Traditional structure (4.01 quintals). Overall, the Pucca floor recorded the highest loss (22.48 quintals), followed by the Traditional structure (21.98 quintals) and

Kanda Chawl (11.41 quintals). The PDKV low-cost portable structure had the lowest overall loss of only 0.54 quintals, highlighting its better performance in reducing both quantitative and qualitative onion losses.

3.1.4 Storage efficiency of different onion storage structures

Table 3.1.4 presents the storage efficiency of different onion storage structures, based on the quantity of onion stored relative to their available storage capacity.

Table 3.1.4: Storage efficiency of different onion storage structures

Sr.no.	Particular	Kanda Chawl	Traditional structure	Pucca floor	PDKV Low cost portable structure	Average
1	Quantity stored (Qtls)	203.66	191.05	231.82	73.48	175.00
2	Storage capacity (Qtls)	223.43	210.00	280.91	84.78	199.78
3	Storage efficiency (%)	90.76	90.94	89.29	90.50	90.37

It is revealed from Table 3.1.4 that, an average storage capacity of 199.78 quintals, of which 175.00 quintals were utilised, resulting in an overall storage efficiency of 90.37%. The Pucca floor had the highest capacity (280.91 quintals) and stored the maximum quantity (231.82 quintals), but

showed the lowest efficiency (89.29%), indicating relatively lower utilisation of its available capacity. The Traditional structure achieved the highest efficiency (90.94%), followed by Kanda Chawl (90.76%) and PDKV low-cost portable structure (90.50%). Although PDKV had the smallest

capacity (84.78 quintals) and stored only 73.48 quintals, its high efficiency indicates effective utilisation of the available space. Overall, the results suggest that storage size alone did not determine efficiency but proper utilisation of available capacity was more important.

3.2 The determinants of storage efficiency

Determinants of storage efficiency is presented in Table 3.2.1

Table 3.2.1: The determinants of storage efficiency

Sr. no.	Particular	Kanda Chawl	Traditional structure	Pucca floor	PDKV Low-cost portable structure
1	Enclosed storage capacity (Qtls)	223.43	210.00	280.91	84.78
2	Depreciation cost (Rs./yr)	15950.95	8612.42	11304.65	1091.01
3	Quantity of onion stored (Qtls.)	203.66	191.05	231.82	73.48
4	Valued at harvest period price (Rs.)	752.24	723.68	750.00	752.17
5	Average no. of days between two consecutive sales of stock (Days)	31.67	44.74	53.64	23.48
6	Quantity at each sale (qtls)	190.28	165.79	208.91	72.65
7	Average quantity sold/sale (Qtls)	106.10	87.96	102.70	59.07
8	Rate at sale (Rs.)	1541.64	1797.37	1769.09	1061.30
9.	Ratio of qty sold and stored	0.95	0.89	0.90	0.99
9	Total loss (qtls)	13.37	25.26	22.91	0.83
10	Total loss (Rs.)	9778.31	21407.89	19034.55	676.09
11	Total cost of storage (Rs.)	14406.54	7818.49	9817.36	95.91
12	Total cost of production (Rs.)	121536.22 (25.76)	114014.48 (24.80)	138342.14 (26.33)	43849.62 (27.11)
13	Total revenue (Rs.)	153090.72	151810.53	171229.09	56502.17
14	Total cost (Rs.)	135942.76	121832.97	148159.50	43945.53
15	Total Profit (Rs.)	17147.96	29977.56	23069.59	12556.65
16	profit per qtl of onion stored (Rs./Qtl)	81.09	140.68	98.12	162.44
17	profit per kg of onion stored (Rs./Kg)	0.81	1.41	0.98	1.62
18	Avg price received from storage (Rs.)	828.33	950.00	862.27	764.93

It is revealed from Table 3.2.1 that, the technical and economic performance of different onion storage structures. The Pucca floor had the highest storage capacity (280.91 quintals) and revenue (Rs. 1,71,229.09), while PDKV had the lowest capacity (84.78 quintals) and revenue (Rs. 56,502.17). Storage losses were highest in the Traditional structure (25.26 quintals; Rs. 21,407.89) and lowest in PDKV (0.83 quintals; Rs. 676.09). The Traditional structure recorded the highest total profit (Rs. 29,977.56), whereas

PDKV achieved the highest profit per quintal stored (Rs. 162.44), indicating better returns per unit of onion despite its smaller capacity. PDKV also had the highest quantity-sold-to-stored ratio (0.99), showing effective utilisation of stored produce. Overall, the results suggest that the Pucca floor was advantageous for large-scale storage and total revenue, while PDKV offered better unit-level profitability and substantially lower storage losses.

Table 3.2.2: Regression results of the analysis of the determinants of storage efficiency

Particular	Explanatory Variables	Kanda Chawl	Traditional storage	Pucca floor	PDKV developed low cost portable
Intercept		87.919	90.697	62.420	18.403
Enclosed storage capacity (Qtls.)	X ₁	-0.359***	-0.560***	-0.123**	-0.644***
Storage cost (Rs./Qtls)	X ₂	0.008	-0.159	0.040	1.334
Valued at harvest period price	X ₃	0.0003	0.008	0.034	-0.003
Avg. no. of days between two consecutive sales of stock	X ₄	0.034	-0.032	-0.158	-0.047
Total quantity sold (Qtls)	X ₅	0.403***	0.611***	0.154**	0.674***
Total loss (Qtls)	X ₆	0.358***	0.603***	0.201	0.912
Profit per qtls of onion stored (Rs/ctl)	X ₇	0.000	0.002	-0.002	-0.134
Avg. price received from storage	X ₈	-0.0004	0.004	0.006	0.131
R ²		0.817	0.871	0.978	0.961

Note: (***) and (**) represent significant at 1% and 5% respectively.)

Table 3.2.2 revealed that, storage efficiency was significantly associated with storage capacity and the quantity of onion marketed. The models recorded high R^2 values of 0.82 for Kanda Chawl, 0.91 for Traditional storage, 0.98 for Pucca floor and 0.88 for the PDKV low-cost portable structure, showing that the selected variables explained 81.70 to 97.80 per cent of the variation in efficiency. Storage capacity (X_1) showed a negative and significant effect across all structures, indicating that efficiency tended to decline as capacity increased. In contrast, total quantity sold (X_5) had a positive and significant effect in all structures, suggesting that better movement of stored onion through sales was associated with higher efficiency. Storage loss (X_6) was positive and significant only in Kanda Chawl and Traditional storage, indicating a significant association in these two structures. Overall, the findings highlight storage capacity and quantity marketed as the most consistent significant factors influencing onion storage efficiency.

4. Conclusion: The study concluded that the PDKV low-cost portable storage structure was more effective in reducing both quantitative and qualitative losses in onion compared with conventional storage structures. Although traditional storage provided higher total profit, the PDKV structure recorded the lowest overall loss, highest profit per quintal stored, and better utilisation of stored produce. Storage efficiency was generally high across all structures, but larger storage capacity did not necessarily result in higher efficiency. Overall, the findings indicate that PDKV storage is a practical, economical, and loss-minimising option, particularly for small and medium-scale onion growers. Its wider adoption can help reduce post-harvest losses and improve farmers' returns.

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