

RESEARCH PAPER

Assessment of Trend for Area, Production, Productivity and Post-harvest losses of Onion and Potato in Uttar Pradesh, India

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ABSTRACT

Uttar Pradesh is the major producer of horticultural crops, especially vegetables. The study was carried out to evaluate the trends in area, production, and productivity of onion and potato farming. This analysis was based on secondary data collected from 2001-2002 through 2021-2022. The study period was split into two sub-periods: period-I (2001-2010), period-II (2011-2022), and the overall period (2001-2022). The compound growth rate of area, production, and productivity was analysed at the national level as well as for Uttar Pradesh. It was found that in India, the growth rates in area, production, and productivity for onion was 6.84, 9.57, and 2.55 percent respectively and for Potato it was 3.23, 4.85 and 1.57 percent respectively. The CAGR of area, production & productivity of Onion in Uttar Pradesh for onion was 0.83, 2.91, and 2.04 percent respectively and for potato it was 2.29, 2.90 and 0.60 percent respectively. At farm level, total post-harvest loss for potato and onion was 7.84 and 6.98 kg/qt respectively.

HIGHLIGHTS

- Total production of Onion in U.P. was increasing due to increase in area and productivity improvement during the study period.
- Potato production in U.P. was increasing due to increase in area under the crop.
- Highest potato and onion losses were observed during the storage at farm, wholesaler and retailer level.
- Creation of modern storage facility and access by farmers will reduce the post-harvest losses of potato and onion.
- Adoption of new technology and innovations for potato and onion cultivation by smallholder farmers to further enhance productivity and their revenue.

Keywords: CAGR, Onion, Potato, Area, Production, Productivity & Post-harvest loss

Agricultural development in respect of crop, fruit, vegetable, animal and allied activities occupied a prominent place in the economic development of India (Singh *et al.* 2020). Indian agriculture specially foodgrain production is characterized by less margins and income from the farm produce that is insufficient to support a family (Priyadarshini *et al.* 2020). Agricultural is one of the largest sectors which provide employment opportunity to 42.38 percent population of the country in 2019 (World Bank, 2020). In 2017-18, total fruit and vegetable production in India was 97.36 and 185.40 million tonnes respectively (GoI, 2020). Diversification of Indian agriculture incline to horticultural crops help to income augmentation, enhancing employment

opportunity and poverty alleviation (Kumar *et al.* 2019). Recent shift towards fruit and vegetable cultivation has been considered as economic opportunity (Mittal, 2007). From 2012, India's horticulture output has continuously outpaced the production of food grains. Therefore, it makes sense that horticulture is becoming the primary growth driver of Indian agriculture. India is blessed with a diverse agro-climatic conditions and soil types for horticultural crops (Kumar *et al.* 2019), which

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make possible to grow diverse crops throughout the year (Kundu and Mondal, 2020). The development of agricultural infrastructure, value chain, and food processing, particularly in agriculture, can significantly contribute to the long-term success of the horticultural sector. Increased employment prospects can also be attained by putting additional land under horticulture crops, as these crops are labour intensive than cereal crops (Kumar *et al.* 2019). Out of total horticultural production, share of vegetables production remain highest viz., 59-61 per cent (Rao, 2019). Out of large number of vegetables grown in India, onion and potato become important which provide food and nutritional security along with socio-economic improvement of farmers. Horticulture sector also serves as a basis for ancillary industries like the canning and processing sectors (Ramaiah, 2022).

In many regions of the world, potatoes have evolved into staple foods that make up a sizable portion of the global food supply (Pandey *et al.* 2018). Total area and production of potato cultivation in the world were 23.91 million hectare and 470.48 million tonnes respectively with an average yield of 19.67 tonnes during 2021-22 (FAOSTAT, 2023). In case of India, total area allocated by the farmers for potato cultivation was 2.20 million hectares and total production was 53.39 million tonnes with average yield of 24.24 tonne per hectare during 2021-22 (GoI, 2023). Among Indian state, Uttar Pradesh placed first position in potato cultivation and production. During 2021-22, total area allocated by potato growers in Uttar Pradesh was 622.50 thousand hectares and production in the state was 16161.97 thousand tonnes with average yield of 25.96 tonnes per hectare. Uttar Pradesh contributing about 30 percent of total potato production in the country. Due to changes in lifestyle, economic expansion, and population growth, India will need approximately 125 million tonnes of potatoes by 2050 (Kharumnuid *et al.* 2023).

The onion is a valuable horticultural crop that is grown all over the world for both culinary and medicinal purposes. Indian onions are available throughout the year and are widely recognized for their pungency. One cup of finely chopped onions has roughly 64 calories, 15 g of carbohydrates, 2 g of protein, and about 10 per cent of the daily necessary amount of vitamin C and B6 (Nalegaonkar *et*

al. 2020). Total area devoted by the farmers for cultivation of onion in the world was 7.12 million hectares with total production of 136.35 million tonnes and average yield of onion was 41.80 tonnes per hectare in 2021-22. In India, during 2021-22, total area under onion cultivation was 1.91 million hectares with total production of 31.27 million tonnes and average yield of onion in the country was 16.34 tonnes per hectare. Uttar Pradesh ranked 11th place among the onion producing Indian states. In Uttar Pradesh, total area diverted by the farmers for onion cultivation was 30 thousand ha and total production of 509 thousand tonnes with an average productivity of 16.97 tonnes per hectares during 2021-22.

Post-harvest loss is increasingly recognized as a crucial element to satisfy the world's expanding food and energy demands. Post-harvest losses in vegetables refer to the decrease in quantity, quality and value of vegetables that occur along the supply chain starting from harvest till its consumption or other end use (Krishna *et al.* 2022). The magnitude of post-harvest losses depends on the length of marketing channel and infrastructure availability during marketing and storage of produce (Krishna *et al.* 2022). The primary causes of post-harvest losses in vegetables include dehydration and withering, physical damage, disease, and biological factors. These issues can arise during the processes of harvesting, transportation, marketing, and storage. (Gathambiri *et al.* 2021). Post-harvest loss of vegetables cause by the fungal and bacterial decay are jeopardising in tropical and sub-tropical region because favourable warm and humid conditions that enhance the growth of microorganisms (Jahan *et al.* 2020). In India, highest economic loss contributed in the form of post-harvest loss is contributed by horticulture sector with the tune of ₹ 14842 crores (Jha *et al.* 2015). The primary causes of food losses stem from insufficient infrastructure, logistics, technology, market access, and a shortage of supply chain participants equipped with the requisite managerial expertise and knowledge (Singh *et al.* 2022). Nearly 30 percent post-harvest loss was found at farm level (Gathambiri *et al.* 2021). Nearly 30 percent of total vegetables production in India is lost (Sahu *et al.* 2021). A sizable proportion of total onion produce goes wasted too. In India, losses in potato are about 7.32 per cent (Krishna *et*

al. 2022). Food processing losses in India before it reaches consumers total ₹ 92651 crores. This amount represents almost 40 per cent of India's total food and crop production (Tiwari *et al.* 2021; Tadesse *et al.* 2018). Keeping in view the above aspects, this study aims to examine the patterns of growth in the cultivation area, production and yield in both Uttar Pradesh & India and estimate the post-harvest losses of Onion & Potato in the study area.

Methodology

All the information used in this study was gathered from secondary as well as primary sources. Growth trend for area, production, and productivity was analysed for potato and onion crop and period of study was 2001-2022. The whole study period was divided into 2 sub-periods: period-I (2001-2010), period-II (2011-2022) and overall period (2001-2022). Primary data was collected for agricultural year 2021-2022 for potato and onion to estimate the post-harvest losses in Uttar Pradesh. The Varanasi district of Eastern U.P. was specifically chosen as study area as it is the major vegetable producing district of the state. The necessary primary data were collected from 100 farmers, 20 wholesalers and 35 retailers who were involved in marketing of potato and onion crop.

Assessment of the growth trend

To study how the variables (area, production and yield) change over time, compound growth trend was calculated. The exponential function ($Y = a \times bt$) was used to analyse the temporal growth in area, yield & production of potato and onion. Where, Y is the dependent variable (it may be area, yield & production), t is the independent variable, signifying the ranking assigned to the specific year. The ranking was determined in ascending order. Additionally, a is the functional coefficient utilized within the exponential function, and b represents the compounding coefficient (Singh and Singh, 1997).

Estimation of the post-harvest losses (PHL) of major vegetables in the study area

The sum of the losses that occur at each stage of supply chain constitutes the total PHL at any stage of vegetable movement from producers to consumers:

Total PHL = Sum of PHL at each stage of the supply chain process (Patrey and Deshmukh, 2022)

$$\text{Total PHL} = \sum Si = \sum f(Xj) \quad \dots(1)$$

Where,

' Si ' = losses in each critical stage of post-harvest;

' Xj ' = factors affecting losses at each stage;

' i ' = critical stages from harvesting to sales.

$$\sum Si = \sum f(Xj) \quad \dots(2)$$

RESULTS AND DISCUSSION

Growth trend for Area, production & productivity of Onion

In India, the area allocated by farmers for onion cultivation increased from 495.8 thousand hectares in 2001-02 to 1914.2 thousand hectares in 2021-22, with a CAGR of 6.84 percent, whereas in case of Uttar Pradesh, it was recorded as 25.20 thousand hectares in 2001-02 and 30.00 thousand hectares in 2021-22, with a CAGR of 0.81 percent (Table 1). During period-I, positive growth was observed for area under onion at national level (9.15 percent per year) but for Uttar Pradesh it revealed declining trend (-0.10 percent). During period-II of study, positive compound growth trend was observed for India level (4.78 percent) and Uttar Pradesh with 1.97 percent (Table 1).

Total production of Onion in India was 5252.1 thousand tonnes in 2001-02 and it was augmented to 31272.70 thousand tonnes in 2021-22, whereas in case of Uttar Pradesh, it was 278.50 thousand tonnes in 2001-02 and it was further increased to 509.00 thousand tonnes in 2021-22. The positive growth trend was observed for country and state level during same period of time (Table 1). During sub-period of study, highest compound annual growth was recorded (15.48 per cent) during period-I and lowest was during period-II (5.71 percent) in India. In Uttar Pradesh highest compound annual growth was found during period-I (3.60 percent) and lowest was 1.70 percent in period-II.

As for as productivity is concern, compound annual growth trend was observed for overall period for country as whole and Uttar Pradesh during study

Table 1: Compound growth trend for area, production& productivity of onions in Uttar Pradesh and India

Sl. No.	Particular India		Period-I (2001-11)		Period-II (2011-22)		Overall Period (2001-22)	
			U.P.	India	U.P.	India	U.P.	
1	AREA (000' Ha)	Initial Value	495.8	25.20	1087.2	23.70	495.8	25.20
		End Value	1063.8	23.20	1914.2	30.00	1914.2	30.00
		CAGR (%)	9.15*	-0.10	4.78*	1.97*	6.84*	0.81
		Std. Error	0.16	0.30	0.09	0.04	0.13	0.20
		R ² (%)	76.61	0.01	78.49	77.57	90.87	6.22
2	Production (000' tonnes)	Initial Value	5252.1	278.50	17511.1	383.50	5252.1	278.50
		End Value	15117.7	368.60	31272.7	509.00	31272.7	509.00
		CAGR (%)	15.48*	3.60	5.71*	1.70**	9.57*	3.25*
		Std. Error	0.23	0.25	0.05	0.06	0.21	0.17
		R ² (%)	80.23	17.56	94.37	50.28	88.81	59.10
3	Productivity (Tonnes/Ha)	Initial Value	10.6	11.10	16.1	16.20	10.6	11.10
		End Value	14.2	15.90	16.3	16.97	16.3	16.97
		CAGR (%)	5.79*	3.65*	0.87	-0.27	2.55*	2.44*
		Std. Error	0.11	0.07	0.06	0.03	0.11	0.09
		R ² (%)	72.30	71.78	22.93	10.05	67.13	75.36

*: Significant at 1 per cent level of significance; **: Significant at 5 per cent level of significance.

period with a CAGR of 2.55 and 2.44 per cent respectively. The sub-period wise analysis suggest that, compound annual growth was found to be 5.79 and 3.65 per cent for India and Uttar Pradesh respectively during period-I, while same was 0.87 and -0.27 per cent during second period of study.

Growth trend for area, production & productivity of Potato

The growth trend for potato area, production and yield was analysed for the period of 2001–02 to 2021–22 and it is represented in Table 2. In India, potato growing area was 1101.80 thousand hectares in 2001 and it was mounted to 2202.20 thousand hectares by the year 2002. The potato area was growing with CAGR of 3.23 percent during same period of time. The area under potato cultivation in the country during two sub-periods: period-I & period-II were augmenting with compound growth rate of 6.08 and 1.23 per cent per annum respectively. In case of Uttar Pradesh, area under potato cultivation was expanding with a compound growth rate of 2.29 per cent during 2001 to 2022. During the sub-period-I and sub-period-II, potato area was annual growing with a compound growth rate of 4.02 and 0.57 per cent respectively.

In 2001, production of potato was 24456 thousand

tonnes, and it was increasing with a growth rate of 4.85 percent per annum, it reached to 53387.3 thousand tonnes in year 2021–22 in India, while in Uttar Pradesh, production of potato rose with a CAGR of 2.90 per cent from 9570 thousand tonnes in 2001–02 to 16161.97 thousand tonnes in 2021–22. The results of all the sub-periods showed that, period-I had the highest CAGR and period-II had the lowest for the country. The growth rate in production of potato for Uttar Pradesh was found 4.04, 0.94 & 2.90 per cent per annum for sub-period-I, II & overall period respectively.

In case of productivity of potato, it is growing with CAGR of 1.57 percent per annum during the overall period of study in India. The annual compound growth rate for potato yield in India during period-I and period-II was observed to be 1.01 and 1.35 per cent respectively. In case of Uttar Pradesh, productivity growth for overall period was 0.60 per cent, whereas for period-I and period-II growth rate was observed for potato yield was 0.05 and 0.37 percent respectively.

Estimation of the post-harvest losses (PHL) of potato and onion

Per hectare average production of potato and onion in the study area was 220 and 175.95 quintal

Table 2: Compound growth trend for area, production and productivity of potato in Uttar Pradesh and India

Sl. No.	Particulars India		Potato					
			Period-I (2001-11)		Period-II (2011-22)		Overall Period (2001-22)	
			U.P.	India	U.P.	India	U.P.	
1	AREA (000' Ha)	Initial Value	1101.8	389.90	1907	567.70	1101.8	389.90
		End Value	1863.2	556.50	2202.2	622.50	2202.2	622.50
		CAGR (%)	6.08*	4.02*	1.23*	0.57	3.23*	2.29*
		Std. Error	0.06	0.02	0.03	0.03	0.09	0.06
		R ² (%)	91.49	97.48	68.32	25.67	84.92	85.15
2	Production (000' MT)	Initial Value	24456	9570.00	41482.8	14125.10	24456	9570.00
		End Value	42339.4	13576.6	53387.3	16161.97	53387.3	16161.97
		CAGR (%)	7.17*	4.04*	2.62*	0.94	4.85*	2.90*
		Std. Error	0.09	0.07	0.05	0.06	0.10	0.08
		R ² (%)	84.83	74.15	74.94	20.69	90.24	82.27
3	Productivity (MT/Ha)	Initial Value	22.2	24.50	21.8	24.90	22.2	24.50
		End Value	22.7	24.40	24.2	25.96	24.2	25.96
		CAGR (%)	1.01	0.05	1.35**	0.37	1.57*	0.60*
		Std. Error	0.10	0.07	0.05	0.04	0.07	0.06
		R ² (%)	10.13	0.06	49.23	7.93	65.56	30.54

*: Significant at 1 per cent level of significance; **: Significant at 5 per cent level of significance.

respectively. Potato and onion are consumed throughout the year. The substantial quantity of post-harvest losses was observed for potato and onion, if it is not handled properly. PHL of potato and onion is varying from different stages of marketing to move from producer to ultimate consumer's viz., harvesting, grading, transportation, storage, packaging etc. The estimation of total PHL of potato and onion at various stages of the marketing are represented in Table 3.

Post-harvest loss at farm level

At farm level, total PHL for potato was 7.84 kg/qt. It was observed from Table 3, that major chunk of post-harvest loss was at farm level which alone accounted for 49.53 percent of total potato PHL. Out of total PHL at farm level, highest loss was observed during storage (12.32 percent) followed by transportation (10.11 percent), harvesting (9.48 percent), collection (6.44 percent), sorting/grading (6.44 percent), and lowest during packaging (4.74 percent). It was noticed that the PHL of potato was highest at storage level where the decay or damaged potato rots self-seasoned potatoes due to lack appropriate storage facility at farmers' level.

Total PHL in terms of quantity for onion was 6.98 kg/qt at farm level, which account for about 45.74 percent of total post-harvest loss of onion. Out of total PHL at farm level, highest share comes from transportation (11.34 percent) followed by storage (10.42 percent), harvesting (8.65 percent), collection (7.14 percent), sorting/grading (4.72 percent), and lowest for packaging (3.47 percent).

Post-harvest loss at wholesaler level

At wholesaler level post-harvest loss was observed during loading/unloading, collection, storage, weighing and physical damage etc. Out of total PHL of potato at wholesaler level was found to be 18.76 percent. Out of total PHL at wholesaler level, highest loss contributed by storage (6.82 per cent) followed by loading and unloading (5.18 percent), sorting/grading (2.21 per cent), weighing or physical damage (2.15 percent) and lowest for collection of potato (1.01 percent). Onion arrives in *mandi* through farmers or middlemen to wholesaler. Out of total PHL of onion, 19.27 percent loss was at wholesaler level in which 5.5 percent loss was at storage level, 5.64 percent at loading and unloading, 2.82 percent loss was during sorting/grading,

Table 3: Post-Harvest Loss of Potato and Onion at different Stages

Sl. No.	Losses	Potato (Kg/q)	Losses in Percent (%)	Onion (Kg/q)	PHL in Percent (%)
I	At Farm Level				
	Harvesting	1.50	9.48	1.32	8.65
	Collection	1.02	6.44	1.09	7.14
	Sorting/Grading	1.02	6.44	0.72	4.72
	Storage	1.95	12.32	1.59	10.42
	Packaging	0.75	4.74	0.53	3.47
	Transportation	1.60	10.11	1.73	11.34
	Total	7.84	49.53	6.98	45.74
II	At <i>Mandi</i>/ Wholesaler Level				
	Sorting/ Grading	0.35	2.21	0.43	2.82
	Collection	0.16	1.01	0.14	0.92
	Loading and unloading	0.82	5.18	0.86	5.64
	Weighing/Physical Damage	0.34	2.15	0.40	2.62
	Packaging	0.22	1.39	0.27	1.77
	Storage	1.08	6.82	0.84	5.50
	Total	2.97	18.76	2.94	19.27
III	At Retailer Level				
	Sorting/Grading	1.34	8.46	1.01	6.62
	Weighing/Physical Damage	1.04	6.57	0.75	4.91
	Transportation	0.85	5.37	1.10	7.21
	Storage	1.79	11.31	2.48	16.25
	Total	5.02	31.71	5.34	34.99
	Total Loss (Kg/q)	15.83		15.26	

Source: Authors computation.

2.62 percent at weighing or physical damage and remaining 0.92 percent at collection of onion.

Post-harvest loss at retail level

Post-harvest loss at retailers' level for potato was 31.71 percent, which was highest after producer/farm level. At retailer level PHL for potato was highest during storage followed by sorting/grading. The losses at retailers' level were at 1.34 kg (8.46 percent), 1.04 kg (6.57 percent), 0.85 kg (5.37 percent) and 1.79 kg (11.31 percent) for sorting/grading, weighing/physical damage, transportation and storage respectively and at retailer's level total PHL for onion were accounted 34.99 percent, which was again highest after producer level. At retailer level PHL for Onion were highest during storage followed by transportation.

Conclusion and Policy Implications

In spite the fact that there is a sizable amount of

variation in the area, production & productivity of onion & potato cultivation in Uttar Pradesh as well as across the country, these variables showed a higher percent share than in Uttar Pradesh. India's agricultural sector is anticipated to advance in the next few years because of increased investment in agricultural infrastructure like irrigation, warehousing, and cold storage etc. Adoption of new technology and innovations for potato and onion cultivation is very important for smallholder farmers to enhance productivity and their revenue (Zenbaba, 2021). Consequently, there are chances to increase potato productivity through changes in modern technology and innovation. An effort should be made by the government to distribute high-yielding varieties of vegetables and provide training to farmers to promote agricultural productivity and food security. Major post-harvest loss of potato and onion was at farm level. Thus, there is urgent need for the government to provide technical knowledge to farmers to reduce

losses at farm level and to improve post-harvest infrastructure, such as cold storage facilities, pack houses, and transport networks, to ensure efficient handling and transportation of vegetables from farms to markets and ultimate consumers.

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