



ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2026): 4.97
IJAFA 2026; 8(9): 79-83
www.agriculturaljournals.com
Received: 04-06-2026
Accepted: 09-07-2026

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Economics and Post-Harvest Losses of Major Cole Vegetables in Nagpur District of Maharashtra state

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DOI: <https://www.doi.org/10.33545/2664844X.2026.v8.i9b.1859>

Abstract

The present study was undertaken to work out the economics of cultivation and post-harvest losses of major cole vegetables, namely cauliflower and cabbage, in Nagpur district of Maharashtra state. The study was based on primary data collected from 120 farmers (60 cauliflower growers and 60 cabbage growers), along with 5 wholesalers and 10 retailers, during the agricultural year 2025–26 through personal interview method using a pre-tested schedule. Cost and returns of cauliflower and cabbage were estimated using standard cost concepts. The per hectare cost of cultivation at Cost C₃ was Rs. 85,293.93 for cauliflower and Rs. 84,174.91 for cabbage. The per hectare net returns at Cost C₃ were Rs. 57,380.99 for cauliflower and Rs. 46,467.57 for cabbage, with benefit-cost ratios of 1.67 and 1.55, respectively, indicating that cauliflower was relatively more profitable than cabbage. Post-harvest losses at the farm level were estimated at 11.15 kg/ql for cauliflower and 10.85 kg/ql for cabbage, with harvesting being the major stage of loss in both crops (58.57 and 57.60 per cent of total farm-level loss, respectively). At the market (retailer) level, losses were 7.27 kg/ql for cauliflower and 7.10 kg/ql for cabbage, with loading and unloading operations accounting for the largest share of loss (34.25 and 34.51 per cent, respectively). The results indicate that both crops were economically viable, with cauliflower recording higher net returns and a higher benefit-cost ratio than cabbage.

The study was undertaken with the following objectives

- To estimate the cost and returns of major cole vegetables
- To work out post-harvest losses of major cole vegetables at various stages of production and marketing.

Keywords: Major cole vegetables, cauliflower, cabbage, cost and returns, post-harvest losses

Introduction

The vegetable sector holds an important position in agricultural development by contributing to nutritional security, income generation and rural employment. Vegetable cultivation provides better economic returns per unit of land compared with conventional field crops and also creates opportunities for rural entrepreneurship through packaging, processing, logistics and marketing activities. Cole vegetables such as cabbage (*Brassica oleracea* var. *capitata* L.) and cauliflower (*Brassica oleracea* var. *botrytis* L.) form an important segment of horticultural crops and have considerable nutritional significance. They provide important vitamins, minerals and dietary fibre and are widely valued as part of a balanced diet. During 2024–25, the area under cole crops in India was about 953 thousand hectares, with an estimated production of 20,700 thousand metric tonnes. In Maharashtra, cole crops occupied about 31.13 thousand hectares with production of 455.46 thousand metric tonnes. In Nagpur district, cole crops were cultivated over 285 hectares with production of 64.13 tonnes. However, fresh vegetables remain highly perishable even after harvesting because of continuous respiration, transpiration and other metabolic activities. As a result, they are vulnerable to physical damage, moisture loss, microbial deterioration and reduction in market quality. Cole vegetables are particularly susceptible to post-harvest losses because of their high moisture content and delicate nature. These losses may occur during harvesting, handling, loading, transportation, storage and marketing. Improper harvesting practices, rough handling, unsuitable packaging, inadequate grading facilities, transportation problems and insufficient cold-chain infrastructure can further increase the magnitude of losses.

Such losses not only reduce the physical quantity of marketable produce but also lower its quality and economic value. Therefore, reducing post-harvest losses is important for improving food availability, marketing efficiency and the profitability of vegetable growers.

In this context, an economic assessment of cabbage and cauliflower along with an analysis of post-harvest losses at different stages of the supply chain is important for identifying major areas of loss and improving post-harvest management. The present study was therefore undertaken in Nagpur district to assess the economics of major cole vegetables and to examine post-harvest losses from the farm level to the market level.

Material and Methods

The present study was undertaken in Nagpur district of the Vidarbha region, where cabbage and cauliflower were major cole crops, considering the concentration of area under these crops. Nagpur district was purposively selected and data pertaining to the 2025–26 agricultural year were considered. Four tehsils, namely Kamptee, Kalameshwar, Umred and Bhiwapur, were purposively selected based on their potential area under cole crops. From each tehsil, three villages were selected randomly, and 10 farmers were selected from each village, giving a total sample of 120 farmers comprising 60 cabbage growers and 60 cauliflower growers. For assessing post-harvest losses at the market level, 5 wholesalers and 10 retailers were also selected from the vegetable markets of the selected tehsils. Primary data on input utilization, cost and returns, post-harvest losses and production and marketing constraints were collected from the selected respondents through personal interviews using a pre-tested, structured schedule. The study pertained to the 2025–26 agricultural year.

Analytical Tools and Techniques

For cost and returns, standard cost concepts Cost A₁, A₂, B₁, B₂, C₁, C₂ and C₃ were used. Gross returns were obtained from output and prevailing rate. Net returns were estimated by deducting the respective cost from gross returns. Benefit-

cost ratio was calculated as gross returns divided by the corresponding cost.

Net returns

Net returns was computed at different costs i.e. cost A₁, cost A₂, cost B₁, cost B₂, cost C₁, cost C₂ and cost C₃ by deducting respective costs from the gross returns.

Net returns at A₁ = Gross returns - Cost 'A₁'

Net returns at A₂ = Gross returns - Cost 'A₂'

Net returns at B₁ = Gross returns - Cost 'B₁'

Net returns at B₂ = Gross returns - Cost 'B₂'

Net returns at C₁ = Gross returns - Cost 'C₁'

Net returns at C₂ = Gross returns - Cost 'C₂'

Net returns at C₃ = Gross returns - Cost 'C₃'

Benefit-cost ratio

It is a ratio between the value of gross returns and the cost of cultivation at different cost concepts. It was worked out by dividing gross returns by the total cost. It was calculated at cost A₁, cost A₂, cost B₁, cost B₂, cost C₁, cost C₂ and cost C₃.

$$\text{Benefit-cost ratio} = \frac{\text{Gross returns}}{\text{Respective cost}}$$

Post-Harvest losses

The post-harvest losses at different stages of marketing were analysed in the form of physical loss as well as monetary loss. Post-harvest monetary loss (ML) was expressed as follows:

$$\text{ML} = \{\text{LF} \times \text{GPF}\} + \{\text{LW} \times \text{GPW}\} + \{\text{LR} \times \text{GPR}\}$$

Where,

LF is the physical loss of produce at field level.

GPF is the gross price received by the farmer.

LW is the physical loss during wholesaling.

LR is the physical loss during retailing.

GPW is the gross wholesale price.

GPR is the gross retail price.

Results and Discussion

Table 1: Per hectare cost of cultivation of cauliflower (Rs./ha)

Sr. No.	Particulars	Unit	Input / Ha	Rate / Unit (Rs.)	Total Cost / Ha (Rs.)	Per cent to Cost C3
1	Hired human labour					
	a) Male	Days	30.25	398.60	12057.65	14.14
	b) Female	Days	25.50	248.75	6343.13	7.44
	Sub-total	Days	55.75	-	18400.78	21.57
2	Machine charges (Hired)	Hours	3.60	1015.75	3656.70	4.29
3	Seed	Kg.	0.67	2298.60	1540.06	1.81
4	Manures	Qtl	27.00	54.85	1480.95	1.74
5	Fertilizer					
	a) N	Kg	98.75	37.50	3703.12	4.34
	b) P	Kg	49.60	59.40	2946.24	3.45
	c) K	Kg	50.35	44.65	2248.13	2.64
	Sub-total	Kg	198.70	-	8897.49	10.43
6	Irrigation charges	Rs.	-	-	895.40	1.05
7	Plant protection	Rs.	-	-	3742.85	4.39
8	Incidental charges	Rs.	6.00	492.50	2955.00	3.46
9	Working capital (1 to 8)	Rs.	-	-	41569.23	48.74
10	Interest on working capital (6% per annum)	Rs.	-	-	831.38	0.97
11	Depreciation charges	Rs.	-	-	985.40	1.16
12	Land revenue	Rs.	-	-	195.98	0.23
13	Cost A1 (9 to 12)	Rs.	-	-	43581.99	51.10

14	Rental value of leased-in land	Rs.	-	-	0.00	0.00
15	Cost A2 (13 + 14)	Rs.	-	-	43581.99	51.10
16	Interest on fixed capital @ 10 per cent	Rs.	-	-	1932.23	2.27
17	Cost B1 (15 + 16)	Rs.	-	-	45514.22	53.36
18	Rental value of owned land	Rs.	-	-	16129.08	18.91
19	Cost B2 (17 + 18)	Rs.	-	-	61643.30	72.27
20	Family human labour					
	a) Male	Days	27.40	398.60	10921.64	12.80
	b) Female	Days	20.00	248.75	4975.00	5.83
	Sub-total	Days	47.40	-	15896.64	18.64
21	Cost C1 (17 + 20)	Rs.	-	-	61410.86	72.00
22	Cost C2 (19 + 20)	Rs.	-	-	77539.94	90.91
23	Supervision charges @ 10% of Cost C2	Rs.	-	-	7753.99	9.09
24	Cost C3 (22 + 23)	Rs.	-	-	85293.93	100.00
25	Yield per hectare (Main produce)	Qtl.	120.35	1185.50	142674.92	-
26	Gross value of produce	Rs.	-	-	142674.92	-
27	Per quintal cost of production	Rs.	-	-	708.72	-

As observed in Table 1, the total cost of cultivation (Cost C3) for cauliflower was estimated at Rs. 85,293.93 per hectare. The direct operational cost (Cost A1 and A2) incurred by the farmer was Rs. 43,581.99, which constituted 51.10 per cent of the total cost. Among the individual cost items, hired human labor formed the largest share at 21.57 per cent (Rs. 18,400.78), indicating the crop's heavy reliance on manual operations. The rental value of owned land was the second major component, accounting for 18.91 per cent (Rs. 16,129.08).

Family human labor also contributed significantly, making up 18.64 per cent (Rs. 15,896.64) of the total expenditure. Investment in fertilizers amounted to Rs. 8,897.49, representing 10.43 per cent of Cost C3. Cost B2, which includes Cost B1 and rental value of owned land, stood at Rs. 61,643.30, while Cost C2 was calculated at Rs. 77,539.94. With an average yield of 120.35 quintals per hectare, the gross value realized was Rs. 1,42,674.92, and the per quintal cost of production was worked out to be Rs. 708.72.

Table 2: Per hectare cost of cultivation of cabbage (Rs./ha)

Sr. No.	Particulars	Unit	Input / Ha	Rate / Unit (Rs.)	Total Cost / Ha (Rs.)	Per cent to Cost C3
1	Hired human labour					
	a) Male	Days	27.25	398.60	10861.85	12.90
	b) Female	Days	26.50	248.75	6591.88	7.83
	Sub-total	Days	53.75	-	17453.72	20.74
2	Machine charges (Hired)	Hours	4.10	1032.40	4232.84	5.03
3	Seed	Kg.	0.68	2340.15	1591.30	1.89
4	Manures	Qtl	28.00	56.10	1570.80	1.87
5	Fertilizer					
	a) N	Kg	148.90	37.50	5583.75	6.63
	b) P	Kg	50.45	59.40	2996.73	3.56
	c) K	Kg	49.70	44.65	2219.11	2.64
	Sub-total	Kg	249.05	-	10799.59	12.83
6	Irrigation charges	Rs.	-	-	948.75	1.13
7	Plant protection	Rs.	-	-	3516.67	4.18
8	Incidental charges	Rs.	6.20	507.25	3144.95	3.74
9	Working capital (1 to 8)	Rs.	-	-	43258.62	51.39
10	Interest on working capital (6% per annum)	Rs.	-	-	865.17	1.03
11	Depreciation charges	Rs.	-	-	1012.75	1.20
12	Land revenue	Rs.	-	-	269.59	0.32
13	Cost A1 (9 to 12)	Rs.	-	-	45406.13	53.94
14	Rental value of leased-in land	Rs.	-	-	0.00	0.00
15	Cost A2 (13 + 14)	Rs.	-	-	45406.13	53.94
16	Interest on fixed capital @ 10 per cent	Rs.	-	-	1941.33	2.31
17	Cost B1 (15 + 16)	Rs.	-	-	47347.46	56.25
18	Rental value of owned land	Rs.	-	-	14783.64	17.56
19	Cost B2 (17 + 18)	Rs.	-	-	62131.10	73.81
20	Family human labour					
	a) Male	Days	23.00	398.60	9167.80	10.89
	b) Female	Days	21.00	248.75	5223.75	6.21
	Sub-total	Days	44.00	-	14391.55	17.10
21	Cost C1 (17 + 20)	Rs.	-	-	61739.01	73.35
22	Cost C2 (19 + 20)	Rs.	-	-	76522.65	90.91
23	Supervision charges @ 10% of Cost C2	Rs.	-	-	7652.26	9.09
24	Cost C3 (22 + 23)	Rs.	-	-	84174.91	100.00
25	Yield per hectare (Main produce)	Qtl.	140.68	928.65	130642.48	-
26	Gross value of produce	Rs.	-	-	130642.48	-
27	Per quintal cost of production	Rs.	-	-	598.34	-

Table 2 demonstrates the cost structure for cabbage cultivation. The overall Cost C3 per hectare was marginally lower at Rs. 84,174.91. The operational expenses (Cost A1 and A2) amounted to Rs. 45,406.13, formulating 53.94 per cent of the total cost. Similar to cauliflower, hired human labor commanded the highest expenditure at Rs. 17,453.72 (20.74 per cent). The rental value of owned land contributed 17.56 per cent (Rs. 14,783.64), while family human labor stood at 17.10 per cent (Rs. 14,391.55). Due to higher nitrogen requirements, the total fertilizer cost for cabbage was higher at Rs. 10,799.59, constituting 12.83 per cent of Cost C3. Cost B2 was Rs. 62,131.10, and Cost C2 was recorded at Rs. 76,522.65. Cabbage cultivation yielded 140.68 quintals per hectare, generating a gross value of Rs. 1,30,642.48, and the per quintal cost of production was Rs. 598.34.

Table 3: Economics of the major cole vegetables

Sr. No.	Particulars	Cauliflower (Rs/ha)	Cabbage (Rs/ha)
1	Yield (qt/ha) - Main Produce	120.35	140.68
2	Price/q - Main Produce	1185.50	928.65
3	Value of main produce	142674.92	130642.48
4	Cost of cultivation at		
	a) Cost 'A2'	43581.99	45406.13
	b) Cost 'B1'	45514.22	47347.46
	c) Cost 'B2'	61643.30	62131.10
	d) Cost 'C2'	77539.94	76522.65
	e) Cost 'C3'	85293.93	84174.91
5	Net return over		
	a) Cost 'A2'	99092.93	85236.35
	b) Cost 'B1'	97160.70	83295.02
	c) Cost 'B2'	81031.62	68511.38
	d) Cost 'C2'	65134.98	54119.83
	e) Cost 'C3'	57380.99	46467.57
6	Benefit-cost ratio at		
	a) Cost 'A2'	3.27	2.88
	b) Cost 'B1'	3.13	2.76
	c) Cost 'B2'	2.31	2.10
	d) Cost 'C2'	1.84	1.71
	e) Cost 'C3'	1.67	1.55

It can be inferred from Table 3 that although cabbage yielded a higher quantity (140.68 qt/ha) compared to cauliflower (120.35 qt/ha), the higher market price commanded by cauliflower (Rs. 1,185.50 per quintal versus Rs. 928.65 for cabbage) resulted in a superior gross value of Rs. 1,42,674.92 against Rs. 1,30,642.48. Analyzing the net returns, cauliflower generated a lucrative net return over Cost C3 of Rs. 57,380.99, outperforming cabbage, which yielded Rs. 46,467.57. The net return over Cost A2 (which represents the actual out-of-pocket expenses for the farmer) was highly impressive at Rs. 99,092.93 for cauliflower and Rs. 85,236.35 for cabbage. The Benefit-Cost Ratio (BCR) calculated at total Cost C3 was 1.67 for cauliflower and 1.55 for cabbage, confirming that both crops are economically viable, with cauliflower being relatively more profitable. At Cost A2, the BCR escalated to 3.27 and 2.88 for the respective crops. These results are in line with Birwa (2016) and Kumari *et al.* (2021), who also reported cole vegetable cultivation to be economically remunerative with favourable benefit-cost ratios in Karnataka and Rajasthan, respectively, and with Rathod *et al.* (2020), who observed efficient

resource use and profitable returns in cabbage cultivation in Madhya Pradesh.

Post-harvest losses in major cole vegetables

Post-Harvest Losses at Farm Level

Table 4: Post-harvest losses of Cauliflower at farm level

Stages	Losses (Kg/qt)	Per cent Loss	Economic Loss (Rs.)
A. Harvesting			
Pest & disease	1.95	17.49	23.12
Physiological disorder	1.28	11.48	15.17
Damage	2.10	18.83	24.90
Over ripe	1.20	10.76	14.23
Sub total	6.53	58.57	77.41
B. Grading & Packing			
Sorting	1.30	11.66	15.41
Packing	0.58	5.20	6.88
Sub total	1.88	16.86	22.29
C. Transportation			
Handling	0.45	4.04	5.33
Poor packing	0.37	3.32	4.39
Loading & unloading	1.32	11.84	15.65
Sub total	2.14	19.19	25.37
D. Self-Marketing			
Over ripening	0.35	3.14	4.15
Other	0.25	2.24	2.96
Sub total	0.60	5.38	7.11
Total	11.15	100.00	132.18

Table no. 4 outline the post-harvest losses encountered at the farm level in cauliflower. The total physical loss in cauliflower was estimated at 11.15 kg per quintal, converting to a direct economic loss of Rs. 132.18 for the farmer. Harvesting proved to be the most critical stage, registering a loss of 6.53 kg/qt, which comprised 58.57 per cent of the total farm-level losses. Within harvesting, mechanical damage accounted for the highest loss (2.10 kg/qt), closely followed by pest and disease issues (1.95 kg/qt). Transportation activities, particularly rough loading and unloading, contributed a sub-total loss of 2.14 kg/qt (19.19 per cent).

Table 5: Post-harvest losses of Cabbage at farm level

Stages	Losses (Kg/qt)	Per cent Loss	Economic Loss (Rs.)
A. Harvesting			
Pest & disease	1.80	16.59	16.72
Physiological disorder	1.25	11.52	11.61
Damage	2.07	19.08	19.22
Over ripe	1.13	10.41	10.49
Sub total	6.25	57.60	58.04
B. Grading & Packing			
Sorting	1.25	11.52	11.61
Packing	0.58	5.35	5.39
Sub total	1.83	16.87	16.99
C. Transportation			
Handling	0.40	3.69	3.71
Poor packing	0.45	4.15	4.18
Loading & unloading	1.32	12.17	12.26
Sub total	2.17	20.00	20.15
D. Self-Marketing			
Over ripening	0.35	3.23	3.25
Other	0.25	2.30	2.32
Sub total	0.60	5.53	5.57
Total	10.85	100.00	100.75

Table no. 5 shows post-harvest losses in cabbage cultivation at farm level, where the total farm-level loss amounted to 10.85 kg per quintal, resulting in a monetary loss of Rs. 100.75. Harvesting operations were responsible for 57.60 per cent (6.25 kg/qt) of the losses, heavily influenced by damage (2.07 kg/qt) and pest & disease (1.80 kg/qt). Losses during transportation constituted an exact 20.00 per cent (2.17 kg/qt) of the total damage. Similar magnitudes of farm-level post-harvest loss in cole crops, with harvesting and handling as the dominant stages, were reported by Koza *et al.* (2018) in Nagaland, Singh and Chauhan (2017) in Himachal Pradesh, and Singh *et al.* (2019) in Uttar Pradesh.

Post-Harvest Losses at Market Level

Table 6: Post-harvest losses of Cauliflower at market level

Stages	Physical Losses (Kg/ctl)	Per cent Loss	Economic Losses (Rs.)
Losses at Retailer level			
Loading & unloading	2.49	34.25	102.58
Sorting & Grading	1.85	25.45	76.22
Storage	1.62	22.28	66.74
Transportation	1.31	18.02	53.97
Total	7.27	100.00	299.52

Table 7: Post-harvest losses of Cabbage at market level

Stages	Physical Losses (Kg/ctl)	Per cent Loss	Economic Losses (Rs.)
Losses at Retailer level			
Loading & unloading	2.45	34.51	96.78
Sorting & Grading	1.80	25.35	71.10
Storage	1.58	22.25	62.41
Transportation	1.27	17.89	50.16
Total	7.10	100.00	280.45

Upon reaching the retailer, the produce undergoes further handling, causing additional damage. Table 6 indicates that cauliflower retailers suffered a total physical loss of 7.27 kg per quintal, translating to a heavy economic loss of Rs. 299.52. The primary cause was improper loading and unloading practices, which led to a loss of 2.49 kg/ctl (34.25 per cent of the market level loss). Sorting and grading activities caused a further loss of 1.85 kg/ctl (25.45 per cent). For cabbage (Table 7), the total loss at the retailer level was assessed at 7.10 kg per quintal, causing an economic drain of Rs. 280.45. Consistent with cauliflower, loading and unloading were the most destructive operations, accounting for 34.51 per cent (2.45 kg/ctl) of the total market losses, while sorting and grading contributed 25.35 per cent (1.80 kg/ctl). These findings corroborate Ramchandra *et al.* (2015), who similarly identified loading, unloading and handling operations as the major sources of market-level post-harvest loss in vegetables in Allahabad district of Uttar Pradesh.

Conclusion

The study concluded that cultivation of both cauliflower and cabbage was economically viable in the study area. Cauliflower generated higher net returns and a higher benefit-cost ratio than cabbage, indicating comparatively greater profitability. Post-harvest losses were considerable at

both farm and market levels. At the farm level, losses were 11.15 kg/ctl in cauliflower and 10.85 kg/ctl in cabbage, with harvesting being the major stage of loss. At the market level, losses were 7.27 kg/ctl in cauliflower and 7.10 kg/ctl in cabbage, where loading and unloading contributed the highest losses. Overall, the findings indicated that improving harvesting, handling, packing, transportation and marketing practices could reduce post-harvest losses and improve the profitability of cauliflower and cabbage cultivation.

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