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Impact of COVID-19 pandemic on potato arrivals and prices in wholesale market of Uttarakhand

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Abstract
The Indian economy has been affected adversely by the waves of COVID-19 pandemic. The adverse impact was observed in Uttarakhand also, especially in the agriculture sector. Potato is a major vegetable crop of Uttarakhand owing to the fact that it is in demand by every family and traded in all the Uttarakhand wholesale mandis. Hence, the study was done to assess the impact of COVID-19 pandemic on wholesale arrivals and prices of potato. There were three time periods chosen for the study viz. the pre-pandemic year (2019-20) and the two pandemic years (2020-21 and 2021-22). All were divided into 13 phases. The movement of average weighted modal prices and arrivals was analyzed using graphs. With pre-pandemic year values (arrivals or average weighted modal prices) as base, the percent decrease in potato arrivals and average weighted modal price during each of the two pandemic years was observed using difference-in-differences model.

Keywords: COVID-19, pandemic, potato, wholesale market, APMC

1. Introduction
The global economy has been adversely affected by the COVID-19 pandemic. The effect was also seen in India. Strict lockdown was imposed all over the country and all major activities were put to halt. Demand, production and supply of goods and services came down. The effect of pandemic was seen in all states and in all the sectors of the economy.

In agriculture sector, farmers faced problems in farming activities right from the purchase of inputs to harvesting and marketing. The arrivals and wholesale price indices for cereals, vegetables, egg and poultry chicken fell down which indicated low price realization by farmers [1]. Due to the COVID-19 pandemic lockdown, the food arrivals declined by around 60% initially [2]. A large number of markets were not operational during the lockdown. In the operational markets, there was sharp decline in agricultural commodities [3].

In Uttarakhand also, adverse impact was observed. NABARD conducted a study on 12 out of 13 districts of Uttarakhand and found that in 6 districts, the farmers' ability to take produce to APMC was adversely affected. In 11 districts, farmers' ability to sell through private agencies was adversely affected. In all the 12 districts rural weekly markets were adversely affected [4].

Uttarakhand is comprised of hilly terrains and plains. The state has potential to grow wide range of crops as it is home to 4 agro-climatic zones that cover 6 altitudinal farming approaches. The net sown area in Uttarakhand declined from 698 thousand hectares in 2015-16[5] to 690 thousand hectares [6] in 2016-17. The contribution of crop sector in Gross State Domestic Product (GSDP) also declined from 7.05 percent in 2011-12 to 4.67 percent in 2018-19 according to advanced estimates [7].

Agriculture is an important sector in Uttarakhand. More than 55 percent workers in Uttarakhand depend on agriculture for their livelihood [8]. The situation of Uttarakhand shows that rural households have low income. The socio-economic caste census-2011 showed that the percentage of rural households wherein the highest earning member earned Rs. 10,000 or more in the districts of Uttarakhand ranged 10 percent to 27 percent [9]. Around 73 percent of land holdings are less than 1 hectare [7]. The agriculture sector in Uttarakhand depends heavily on rainfall. The net irrigated area in hills is only around 14 percent of the total land area in Uttarakhand [10]. There are also growing instances of damage of crops by animal attack. Climate change is posing critical issues to crop sector. Heavy rainfall accompanied by the problem of soil erosion is making agriculture vulnerable.

Among crops grown in Uttarakhand, vegetable crops are highly sensitive to climatic conditions. Because of high perishability, when conditions like lockdown are imposed, the vegetable sector show high adverse effect. Among vegetables, potato is the major crop sown in

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Uttarakhand. Being in demand by every family, potato is a very important crop of Uttarakhand. It also covers highest area among vegetable crops as given in table 1. In 2019-20, potato covered 26,769.38 ha in Uttarakhand. Potato is traded in Uttarakhand mandis round the year. The off-season potato growing in Kumaun & Garhwal region during summer season are in much demand in the plains areas [11]. Hence, the study was conducted to analyse the impact of COVID-19 pandemic on arrivals and modal prices of potato in wholesale market of Uttarakhand.

Table 1: Area under vegetable crops in Uttarakhand in 2019-20

Vegetable Crop	Area (Ha)	Area (%)
Potato	26769.38	17.08
Green pea	13497.39	8.61
Tomato	9360.75	5.97
Cabbage	6568.25	4.19
French Bean	6110.02	3.90
Radish	5287.85	3.37
Onion	4459.82	2.85
Okra	3723.36	2.38
Cauliflower	3367.06	2.15
Capsicum	2807.1	1.79
Brinjal	2729.68	1.74
Other vegetables	72071.35	45.98
Total Area	156752	100.00

2. Data and Methodology

The Agriculture Produce Marketing Committee (APMC) Mandi data of potato was taken from the website of Agricultural Marketing Information Network [12]. Daily data of potato arrival and modal price were taken for 3 years - 2019-20 (the pre-pandemic year; 25-03-2019 to 24-03-2020) and 2020-21 and 2021-22 (the two pandemic years; 25-03-2020 to 24-03-2021 and 25-03-2021 to 24-03-2022). The lockdown was imposed over 4 phases viz. phase 1(25 March 2020 – 14 April 2020), phase 2(15 April 2020 – 3 May 2020), phase 3(4 May 2020 – 17 May 2020) and phase 4(18 May 2020 – 31 May 2020) whereas the remaining 9 phases were of unlock, thus, making a total of 13 phases.

All the mandis where trade took place during the period were considered for the study. The mandis were 19 in number (Bazpur, Bhagwanpur [Naveen Mandi Sthal], Dehradun, Haldwani, Haridwar, Jaspur, Kashipur, Khateema, Kichchha, Kotdwar, Lakshar, Manglaur, Ramnagar, Rishikesh, Roorkee, Rudrapur, Sitarganj, Tanakpur and Vikasnagar). The data of area under vegetable crops in Uttarakhand was taken from the website of State Horticulture Mission, Govt. of Uttarakhand [13].

Weighted average modal price for the state were calculated by using the following formula:

$$P_{dt} = \left(\sum_{j=1}^{n} A_{jdt}.p_{jdt}\right) / \left(\sum_{j=1}^{n} A_{jdt}\right) \qquad (1)$$

Where, P_{dt}= Average weighted modal price in Uttarakhand on d^{th} date and t^{th} year
p_{jdt}= Modal Price in j^{th} APMC mandi on d^{th} date and t^{th} year
d=date|
t=year(1 for pre-pandemic year, 2 for pandemic year, 2020-21 and 3 for pandemic year 2021-22)

A_{jdt}=Arrival in j^{th} APMC mandi on d^{th} date and t^{th} year

The average weighted modal price is hereafter referred to as price or modal price.

Difference-in-differences specification was used to find out the percent decrease in prices (or arrivals) in each of the pandemic year over pre-pandemic year. The following difference-in-differences specification was used as given in Eq. (2) as used in [2].

$$LnY_{yd} = \alpha_y + \alpha_d + \sum_{t=1}^{13} \beta_t Phase^t_{yd} + \varepsilon_{yd} \qquad (2)$$

Where, $\ln(Y_{yd})$ is the log of the total volume of food arrivals (or price) of potato, on calendar date d during year y. α_y and α_d are year and calendar date fixed effects, respectively. The model was run for the year 2020-21 with pre-pandemic year as the base year. Then, the model was run for the year 2021-22 with pre-pandemic year as the base year for both modal prices and arrivals. Both models were run using R. To estimate the separate effects for each phase of the lockdown and of the unlock, a set of dummy

Variables were added for the thirteen phases. The Phase dummy variable was put equal to 1 during respective phase dates and was put to 0 otherwise. For example, Phase$^1_{yd}$ was put equal to 1 for the period 25 March – 14 April of 2020-21 and 2021-22 and 0 otherwise.

The Phase t volume fall in % is estimated as 100x $(1-e^\beta)$. The analysis was done in R. Besides this, graphs and boxplots were made using stata.

3. Results and Discussion

It can be observed from figure 1 that the arrival of potato was higher in 2019-20 as compared to 2020-21 for most of the year until February-March. From the figure 2, it can be observed that potato arrivals in wholesale market were higher during the year 2019-20 until around February after which 2021-22 potato arrivals became higher. From the boxplot of arrivals shown in figure 3, it can be observed that overall 2019-20 arrivals were more than that of the years 2020-21 and 2021-22. The 25th percentile of arrivals of 2019-20 is about 50th percentile of arrivals of 2020-21 and 2021-22. There was no considerable difference between the boxplots of arrivals for the years 2020-21 and 2021-22 showing that the pandemic years were quite different from the pre-pandemic year with arrivals being lower in the pandemic years. It has been found in another study through paired t-test that 2020-21 values of arrivals and prices were significantly different from the values of 2019-20 [14].

The modal prices of 2020-21, as shown in figure 4, were higher than those of 2019-20 for most of the year until mid-December after which 2019-20 prices became higher for most of the days. As shown in figure 5, the 2021-22 modal prices were higher than 2019-20 modal prices until around December after which 2019-20 were mostly higher. From the figure 6, it is understood that 2020-21 prices were the highest among all the three years in terms of percentiles and range. The range of 2021-22 prices was quite low whereas 2019-20 prices had slightly more fluctuations as its range was higher than the year 2021-22.
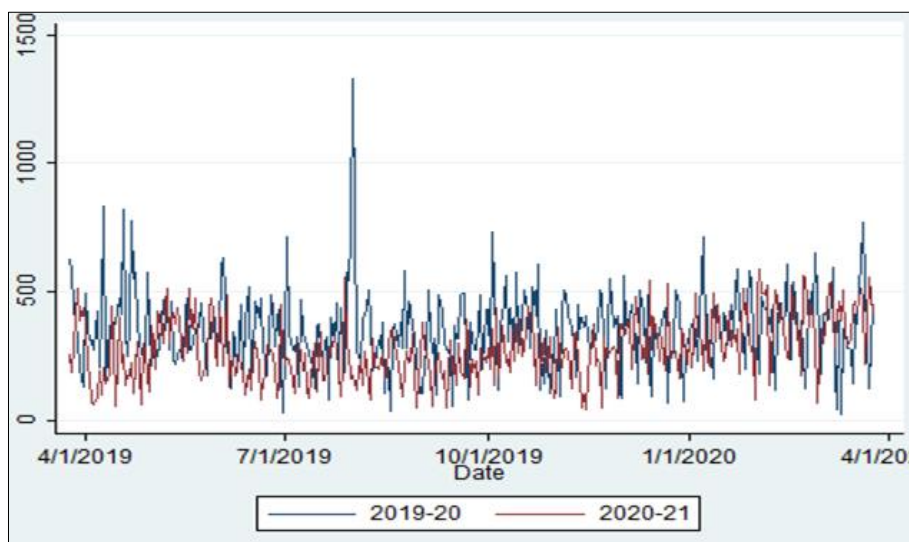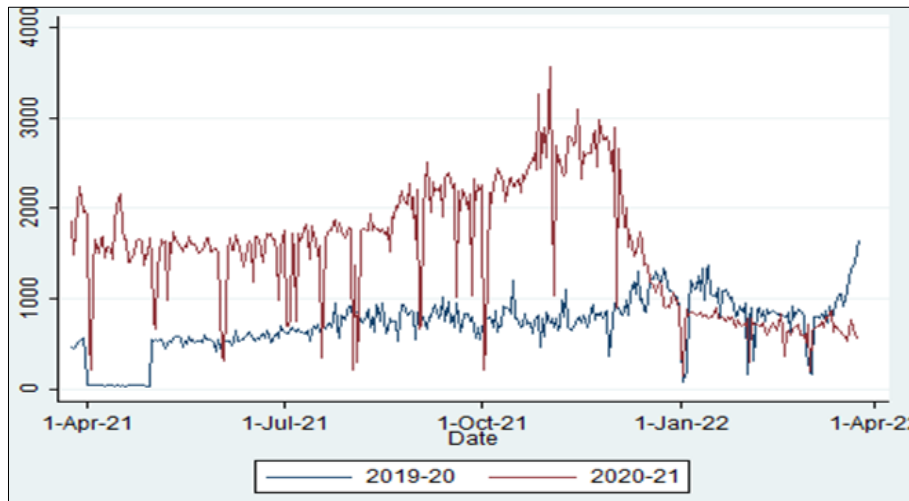
Fig 1: Arrival (in tonnes) of potato in Uttarakhand mandis during 2019-20 and 2020-21
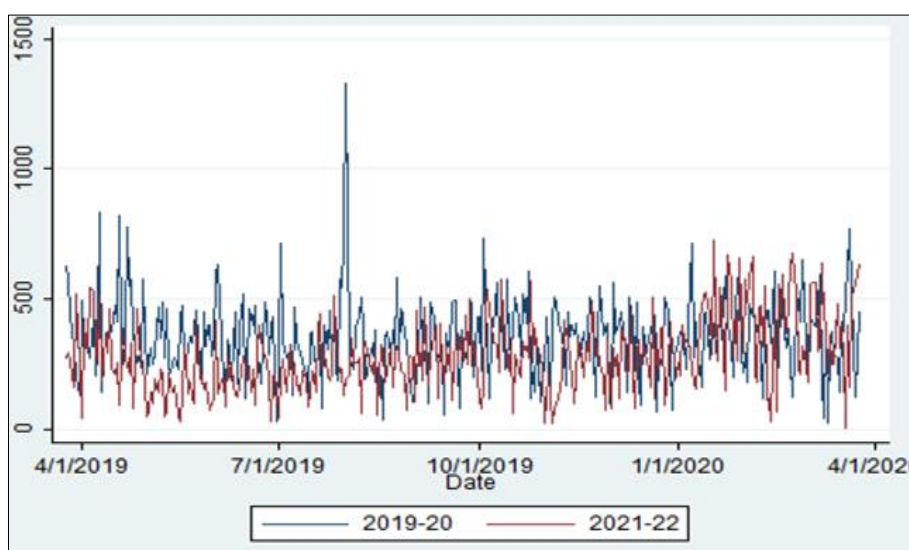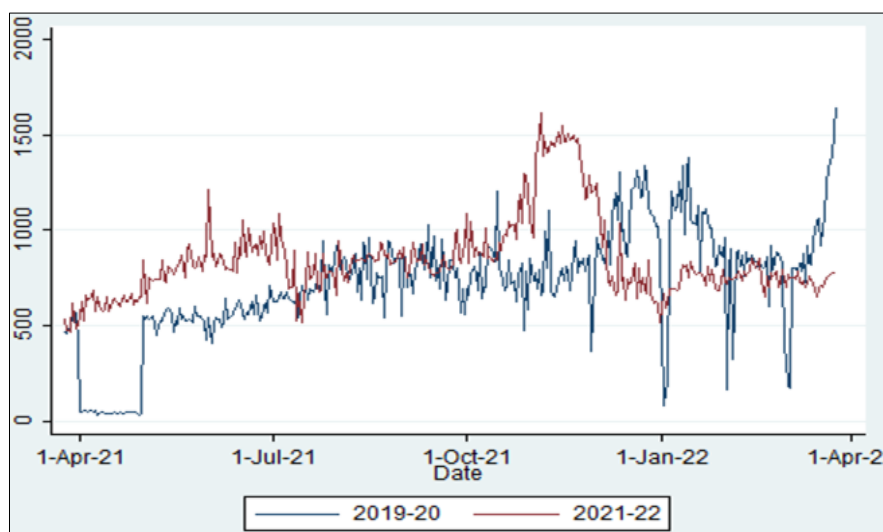

Fig 2: Arrival (in tonnes) of potato in Uttarakhand mandis during 2019-20 and 2021-22
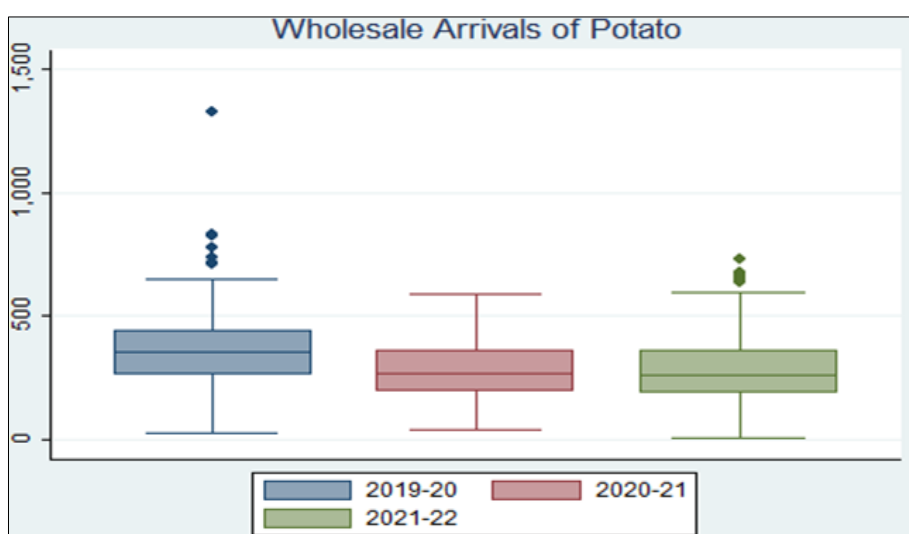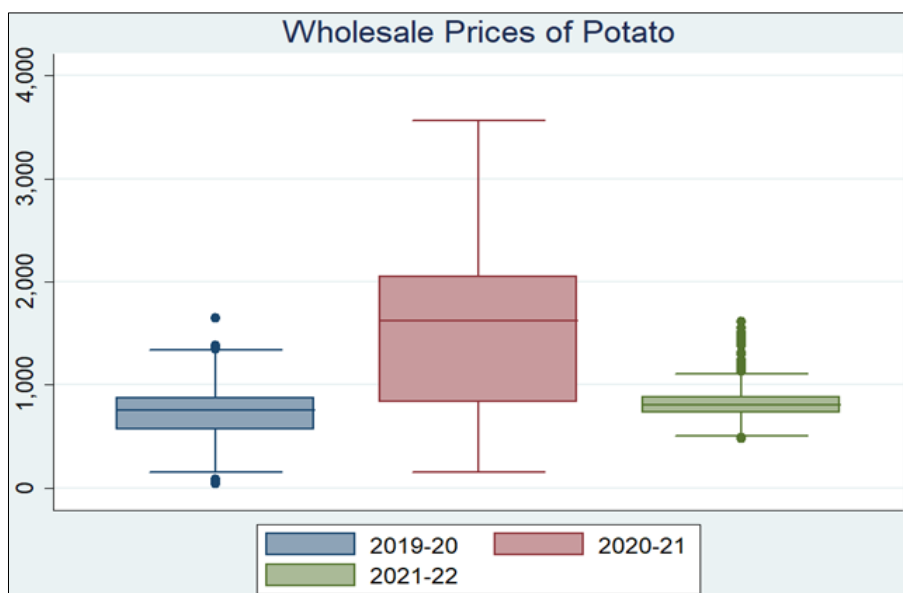

Fig 3: Boxplot of wholesale arrivals of potato

Fig 4: Modal prices (Rs. per quintal) of potato in Uttarakhand mandis during the years 2019-20 and 2020-21

Fig 5: Modal prices (Rs. per quintal) of potato in Uttarakhand mandis during the years 2019-20 and 2021-22

Fig 6: Boxplot of wholesale arrivals of potato

Table 3 shows that the phase 2 of the lockdown reduced potato arrivals in Uttarakhand mandis by 52% in 2020-21 over the base year 2019-20 which was the highest among all phases whereas lowest percentage decrease (9%) was observed in phase 3. All the phases showed decrease in arrivals in 2020-21 as compared to 2019-20. In the year 2021-22, phases 12 and 13 showed increase in potato arrivals non-significantly whereas all other phases showed decline in

potato arrivals indicating that the pandemic situation of Uttarakhand stabilized after showing decline for 11 phases. Arrivals were worst affected in phases 2, 3 and 4. Barring phases 3 and 4, during all other phases, the year 2020-21 showed more adverse effect than the year 2021-22. However, coefficients of phases 1, 8, 9, 11-13 were not found to be significant for the period 2019-20 and 2021-22.

Table 4 shows that phase-10 of the lockdown increased modal price of potato in 2020-21 over the base year 2019-20 in Uttarakhand mandis by 300% which was the highest among all phases. However, the increase in modal price was less (89%) in the same phase of the year 2021-22. Phase 8-10 showed the highest increase in 2020-21 over 2019-20 whereas lowest percentage decrease was 104% and was observed in phase-11 for the same year. Thus, after showing peak in the increase in modal prices, the price increase suddenly dropped to the lowest. Only phase-10 showed significant percentage decrease in prices (35%) among all phases in 2021-22 when compared to the base year of 2019-20.

Table 3: Impact of Pandemic on Arrivals of Potato in APMC mandis of Uttarakhand

Phases	Ln(Arrivals) (1)	Decrease (%) (2)	Ln(Arrivals) (3)	Decrease (%) (4)
Phase1 (25 March – 14 April)	-0.66 ** (0.14)	48.37	-0.06 (0.17)	6.23
Phase2 (15 April – 3 May)	-0.74** (0.15)	52.39	-0.46** (0.17)	36.69
Phase3 (4 May – 17 May)	-0.09 (0.16)	8.60	-0.97** (0.18)	62.08
Phase4 (18 May – 31 May)	-0.27 (0.16)	23.83	-0.64** (0.18)	47.08
Phase5 (1 June – 30 June)	-0.63** (0.13)	46.93	-0.51** (0.14)	40.20
Phase6 (1 July – 31 July)	-0.63** (0.13)	46.88	-0.42** (0.15)	34.16
Phase7 (1 August – 31 August)	-0.71 ** (0.13)	50.67	-0.34* (0.15)	28.86
Phase8 (1 September – 30 September)	-0.69** (0.13)	49.84	-0.15 (0.15)	13.66
Phase9 (1 October – 31 October)	-0.44** (0.13)	35.72	-0.20 (0.15)	17.83
Phase10 (1 November – 30 November)	-0.71** (0.13)	50.60	-0.43** (0.15)	34.72
Phase11 (1 December – 31 December)	-0.30* (0.13)	25.64	-0.25. (0.15)	22.37
Phase12 (1 January – 31 January)	-0.28* (0.13)	24.21	0.11 (0.15)	-11.90
Phase13 (1 February to 28 February)	-0.11 (0.13)	10.52	0.04 (0.15)	-3.63

'**'and '*' show significance at 1% and 5% respectively.

(1) and (2) show results for the period, 2019-21 whereas (3) and (4) show results for the period, 2019-20 and 2021-22. (1) and (3) show the coefficients of phases when Ln(Arrivals) is the dependent variable. (2) and (4) show percentage decrease in potato arrivals in 2020-21 and 2021-22 respectively over 2019-20. The number of observations is a total of all calendar days in a year except few days like holidays when no trade took place and 29th February that were omitted to make it a balanced panel.

Table 4: Impact of Pandemic on Modal Price of Potato in APMC mandis of Uttarakhand

Phases	Ln(Modal Price) (1)	Decrease (%) (2)	Ln(Modal Price) (3)	Decrease (%) (4)
Phase1 (25 March – 14 April)	0.83 ** (0.19)	-128.37	-0.17 (0.18)	16.03
Phase2 (15 April – 3 May)	0.81** (0.19)	-125.08	-0.13 (0.18)	12.05
Phase3 (4 May – 17 May)	0.89** (0.21)	-143.82	0.05 (0.2)	-4.77
Phase4 (18 May – 31 May)	0.9 ** (0.21)	-145.42	0.13 (0.2)	-13.87
Phase5 (1 June – 30 June)	0.77 **(0.17)	-114.92	0.19 (0.16)	-20.71
Phase6 (1 July – 31 July)	0.82 **(0.17)	-127.36	0.05 (0.16)	-4.87
Phase7 (1 August – 31 August)	0.91 **(0.17)	-148.51	0.14 (0.16)	-15.33
Phase8 (1 September – 30 September)	1.1 **(0.17)	-200.78	0.14 (0.16)	-14.52
Phase9 (1 October – 31 October)	1.21** (0.17)	-234.49	0.28 (0.16)	-32.79
Phase10 (1 November – 30 November)	1.39 **(0.17)	-299.91	0.64 **(0.16)	-88.89
Phase11 (1 December – 31 December)	0.71 **(0.17)	-103.53	0.04 (0.16)	-3.80
Phase12 (1 January – 31 January)	0.21 (0.17)	-23.37	0.04 (0.16)	-3.80
Phase13 (1 February to 28 February)	0 (0.18)	-0.39	0.03 (0.16)	-3.30

'**'and '*' show significance at 1% and 5% respectively.

(1) and (2) show results for the period, 2019-20 and 2020-21 whereas (3) and (4) show results for the period, 2019-20 and 2021-22. (1) and (3) show the coefficients of phases when Ln(Modal Price) is the dependent variable. (2) and (4) show percentage decrease in modal prices of potato in 2020-21 and 2021-22 respectively over 2019-20. The number of observations is a total of all calendar days in a year except few days like holidays when no trade took place and 29th February that were omitted to make it a balanced panel.

4. Conclusion and Recommendations
The study was done to assess the impact of COVID-19 pandemic on wholeasale prices of potato in Uttarakhand. Potato was chosen as it is one of the major vegetables grown in Uttarakhand and consumed by every family. It was observed that potato arrivals in wholesale market were higher during the year 2019-20 until around February-March after which 2020-21 and 2021-22 potato arrivals became higher. The modal prices of 2020-21 and 2021-22 were higher than that of 2019-20 for most of the year until mid-December after which 2019-20 prices became higher for most of the days. All the phases showed decrease in arrivals and prices in 2020-21 as compared to 2019-20. In the year 2021-22, phases 12 and 13 showed increase in potato arrivals non-significantly as compared to the year 2019-20 whereas all other phases showed decline in potato arrivals. Only phase-10 showed significant percentage decrease in prices among all phases in 2021-22 when compared to the base year of 2019-20.

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