COVID-19 Impact on Indian Food and Hospitality Sector with Specific Reference to Potato Crop

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Abstract

Disruption through present pandemic is applicable to almost all the sectors of economy. However, impact of COVID-19 pandemic on Indian food, agribusiness and hospitality industry is largely experienced. Further, it is believed that fluctuations in arrivals and price surge of essential staple vegetables like potato can have severe multifold effects on hospitality sector including restaurants and online food delivery platforms. Keeping the vitality of these issues in mind, in present study we decided to keep potato as a focused commodity to be analyzed since it is the most popular vegetable across the globe. Daily data for potato arrivals and prices was considered for the date range between 1st January 2018 to 16th April 2020 using online mandi data from Agmark (government recognized site for vegetable price and arrivals). Arrivals and trends of price behavior over the coming six months during the pandemic was attempted to measure. Time series ARIMA model was adapted for this purpose. Azadpur mandi being the Asia's largest mandi was purposively chosen as study area. Forecasting range suggested the stress in potato supply chain for coming 6 months also depicted that fluctuation in both prices and arrivals. This study forecasted that the potato price would increase by 58.7% by October 2020 compared to October 2019 and arrivals would be just 3.11% less compared to last year. Situation assessment through forecasted range can draw attention of policy makers to ensure streamlined chain of supply for essentials and preventing any devastating effects of COVID-19 on food and hospitality sector.

Introduction

In recent times, COVID-19 crisis has affected global food supply chain and has poised great threat to household food security, by disturbing national and international agricultural supply chains as well as hotel and tourism industry [1, 2]. As like other developing countries, India is facing outrageous crisis due to COVID-19, which has compelled all countrymen to remain under lockdown for uncertain period. COVID-19 has hit various sectors including agriculture, hotels, restaurants, tourism, food processing, packaging and other industries [3, 4]. The intensity of panic can be ascertained from the fact that it has curbed the agricultural food supply chain and has affected both farmers and consumers [5, 6, 7, 8]. This entire lockdown has resulted in disturbance of various segments of food, agribusiness and hospitality industry mainly due to closure of restaurants, hotels, local sweet shops, food vendors and tea stalls [9]. Local restaurants and food cafes selling non-veg food are also badly impacted because of misinformation on social media about chicken as carrier of COVID-19 [10, 11, 12]. Horticulture products especially fruits and vegetables due to highly perishable nature and high seasonal labour requirements had been adversely affected through this pandemic [11, 12]. Moreover, sealing of state and district borders has ceased the movement of carriers to and from *mandies* across the country, thus bringing the value of fruits and vegetables to stand still [13, 14]. This disruption in the agribusiness supply chain has affected the stakeholders on the demand side as well as on the supply side. Amid this situation, consumers are anxious and trying to stock vegetables (for household purpose and also owners of hotels and restaurants to ensure online food delivery), despite of the regular advisory notice from the government against food stocking during locked down and pandemic [5-8, 15-18]. Confronting people's quest of being fit and

retaining a healthy state, vegetables can be considered significant in providing a major source of vitamins and minerals; its importance is even mentioned in Vedic scripts of India in Sanskrit language [19, 20]. Some studies have identified potato as one of the major staple foods capable to contributing in future food supply of India in coming 10 years which is always overlooked due to more b attention on cereal crops wheat and rice [20, 21]. Potato (*Solanum tuberosum* L.) is called 'The king of vegetables', due to its role in multiple veg and non-veg dishes. Potato is assumed as fourth most important food crop in India after major cereals like rice, wheat and maize. Potato crop accounts for total production of about 52.5 MT in India, where Uttar Pradesh, Gujarat, and West Bengal ate the topmost producing states [22]. Many popular Indians dishes are incomplete without Potato. Potato is short duration crop (90-100 days generally), thus its availability is more as it can grow in rabi and kharif seasons. Potato provides essential carbohydrates, proteins and fiber for consumption in lesser duration of time than cereals like rice and wheat. Therefore, potato could play an important role in achieving the nutritional security for the country. Potato has become one of the most staple foods for most of the Indians due to the present crisis while it was always an integral part of diet having essential human nutrients as compared to other vegetables [23-26]. Beside this contemplation of staple food, potential health attributes and nonperishable nature of potato has ignited its severe demand and stocking due to panic obsession across PAN India [24, 26]. This untimely incident has called for fluctuations in demand and supply gap of potatoes in the country and calls for efforts to reduce the food wastage both at household level and institutional level (food wastage at hostels, restaurants, service mess, cafes etc.) [27]. Repercussions of these gaps in demand and supply can have devastating effects in tackling and normalizing the situation. Knowing the severity of the issue, present study has attempted to examine the market arrival and price trend of potatoes in the Northern part of the country with specific reference to Asia's biggest Azadpur *mandi*, Delhi NCR region. In the last few weeks, unprecedented price surge i.e. 28% to 38% in states like Uttar Pradesh and West Bengal has been observed, while other southern states like Maharashtra, Bihar and Assam has also witnessed an upward trend to 23-25 Rs. per kg than Rs. 18 per kg [28, 29]. In Delhi NCR region, prices of potato retail market have hiked 25% in the last week of March 2020, however in normal season time, prices generally trend to be at a stationary phase during this period. Computations from the Ministry of Consumer Affairs also accorded the similar findings and highlighted that the potato has become costlier by 60% over the last month, due to limited flow of cash in market, as a result, people have started using mobile based or online payments more which further lead to lack of liquid cash in vegetable supply chain market [16, 17, 18, 30]. From the supplier side perspective, major hindrances observed in present Corona crisis include labour shortage, lack of transportation facilities, untimely rains, farmers shift to alternate crops disillusioned by previous losses e.g. area under potato in Punjab has shrunk by 35% [31-34]. Amid lockdown, the circumstances in Azadpur *mandi* have also ceased, due to limited buyers as many retailers and shopkeepers are unable to reach here [5-8, 35, 36]. Various potato traders in Azadpur *mandi* are refusing farmers for the produce because the presently available kacha potato is not feasible for long term storage [35, 36]. Keeping the sensitivity of the situation in mind, market intelligence on potential arrivals and prices of potatoes in the coming days is going to be very crucial and would require much attention for the government and policy makers.

Several attempts have been made in the past by academicians to develop price forecast models for

various agricultural commodities. Most general class model for price forecasting used in various agricultural commodities over the years is ARIMA model [37-44]. Seasonal ARIMA (SARIMA) model for time series analysis specifically for analyzing potato prices and arrivals has been used by various scholars in different markets of the country [43, 44]. Chandran and Pandey (2007) have studied the seasonal fluctuation of potato price in Delhi market using seasonal ARIMA (SARIMA) approach [45]; while Kumar *et al.*, 2011, Mithiya *et al.*, 2019 and Mishra *et al.*, 2019 used similar models for forecasting monthly prices of potato in Bangalore, Hooghly West Bengal and Uttar Pradesh, respectively [43, 46, 47]. Over the years, advancement in forecasting models has been observed along with use of Artificial Intelligence [47]. Choudhary *et al.*, (2019) have studied potato forecasting with an artificial neural network with a single hidden layer in the Delhi market [48]. Choudhary *et al.*, (2018) in their study on potato price analysis in Delhi advocated the use of Empirical Model Deconvolution (EMD) to accurately analyze non-stationary and non-linear properties in price series data [49]. However, computing the impact of present unforeseen COVID-19 situation on potato arrivals and price trends in Delhi, Azadpur market considered to be the need of present hour which may provide an insight and contribute to the policy makers and government for tackling any havoc issues in upcoming crucial time.

In this paper we focus on examining and forecasting seasonal fluctuation of potato arrivals and price trends due to the present severe situation of COVID-19 which has mainly impacted the time period of Feb-May 2020.

Materials And Methods

Source of data: To get the data for potato prices and arrivals, we chose the official site of government of India called Agmarknet (<https://agmarknet.gov.in/>). This site provides information about all the agriculture commodity being grown in India, where price of commodity is provided in INR per ton and quantity of commodity arrived in *mandi* is provided in quintals [50].

Area Studied: Azadpur *Mandi* is Asia's biggest fruit and vegetable market, spread over almost 44 acres in north-west Delhi. The *mandi* has almost 1,400 shops and handles almost 50 lakh tonnes of produce every year. Azadpur *mandi* of Delhi NCR, was purposely selected since everyday huge quantity of potato is traded in this *mandi*, this makes it a most favorable market to conduct forecasting study of price and quantity arrivals of potato in Northern India [51].

Major potato producing areas in India are Uttar Pradesh, West Bengal, Bihar, Gujarat, Madhya Pradesh, Punjab, Assam, Chhattisgarh, Jharkhand and Haryana. However, potato comes to Azadpur *mandi* mainly from Uttar Pradesh, Punjab, Haryana, Bihar, Jharkhand and Madhya Pradesh. Uttar Pradesh is one the highest potato producing state of India (see fig. 1) [52].

Channels involved in marketing of potato at Azadpur mandi (Delhi NCR)

1. Institutional Channels

The institutions involve in the marketing channels of potato as follows:

- 1) Producer___ State Marketing Agencies ___ Retailer ___ Consumer
- 2) Producer___ Co-operative Societies ___ Retailer ___ Consumer
- 3) Producer___ NAFED ___ Retailer ___ Consumer
- 4) Producer___ Marketing Federation (MARKFED) ___ Retailer ___ Consumer ___Export

In Potato supply chain, government manages only 4% of total marketing channels throughout India. Amongst 4 channels mentioned above, channel 1 and channel 2 are most operational institutional channels in Azadpur *mandi* (see fig. 2) [52].

1. Private Channels

The different private agencies such as Producers, Commission agent, Wholesaler, Retailer and consumers are involved in the route of marketing channels of potato. These are:

- 1) Producer___Cold storage___Commission agent___Wholesaler___Retailer___Consumer
- 2) Producer___Commission agent___Wholesaler___Retailer___Consumer
- 3) Producer___Wholesaler___Retailer___Consumer

Potato supply chain in India is 96% dependent on the private sector (see fig. 3). It is characterized by highly integrated rural, semi-urban and urban areas. Private channels are active in wholesaling (both on-market in *mandis* and off-market in rural towns), processing, logistics, retailing (for example, kiranas, haats), and food services (such as small restaurants and street meal vendors, or dhabas). These private institutions are part of potato supply chain in Azadpur *mandi* and clusters of potato cold storages in Agra serving the Delhi market [28, 29, 32, 33].

Duration: Duration of data collection was 1st January 2018 to 16th April 2020. Day-wise data of potato arrivals and potato prices were studied to get highly accurate data forecast for next 6 months (approximately 200 days) [50].

Technique used: ARIMA forecasting technique was used to predict the potato arrivals and potato prices for coming 6 months at Azadpur *mandi* (Delhi NCR). ARIMA models are best for non-stationary data example daily prices of vegetables or daily stock prices. In ARIMA, the initial differencing step is incorporated a few or multiple times to remove or reduce the data non-stationarity. The AR part of ARIMA represents regressed own lagged values of the evolving variable of interest. The MA part considers regression error as linear combination of error terms (values of error terms are believed to have occurred

contemporaneously and at multiple times in the past). I (stands for "integrated") represents the data values were replaced with the difference between their values and the previous values. ARIMA models works in a function to provide the best fit forecasted model using the given values. However, in situation, where two out of the three terms are zeros, the model is called as base on the nonzero parameter, dropping "AR", "I" or "MA" parts of the models. For example, ARIMA (1,0,0) is AR (1), ARIMA (0,1,0) is I(1), and ARIMA(0,0,1) is MA(1). ARIMA models could be best understood using Box–Jenkins approach. Where, time series of data is X_t , t is an integer index, X_t are real numbers and an ARMA (p, q) model is given as:

$$X_t - \alpha_1 X_{t-1} - \dots - \alpha_p X_{t-p} = \varepsilon_t + \theta_1 \varepsilon_{t-1} + \dots + \theta_q \varepsilon_{t-q}$$

Here L is the lag operator and α_i are the parameters of the autoregressive part of the model and θ_i are the parameters of the moving average part and ε_t are error terms. The error terms pre-assumed to be independent and identically distributed variables [53, 54].

Results

Price Forecast of Potato in India

Potato in North India is majorly a Rabi season crop, where potato tuber is sown in field in mid-September to November and final harvesting is done in months of December to March (see fig 4a). About 98% of potato is harvested as a rabi crop. However about 1.5-2% potato crop is also harvested as kharif crop, where sowing is done in June and harvested in September to November. Thus, potato prices are generally **highest in September to November** every year, due to high demand of potato as seed tuber and demand for potato for consumption in hostels and restaurants (due to Dussehra and Diwali vacations). Potato prices drop drastically after December every year since new harvested crop is ready to come in the market. However unlike 2018 and 2019, the prices of potato that goes high in September to November and comes down in December to March, due to COVID-19, the prices continued to increase. There was lot of chaos and unrest in people regarding the decision of locked down thus people started to make bulk purchases to stock the potatoes for 15-30 days, thus the prices of potato continued to rise [30-38].

Potato trends were quite stable in 2018 and 2019, where price goes high during September to November and then comes down. The major Potato producing states are Uttar Pradesh, West Bengal, Bihar, Gujarat, Madhya Pradesh, Punjab, Assam, Chhattisgarh, Jharkhand and Haryana. However, in January 2020, apart from the COVID-19 pandemic, other reasons for increase in price of potato crop were potato blight in some part of Uttar Pradesh and Punjab. The potato harvesting was also adversely affected during December 2019 and January 2020 because of rains and cold spell in Punjab and Uttar Pradesh [15, 16]. Potato prices in March 2020 and April 2020 were Rs. 12.79 and Rs. 14.09 which is almost 75% higher compared to prices of March 2019 and April 2019 (see fig 4b).

Ljung-Box test

Data: Residuals from ARIMA(5,1,0)(0,1,0)[300]

Q* = 248.78, df = 134, p-value = 6.59e-09

Model df: 5. Total lags used: 139

Looking at the continuous rise in potato prices, we decided to reduce the seasonality of data using best fit ARIMA best. The residual plot of ARIMA models (4,1,0) and (0,1,0) for next 6 months revealed that the model was best fit with p value less than 0.001 (see fig. 5). According to data from Agricultural Produce Marketing Committee (APMC) in Azadpur, the trade of potatoes due to long storage life, has not been affected much during COVID-19. However, many retailers are taking advantage of the fact that there is a disruption in the supply chain and goods are not being able to reach markets. Some local shopkeepers are also taking advantage of the shortage to sell at potato higher market rates, but if this shortage of supply continues in retail markets, the prices will automatically start going up [15, 16].

Best model: ARIMA(4,1,0)(0,1,0)

Coefficients:

	ar1	ar2	ar3	ar4
	0.1106	0.0452	0.0142	-0.1198
s.e.	0.0503	0.0507	0.0506	0.0502

sigma² estimated as 3399: log likelihood=-2157

AIC=4324 AICc=4324.16 BIC=4343.87

Training set error measures ARIMA: ME=1.042929, RMSE=43.64782, MAE=18.02009, MPE=0.01102842, MAPE=1.89753, MASE=0.04937731, ACF1=-0.009447431

The forecasted model revealed that financial burden on common man's pocket would continue to rise in 2020 due to the rising prices of potato. We tried to forecast average wholesale prices at Azadpur *mandi* for next 6 months (see appendix table 1). As per forecasted model, in May 2020 the average price of potato would be about Rs, 15/kg (Rs. 1530 per quintal). In the month of June 2020, the forecasted average price would be Rs. 16/ kg, followed by Rs. 19/ kg in July 2020, Rs. 19.50/kg in August 2020 and about Rs. 22/kg in September 2020 and October 2020 (see fig. 6). It was forecasted that the potato price would increase by 58.7% by October 2020 compared to October 2019. In the last few months, retail prices of potatoes have increased by more than 60-100 percent since 2018 and 2019. The wholesale price of potato has gone up to Rs. 12-15 per kg. Maximum retail price could go upto Rs. 30-40 due to potato stocking by traders and bulk potato purchases by people. Potato prices have increased by two to three times in December as compared to the last year. The maximum wholesale price in Azadpur *mandi* was Rs 21 per kg, which was about Rs 6-10 per kg in December 2018. Looking at the current situation, potato traders have increased prices due to reduced arrival of new potatoes from Punjab and untimely rains. However, retail prices will remain at the 20-25 level for coming 6 months (May-October) due to supply of potatoes from cold storages and supply of new potatoes from UP from Kharif season crop [30-32].

Another possible cause for price rise in COVID-19 scenario is increased marketing cost and marketing margin due to limited availability of labour, logistic facilities and storage facilities. Marketing cost includes actual expenses required for bringing potato from farm gate to the consumers, handling charges at local points, transportation and storage costs, handling charges by wholesaler's and retailer to

consumers, expenses on secondary services like financing, risk taking and market intelligence and profit margins taken out by different agencies. The marketing margins of potato are the difference between the actual price paid by the consumer and the price received by farmer for an equivalent quantity and quality of potato. Potato prices are expected to remain 20% higher year-on-year because of the adverse market conditions created by COVID-19 pandemic [33-36]. When compared to last year, price of potato in April was 75% lower, due to effective supply chain. Potato prices might further increase till September due to disturbed supply chain, increase in number of Coronavirus positive cases at Azadpur *mandi* traders and travel restrictions which would dent the future arrivals and transactions [55].

Forecast of Potato Arrivals in India

Due to COVID-19 pandemic, more than 95% Potato is coming months would be sold from cold storages. It can be observed that potato arrivals plunged immediately after the lockdown. Despite the government's decision to keep the Azadpur *mandi* open and to exempt agricultural activity and transport from lockdown restrictions, arrivals remained low in March and April 2020. Potato arrivals were over 40% lower than the previous year for the month of April (see fig 7a) [15, 16].

APMC informed *mandi* traders that they would only be allowed to bring in one truck each per day. The APMC also decided to allow trade in alternate auction sheds only. These moves are meant to prevent the *mandi* from becoming another hotspot of COVID-19 infections but are also likely to further reduce the volumes of potatoes arriving at the *mandi* [15, 16]. Another study revealed that potato prices usually plummet in India by January as fresh arrivals gather pace in Uttar Pradesh, Punjab, West Bengal and Haryana. Potato arrivals in January this year were 5% less than January 2019 and 14% less than January 2018 (see fig 7b) [28, 29, 32, 33]. Potato arrivals are slowed down due to COVID-19 pandemic, uncertain rainfall in month of February and March 60-70 in North India and infection of COVID-19 amongst Azadpur *mandi* traders [50].

Ljung-Box test

Data: Residuals from ARIMA(5,1,0)(0,1,0)[300]

Q* = 248.78, df = 134, p-value = 6.59e-09

Model df: 5. Total lags used: 139

When news of the lockdown was announced, people bought potato in bulk and stored it amid fears that they might not get their supplies later [18-20]. This led to the spurt in prices and decline in arrivals. To get the accurate forecast about potato arrivals in Azadpur *mandi*, ARIMA model (5,1,0) (0,1,0) were used to reduce seasonality of data occurred due to COVID-19 crisis (see fig. 8) [54].

Best model: ARIMA(5,1,0)(0,1,0)

Coefficients:

	ar1	ar2	ar3	ar4	ar5
	-1.0357	-0.916	-0.8415	-0.7166	-0.6354
s.e.	0.0388	0.054	0.0569	0.0538	0.0386

sigma² estimated as 486191: log likelihood=-3133.57

AIC=6279.13 AICc=6279.35 BIC=6302.97

Training set error measures ARIMA: ME=-5.64435, RMSE=521.3624, MAE=287.7029, MPE=-74.03205, MAPE=99.91637, MASE=0.4516221, ACF1=-0.06823313

The COVID-19 lockdown caused a 40-50% drop in the volume of potatoes arriving at the Azadpur *mandi*, according to analysis of the market arrivals data [50] (see appendix table 2). As per our forecasted model, average potato arrival in May 2020 in Azadpur *mandi* would be about 602.45 tonnes which is 46.08% and 33.96% lesser than potato arrival in May 2019 and May 2018. By June 2020, the potato arrival would increase to 717.7 tonnes, followed by 826.13 tonnes in July 2020, 1042.1 tonnes in August 2020, 1009.3 tonnes in September 2020 and finally 1228.5 tonnes in October 2020 (see fig 9). As per the forecasted model, potato arrivals in June 2020 24.45% less than June 2019, however till October 2020, the potato arrival would increase and arrivals would be just 3.11% less compared to October 2019. Potato arrivals and prices have remained fluctuated from the beginning of this year, as harvesting was delayed due to unseasonal rains. It was expected that potato prices would fall from March onwards due to increase potato arrival from UP and Punjab, but that didn't happen as a sudden demand emerged due to the lockdown [28, 29]. About 60-65% of the cold storages in UP have been loaded with potatoes. Still potatoes are in Azadpur *mandi* coming from Agra and Allahabad [50-55].

Discussion

Azadpur mandi is considered to be one of the largest vegetables and fruits market in Asia. Fruits and vegetable from Azadpur mandi are supplied to Delhi and NCR, Punjab, Haryana, Rajasthan, Uttar Pradesh and some markets of Southern India. Due to COVID-19 crisis, a drop of 50% was recorded in prices potato by May 1st, 2020. By 30 April 2020, the potato prices touched Rs. 15/kg which is more than double last year's price of Rs 7-8/kg. Due to the shortage of potato supply, the prices this year rose very high, however by the month of September 2020, the potato prices are forecasted to get stable. Potato being the staple food, widely recognized by vegetarians and mass transformation towards vegetarian diet fearing present pandemic makes it valuable and therefore, was considered as focus commodity in this study. Moreover, because of present pandemic major focus of people is towards the vegetarian diet. Present study emphasizes the impact of present pandemic on focus commodity potato arrivals and prices for coming 6 months. Further, it is recognized that potato supply chain in Azadpur market is majorly dependent on private channels which further links food service sector referring to small restaurants, street meal vendors or dhabas. HORECA industry in India is huge comprising of 4 lakh crore turn over and over 7 million people are directly employed. Keeping in view the huge size of industry, state level authorities decided to open online food delivery channels but due to shortage of essential commodity like potato, surge in the rate of dishes emerged. As per the analysis of last 2-year daily potato arrivals and prices data by using analytical framework as ARIMA model and forecasted range for arrivals and price trend was worked out

for next 6 months. It is observed from the forecasted range that the supply of potato can further worsen up resulting in higher prices. These devastating effects can result in costlier food items and dishes with potato as an ingredient and other essentials like onions. These all incidents have adverse effects on hospitality industry including restaurants and online delivery platforms like Zomato, Swiggy in India. [16-24, 49-55].

Traditionally in Azadpur mandi, potato supply directly moves from farmers to retailers between December and April, and then potato comes to cold stores after May [51]. Situations arising due to the pandemic like locked down, sealing of borders, hoarding, sudden spike in demand further added to the increase in prices of potato. Delhi and adjoining states witnessed price hike of potatoes more than 80-100% compared to last 2 consecutive years. Due to increased demand and broken supply chain, the potato arrivals at Azadpur mandi was adversely impacted [35, 36]. Broken vegetable supply chain also negatively affected the HORECA (Hotels, restaurants and cafes) segment including hotels and restaurant and marriage palaces [36]. The forecast of next 6 months in the study revealed that potato price and arrivals forecast is majorly affected due to COVID-19. India has majorly unorganized fruits and vegetable sector mainly consisting of small hawkers, vendors and temporary vegetable stores. Fluctuations in demand of potato prices and lack of supply, has pose a major threat to the livelihood earnings of the vegetable vendors, who were already facing challenges like lack of labour and transportation facilities due to the locked-down. Even big traders are afraid to do trading and to physically come to vegetable market due to the fear of getting the COVID infection [11-14].

Supplies arrival in Azadpur mandi has lowered to 55-60%, which is going to escalate about 60-80% thus resultant on a higher price of potatoes. Average post-harvest losses of potato in India are recorded at an average rate of 30%. Due to late arrivals and delayed transactions there is an increment trend in the high post-harvest losses which is affecting the functioning of whole supply chain [15-18]. These evidences of price fluctuations can be advocated for strong policy framework ensuring smooth supply chain of Potato considering forecasted range in this case. This will not only realize the demarcation of demand and supply appraisal in local markets but price surge and availability of essentials to hospitality industry can also be ensured. Further, this study can be replicated for assessing the impacts of other commodities which are price sensitive and accordingly suitable layout for market intelligence ensuring prices and arrivals can be suggested [55, 56].

Conclusion

Due to present pandemic unforeseen turbulences were observed in every sector constituent of the economy. Food, Agribusiness and HORECA industry are also seemed to be severely affected due to this crisis. Along with speeding up the impact of pandemic in India, people foresighted emergency and thus panic buying started. Situation got more affected with declaration of nationwide lockdown. On supply side, labour shortage, transportation issues, incidences of corona positive traders in Azadpur *mandi* has ignited the problem to next level. With such fluctuations, it is realized that essentials must be addressed, and fluctuations in demand and supply gap must be properly monitored. Potato being the staple food,

widely recognized by vegetarians and mass transformation towards vegetarian diet fearing present pandemic makes it valuable and therefore, was considered as focus commodity in this study. Moreover, because of present pandemic major focus of people is towards the vegetarian diet. Present study emphasizes the impact of present pandemic on focus commodity potato arrivals and prices for coming 6 months. As per forecasted model, in May 2020 the average price of potato would be about Rs, 15/kg (Rs. 1530 per quintal). In the month of June 2020, the forecasted average price would be Rs. 16/ kg, followed by Rs. 19/ kg in July 2020, Rs. 19.50/kg in August 2020 and about Rs. 22/kg in September 2020 and October 2020. As per our forecasted model, average potato arrival in May 2020 in Azadpur *mandi* would be about 602.45 tonnes which is 46.08% and 33.96% lesser than potato arrival in May 2019 and May 2018. By June 2020, the potato arrival would increase to 717.7 tonnes, followed by 826.13 tonnes in July 2020, 1042.1 tonnes in August 2020, 1009.3 tonnes in September 2020 and finally 1228.5 tonnes in October 2020. Further, it is recognized that potato supply chain in Azadpur market is majorly dependent on private channels which further links food service sector referring to small restaurants, street meal vendors or *dhabas*. HORECA industry in India is huge comprising of 4 lakh crore turn over and over 7 million people are directly employed. Keeping in view the huge size of industry, state level authorities decided to open online food delivery channels but due to shortage of essential commodity like potato, surge in the rate of dishes emerged. As per the analysis of last 2-year daily potato arrivals and prices data by using analytical framework as ARIMA model and forecasted range for arrivals and price trend was worked out for next 6 months. It is observed from the forecasted range that the supply of potato can further worsen up resulting in higher prices. These devastating effects can result in costlier food items and dishes with potato as an ingredient and other essentials like onions. These all incidents have adverse effects on hospitality industry including restaurants and online delivery platforms like Zomato, swiggy in India.

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Tables

Table 1: Daywise forecast of potato price in quintals at Azadpur mandi from 17th April, 2020 to 31st October, 2020 obtained from ARIMA (4,1,0) (0,1,0) model.

(Point forecast-Average forecasted price for each day; Lo 80-Lower price limit at 80% confidence interval, Hi-Higher price limit at 80 % confidence interval, Lo 95-Lower price limit at 95% confidence interval, Hi-Higher price limit at 95% confidence interval)

Date	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
17-04-2020	1497.49	1422.78	1572.21	1383.23	1611.76
18-04-2020	1524.48	1412.82	1636.13	1353.71	1695.24
19-04-2020	1522.97	1381.25	1664.68	1306.23	1739.70
20-04-2020	1528.43	1360.99	1695.87	1272.35	1784.50
21-04-2020	1519.58	1333.68	1705.48	1235.27	1803.88
22-04-2020	1504.29	1302.31	1706.27	1195.39	1813.19
23-04-2020	1504.68	1288.19	1721.17	1173.59	1835.77
24-04-2020	1549.12	1319.22	1779.02	1197.52	1900.72
25-04-2020	1548.95	1306.10	1791.80	1177.54	1920.35
26-04-2020	1548.82	1293.60	1804.05	1158.49	1939.16
27-04-2020	1537.75	1270.66	1804.83	1129.27	1946.22
28-04-2020	1537.80	1259.32	1816.27	1111.91	1963.69
29-04-2020	1537.82	1248.43	1827.21	1095.24	1980.40
30-04-2020	1537.84	1237.94	1837.74	1079.18	1996.50
01-05-2020	1537.85	1227.80	1847.90	1063.67	2012.03
02-05-2020	1533.85	1213.98	1853.72	1044.65	2023.05
03-05-2020	1561.84	1232.44	1891.24	1058.07	2065.62
04-05-2020	1531.84	1193.18	1870.50	1013.90	2049.78
05-05-2020	1531.84	1184.16	1879.52	1000.11	2063.57
06-05-2020	1531.84	1175.37	1888.31	986.67	2077.01
07-05-2020	1531.84	1166.79	1896.89	973.55	2090.13
08-05-2020	1531.84	1158.41	1905.27	960.73	2102.95
09-05-2020	1531.84	1150.22	1913.47	948.20	2115.49
10-05-2020	1536.84	1147.19	1926.49	940.92	2132.76
11-05-2020	1561.84	1164.33	1959.35	953.90	2169.78
12-05-2020	1561.84	1156.62	1967.06	942.11	2181.57
13-05-2020	1544.84	1132.05	1957.63	913.54	2176.14
14-05-2020	1544.84	1124.62	1965.06	902.18	2187.51
15-05-2020	1519.84	1092.32	1947.36	866.01	2173.67
16-05-2020	1519.84	1085.15	1954.54	855.03	2184.65
17-05-2020	1527.84	1086.08	1969.60	852.23	2203.45
18-05-2020	1541.84	1093.13	1990.55	855.60	2228.08
19-05-2020	1541.84	1086.29	1997.39	845.14	2238.55
20-05-2020	1541.84	1079.55	2004.13	834.82	2248.86
21-05-2020	1541.84	1072.90	2010.78	824.66	2259.02
22-05-2020	1541.84	1066.35	2017.33	814.64	2269.04
23-05-2020	1541.84	1059.88	2023.80	804.75	2278.93
24-05-2020	1541.84	1053.51	2030.18	795.00	2288.68
25-05-2020	1514.84	1020.21	2009.47	758.37	2271.31
26-05-2020	1514.84	1013.99	2015.69	748.86	2280.82
27-05-2020	1514.84	1007.85	2021.83	739.47	2290.21
28-05-2020	1494.84	981.78	2007.90	710.19	2279.49
29-05-2020	1494.84	975.79	2013.89	701.02	2288.66
30-05-2020	1489.84	964.86	2014.82	686.95	2292.73
31-05-2020	1489.84	959.00	2020.68	677.99	2301.69
01-06-2020	1489.84	953.20	2026.48	669.12	2310.56
02-06-2020	1489.84	947.47	2032.22	660.35	2319.33
03-06-2020	1489.84	941.79	2037.89	651.67	2328.01
04-06-2020	1489.84	936.17	2043.51	643.08	2336.60
05-06-2020	1489.84	930.61	2049.07	634.57	2345.11

06-06-2020	1527.84	963.11	2092.58	664.15	2391.53
07-06-2020	1536.84	966.65	2107.03	664.81	2408.87
08-06-2020	1569.84	994.25	2145.43	689.55	2450.13
09-06-2020	1569.84	988.90	2150.78	681.37	2458.31
10-06-2020	1549.84	963.60	2136.09	653.26	2446.42
11-06-2020	1535.84	944.34	2127.34	631.22	2440.46
12-06-2020	1535.84	939.13	2132.55	623.26	2448.43
13-06-2020	1535.84	933.97	2137.71	615.36	2456.32
14-06-2020	1480.84	873.85	2087.83	552.53	2409.15
15-06-2020	1480.84	868.77	2092.91	544.76	2416.92
16-06-2020	1464.84	847.74	2081.94	521.06	2408.62
17-06-2020	1501.84	879.74	2123.94	550.43	2453.26
18-06-2020	1501.84	874.79	2128.89	542.85	2460.83
19-06-2020	1485.84	853.87	2117.81	519.33	2452.35
20-06-2020	1469.84	833.00	2106.69	495.87	2443.81
21-06-2020	1469.84	828.16	2111.53	488.47	2451.21
22-06-2020	1534.84	888.35	2181.33	546.12	2523.56
23-06-2020	1682.84	1031.58	2334.10	686.83	2678.86
24-06-2020	1863.84	1207.85	2519.83	860.59	2867.10
25-06-2020	1863.84	1203.15	2524.53	853.40	2874.28
26-06-2020	1867.84	1202.48	2533.20	850.26	2885.42
27-06-2020	1867.84	1197.85	2537.84	843.17	2892.51
28-06-2020	1867.84	1193.24	2542.44	836.13	2899.55
29-06-2020	1876.84	1197.67	2556.01	838.14	2915.54
30-06-2020	1876.84	1193.13	2560.55	831.20	2922.49
01-07-2020	1879.84	1191.62	2568.06	827.30	2932.39
02-07-2020	1891.84	1199.14	2584.54	832.44	2951.24
03-07-2020	1891.84	1194.68	2589.00	825.63	2958.05
04-07-2020	1891.84	1190.26	2593.42	818.87	2964.82
05-07-2020	1891.84	1185.86	2597.82	812.14	2971.54
06-07-2020	1891.84	1181.49	2602.19	805.46	2978.22
07-07-2020	1866.84	1152.15	2581.53	773.82	2959.87
08-07-2020	1866.84	1147.83	2585.85	767.21	2966.47
09-07-2020	1884.84	1161.54	2608.14	778.65	2991.03
10-07-2020	1996.84	1269.28	2724.40	884.13	3109.55
11-07-2020	2004.84	1273.04	2736.65	885.64	3124.04
12-07-2020	2012.84	1276.82	2748.86	887.19	3138.49
13-07-2020	2012.84	1272.63	2753.05	880.78	3144.90
14-07-2020	1945.84	1201.46	2690.22	807.41	3084.28
15-07-2020	1875.84	1127.31	2624.37	731.07	3020.62
16-07-2020	1875.84	1123.19	2628.49	724.76	3026.92
17-07-2020	1875.84	1119.09	2632.59	718.49	3033.19
18-07-2020	1875.84	1115.01	2636.67	712.25	3039.43
19-07-2020	1875.84	1110.96	2640.73	706.05	3045.63
20-07-2020	1863.84	1094.92	2632.76	687.88	3039.80
21-07-2020	1863.84	1090.91	2636.78	681.74	3045.94
22-07-2020	1855.84	1078.91	2632.77	667.63	3044.05
23-07-2020	1916.84	1135.94	2697.74	722.56	3111.12
24-07-2020	1916.84	1131.99	2701.69	716.51	3117.17
25-07-2020	1916.84	1128.06	2705.63	710.50	3123.18
26-07-2020	1916.84	1124.14	2709.54	704.51	3129.17

27-07-2020	1901.84	1105.25	2698.43	683.56	3120.13
28-07-2020	1920.84	1120.37	2721.31	696.63	3145.05
29-07-2020	1920.84	1116.52	2725.17	690.73	3150.95
30-07-2020	1920.84	1112.68	2729.00	684.86	3156.82
31-07-2020	1920.84	1108.86	2732.82	679.02	3162.66
01-08-2020	1920.84	1105.06	2736.63	673.21	3168.48
02-08-2020	1920.84	1101.27	2740.41	667.42	3174.26
03-08-2020	1904.84	1081.50	2728.18	645.66	3164.03
04-08-2020	1904.84	1077.75	2731.93	639.92	3169.76
05-08-2020	1904.84	1074.02	2735.66	634.21	3175.47
06-08-2020	1946.84	1112.31	2781.38	670.53	3223.15
07-08-2020	1946.84	1108.61	2785.08	664.87	3228.81
08-08-2020	1946.84	1104.92	2788.76	659.24	3234.44
09-08-2020	1946.84	1101.25	2792.43	653.63	3240.05
10-08-2020	1946.84	1097.60	2796.08	648.04	3245.64
11-08-2020	1922.84	1069.97	2775.72	618.48	3227.20
12-08-2020	1922.84	1066.35	2779.34	612.95	3232.74
13-08-2020	1922.84	1062.74	2782.94	607.43	3238.25
14-08-2020	1922.84	1059.15	2786.53	601.94	3243.74
15-08-2020	1922.84	1055.58	2790.11	596.47	3249.21
16-08-2020	1922.84	1052.01	2793.67	591.03	3254.66
17-08-2020	1922.84	1048.47	2797.21	585.60	3260.08
18-08-2020	1922.84	1044.94	2800.75	580.20	3265.48
19-08-2020	1922.84	1041.42	2804.26	574.82	3270.86
20-08-2020	1922.84	1037.91	2807.77	569.46	3276.22
21-08-2020	1922.84	1034.42	2811.26	564.13	3281.56
22-08-2020	1982.84	1090.95	2874.73	618.81	3346.87
23-08-2020	1988.84	1093.49	2884.20	619.51	3358.17
24-08-2020	1988.84	1090.04	2887.65	614.24	3363.44
25-08-2020	1988.84	1086.60	2891.08	608.98	3368.70
26-08-2020	1988.84	1083.18	2894.51	603.75	3373.93
27-08-2020	1988.84	1079.77	2897.92	598.53	3379.15
28-08-2020	1988.84	1076.37	2901.31	593.33	3384.35
29-08-2020	1988.84	1072.98	2904.70	588.16	3389.52
30-08-2020	2048.84	1129.61	2968.07	643.00	3454.68
31-08-2020	2079.84	1157.25	3002.43	668.86	3490.82
01-09-2020	2079.84	1153.90	3005.78	663.74	3495.94
02-09-2020	2079.84	1150.57	3009.12	658.64	3501.04
03-09-2020	2079.84	1147.24	3012.44	653.56	3506.13
04-09-2020	2063.84	1127.93	2999.75	632.49	3495.19
05-09-2020	2063.84	1124.63	3003.05	627.44	3500.24
06-09-2020	2063.84	1121.34	3006.34	622.41	3505.27
07-09-2020	2063.84	1118.06	3009.62	617.40	3510.28
08-09-2020	2067.84	1118.80	3016.88	616.40	3519.28
09-09-2020	2067.84	1115.54	3020.14	611.43	3524.26
10-09-2020	2067.84	1112.30	3023.38	606.46	3529.22
11-09-2020	2064.84	1106.07	3023.62	598.52	3531.16
12-09-2020	2064.84	1102.84	3026.84	593.59	3536.09
13-09-2020	2064.84	1099.63	3030.05	588.68	3541.00
14-09-2020	2161.84	1193.43	3130.25	680.79	3642.90
15-09-2020	2226.84	1255.24	3198.44	740.91	3712.77

16-09-2020	2226.84	1252.06	3201.62	736.04	3717.64
17-09-2020	2226.84	1248.89	3204.79	731.20	3722.48
18-09-2020	2284.84	1303.73	3265.95	784.37	3785.32
19-09-2020	2284.84	1300.58	3269.10	779.55	3790.13
20-09-2020	2284.84	1297.45	3272.24	774.75	3794.93
21-09-2020	2284.84	1294.32	3275.37	769.96	3799.72
22-09-2020	2297.84	1304.20	3291.48	778.19	3817.49
23-09-2020	2297.84	1301.09	3294.59	773.44	3822.24
24-09-2020	2310.84	1310.99	3310.69	781.70	3839.98
25-09-2020	2310.84	1307.90	3313.78	776.97	3844.71
26-09-2020	2310.84	1304.82	3316.86	772.26	3849.42
27-09-2020	2310.84	1301.75	3319.94	767.56	3854.12
28-09-2020	2406.84	1394.68	3419.00	858.88	3954.80
29-09-2020	2406.84	1391.63	3422.05	854.21	3959.47
30-09-2020	2406.84	1388.59	3425.09	849.56	3964.12
01-10-2020	2383.84	1362.55	3405.13	821.92	3945.77
02-10-2020	2383.84	1359.53	3408.15	817.29	3950.39
03-10-2020	2383.84	1356.51	3411.17	812.68	3955.01
04-10-2020	2363.84	1333.50	3394.18	788.08	3939.61
05-10-2020	2329.84	1296.50	3363.18	749.49	3910.19
06-10-2020	2329.84	1293.51	3366.17	744.92	3914.77
07-10-2020	2329.84	1290.53	3369.15	740.36	3919.33
08-10-2020	2097.84	1055.56	3140.12	503.81	3691.87
09-10-2020	2107.84	1062.59	3153.09	509.27	3706.41
10-10-2020	2107.84	1059.64	3156.04	504.75	3710.93
11-10-2020	2069.84	1018.69	3120.99	462.24	3677.44
12-10-2020	2069.84	1015.75	3123.93	457.75	3681.93
13-10-2020	2069.84	1012.82	3126.86	453.27	3686.42
14-10-2020	2069.84	1009.90	3129.79	448.79	3690.89
15-10-2020	2069.84	1006.98	3132.70	444.34	3695.35
16-10-2020	1971.84	906.07	3037.61	341.89	3601.79
17-10-2020	1980.84	912.17	3049.51	346.45	3615.23
18-10-2020	1996.84	925.28	3068.40	358.03	3635.65
19-10-2020	2056.84	982.40	3131.28	413.62	3700.06
20-10-2020	2058.84	981.52	3136.16	411.22	3706.46
21-10-2020	2058.84	978.65	3139.03	406.84	3710.85
22-10-2020	2080.84	997.79	3163.89	424.46	3737.22
23-10-2020	2133.84	1047.94	3219.74	473.10	3794.59
24-10-2020	2133.84	1045.09	3222.59	468.74	3798.94
25-10-2020	2323.84	1232.25	3415.43	654.40	3993.28
26-10-2020	2336.84	1242.42	3431.26	663.07	4010.61
27-10-2020	2256.84	1159.60	3354.08	578.75	3934.93
28-10-2020	2256.84	1156.78	3356.90	574.45	3939.24
29-10-2020	2256.84	1153.97	3359.71	570.15	3943.53
30-10-2020	2256.84	1151.17	3362.51	565.86	3947.82
31-10-2020	2256.84	1148.38	3365.31	561.59	3952.09

Table 2: Daywise forecast of potato arrivals in tonnes at Azadpur mandi from 17th April, 2020 to 31st October, 2020 obtained from ARIMA (5,1,0) (0,1,0) model.

(Point forecast-Average forecasted arrivals for each day; Lo 80-Lower arrival limit at 80% confidence interval, Hi-Higher arrival limit at 80 % confidence interval, Lo 95-Lower arrival limit at 95% confidence interval, Hi-Higher arrival limit at 95% confidence interval)

Date	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
17-04-2020	560.13	-333.46	1453.72	-806.50	1926.76
18-04-2020	887.26	-6.91	1781.42	-480.25	2254.76
19-04-2020	-50.00	-950.68	850.68	-1427.47	1327.47
20-04-2020	1553.41	650.81	2456.01	173.00	2933.82
21-04-2020	650.64	-259.93	1561.20	-741.95	2043.22
22-04-2020	677.29	-236.73	1591.30	-720.58	2075.15
23-04-2020	652.16	-438.24	1742.57	-1015.47	2319.80
24-04-2020	878.19	-212.24	1968.62	-789.48	2545.86
25-04-2020	-128.63	-1231.61	974.34	-1815.49	1558.22
26-04-2020	1354.99	247.97	2462.01	-338.05	3048.03
27-04-2020	844.50	-275.97	1964.96	-869.10	2558.10
28-04-2020	717.03	-409.35	1843.42	-1005.63	2439.69
29-04-2020	476.98	-725.73	1679.68	-1362.40	2316.35
30-04-2020	841.11	-362.03	2044.25	-998.93	2681.16
01-05-2020	-134.19	-1352.66	1084.27	-1997.67	1729.28
02-05-2020	1306.01	81.95	2530.07	-566.03	3178.05
03-05-2020	690.09	-549.14	1929.32	-1205.15	2585.33
04-05-2020	890.82	-355.53	2137.17	-1015.30	2796.95
05-05-2020	845.93	-441.26	2133.12	-1122.66	2814.52
06-05-2020	925.49	-363.59	2214.57	-1045.99	2896.97
07-05-2020	-115.95	-1420.76	1188.85	-2111.48	1879.58
08-05-2020	852.15	-459.28	2163.59	-1153.52	2857.82
09-05-2020	597.51	-728.86	1923.88	-1431.00	2626.02
10-05-2020	895.29	-438.78	2229.35	-1144.99	2935.57
11-05-2020	766.43	-593.46	2126.32	-1313.34	2846.20
12-05-2020	774.25	-589.28	2137.78	-1311.09	2859.59
13-05-2020	41.69	-1336.80	1420.18	-2066.52	2149.91
14-05-2020	1206.58	-179.20	2592.37	-912.79	3325.95
15-05-2020	597.07	-802.69	1996.82	-1543.68	2737.81
16-05-2020	710.03	-697.72	2117.78	-1442.93	2863.00
17-05-2020	554.11	-872.28	1980.49	-1627.36	2735.57
18-05-2020	401.64	-1029.95	1833.22	-1787.78	2591.05
19-05-2020	-153.23	-1598.60	1292.14	-2363.73	2057.28
20-05-2020	881.16	-571.93	2334.25	-1341.15	3103.47
21-05-2020	868.53	-597.42	2334.49	-1373.45	3110.52
22-05-2020	836.01	-638.11	2310.12	-1418.46	3090.47
23-05-2020	581.79	-907.16	2070.73	-1695.36	2858.93
24-05-2020	814.94	-680.37	2310.25	-1471.93	3101.82
25-05-2020	-119.60	-1627.52	1388.32	-2425.77	2186.56
26-05-2020	828.17	-687.73	2344.06	-1490.19	3146.52
27-05-2020	694.33	-833.42	2222.07	-1642.16	3030.81
28-05-2020	327.18	-1208.81	1863.17	-2021.91	2676.28
29-05-2020	625.66	-922.95	2174.27	-1742.74	2994.06
30-05-2020	821.14	-734.61	2376.90	-1558.18	3200.46
31-05-2020	-135.04	-1702.37	1432.28	-2532.07	2261.98
01-06-2020	1161.76	-413.68	2737.20	-1247.67	3571.19
02-06-2020	714.63	-871.80	2301.06	-1711.60	3140.86
03-06-2020	646.32	-948.38	2241.02	-1792.56	3085.21
04-06-2020	693.12	-912.82	2299.05	-1762.95	3149.19
05-06-2020	923.81	-689.73	2537.36	-1543.89	3391.52

06-06-2020	1365.95	-258.31	2990.21	-1118.14	3850.04
07-06-2020	614.08	-1018.34	2246.51	-1882.49	3110.66
08-06-2020	755.20	-887.50	2397.89	-1757.09	3267.48
09-06-2020	878.70	-772.25	2529.65	-1646.21	3403.61
10-06-2020	780.82	-880.43	2442.07	-1759.84	3321.48
11-06-2020	-245.73	-1914.83	1423.38	-2798.40	2306.95
12-06-2020	1244.33	-434.79	2923.44	-1323.66	3812.32
13-06-2020	624.96	-1062.31	2312.23	-1955.50	3205.42
14-06-2020	818.58	-878.37	2515.54	-1776.69	3413.85
15-06-2020	937.83	-767.32	2642.98	-1669.97	3545.63
16-06-2020	874.43	-840.34	2589.20	-1748.09	3496.95
17-06-2020	-212.92	-1935.65	1509.80	-2847.60	2421.76
18-06-2020	351.29	-1380.88	2083.46	-2297.84	3000.42
19-06-2020	663.91	-1076.36	2404.18	-1997.60	3325.43
20-06-2020	775.51	-973.96	2524.99	-1900.08	3451.10
21-06-2020	713.10	-1044.48	2470.68	-1974.89	3401.08
22-06-2020	666.53	-1100.16	2433.22	-2035.39	3368.45
23-06-2020	-149.54	-1924.18	1625.10	-2863.62	2564.53
24-06-2020	1420.94	-362.68	3204.57	-1306.88	4148.77
25-06-2020	1052.52	-739.12	2844.15	-1687.55	3792.59
26-06-2020	882.62	-917.82	2683.06	-1870.91	3636.15
27-06-2020	931.42	-877.01	2739.86	-1834.33	3697.18
28-06-2020	651.65	-1165.48	2468.79	-2127.42	3430.72
29-06-2020	-181.89	-2006.91	1643.14	-2973.02	2609.25
30-06-2020	1178.96	-654.67	3012.59	-1625.34	3983.25
01-07-2020	866.96	-974.57	2708.49	-1949.41	3683.33
02-07-2020	814.49	-1035.50	2664.48	-2014.82	3643.80
03-07-2020	249.71	-1608.15	2107.57	-2591.64	3091.06
04-07-2020	11.52	-1854.71	1877.75	-2842.63	2865.67
05-07-2020	1657.08	-216.94	3531.10	-1208.99	4523.14
06-07-2020	885.93	-996.38	2768.24	-1992.81	3764.67
07-07-2020	333.33	-1556.74	2223.41	-2557.29	3223.96
08-07-2020	895.37	-1002.88	2793.62	-2007.75	3798.50
09-07-2020	-92.84	-1998.83	1813.14	-3007.80	2822.11
10-07-2020	1609.05	-305.02	3523.12	-1318.27	4536.37
11-07-2020	777.72	-1144.03	2699.46	-2161.34	3716.77
12-07-2020	1189.86	-739.90	3119.62	-1761.45	4141.17
13-07-2020	1226.03	-711.36	3163.43	-1736.96	4189.02
14-07-2020	1168.80	-776.51	3114.12	-1806.30	4143.90
15-07-2020	-41.36	-1994.28	1911.55	-3028.09	2945.36
16-07-2020	1721.84	-238.91	3682.60	-1276.87	4720.56
17-07-2020	1116.51	-851.79	3084.81	-1893.75	4126.76
18-07-2020	871.66	-1104.42	2847.73	-2150.49	3893.80
19-07-2020	1201.96	-781.62	3185.53	-1831.66	4235.57
20-07-2020	-110.41	-2101.68	1880.86	-3155.80	2934.98
21-07-2020	-109.95	-2108.68	1888.78	-3166.74	2946.85
22-07-2020	1040.52	-965.84	3046.88	-2027.95	4108.98
23-07-2020	802.73	-1211.04	2816.50	-2277.06	3882.52
24-07-2020	-90.57	-2111.90	1930.76	-3181.93	3000.79
25-07-2020	1055.80	-972.90	3084.49	-2046.83	4158.42
26-07-2020	1591.35	-444.84	3627.55	-1522.74	4705.45

27-07-2020	1295.59	-747.93	3339.11	-1829.70	4420.88
28-07-2020	1479.97	-570.98	3530.92	-1656.69	4616.63
29-07-2020	1115.87	-942.35	3174.10	-2031.91	4263.66
30-07-2020	1199.58	-866.02	3265.19	-1959.49	4358.65
31-07-2020	-124.05	-2196.88	1948.79	-3294.17	3046.08
01-08-2020	1175.50	-904.65	3255.65	-2005.82	4356.82
02-08-2020	937.65	-1149.69	3024.98	-2254.66	4129.95
03-08-2020	1070.81	-1023.79	3165.41	-2132.60	4274.23
04-08-2020	1096.73	-1005.01	3198.47	-2117.60	4311.07
05-08-2020	1171.62	-937.33	3280.57	-2053.74	4396.98
06-08-2020	-64.78	-2180.83	2051.26	-3300.99	3171.43
07-08-2020	1752.03	-371.17	3875.23	-1495.12	4999.19
08-08-2020	984.81	-1145.44	3115.07	-2273.13	4242.76
09-08-2020	946.14	-1191.22	3083.50	-2322.67	4214.95
10-08-2020	1007.00	-1137.37	3151.37	-2272.53	4286.53
11-08-2020	927.25	-1224.17	3078.67	-2363.07	4217.57
12-08-2020	-30.51	-2188.90	2127.88	-3331.48	3270.47
13-08-2020	1474.06	-691.34	3639.45	-1837.63	4785.74
14-08-2020	957.09	-1215.23	3129.41	-2365.19	4279.37
15-08-2020	976.26	-1203.02	3155.54	-2356.66	4309.18
16-08-2020	1164.08	-1022.08	3350.25	-2179.37	4507.53
17-08-2020	1421.97	-771.11	3615.04	-1932.05	4775.99
18-08-2020	-23.82	-2223.74	2176.09	-3388.31	3340.66
19-08-2020	1494.78	-712.01	3701.56	-1880.21	4869.76
20-08-2020	1182.17	-1031.42	3395.76	-2203.22	4567.56
21-08-2020	1446.88	-773.53	3667.29	-1948.94	4842.70
22-08-2020	1359.37	-867.81	3586.54	-2046.80	4765.53
23-08-2020	911.98	-1321.97	3145.94	-2504.55	4328.52
24-08-2020	-2.64	-2243.32	2238.04	-3429.46	3424.18
25-08-2020	1600.29	-647.12	3847.70	-1836.83	5037.41
26-08-2020	1232.16	-1021.94	3486.26	-2215.19	4679.51
27-08-2020	1089.09	-1171.70	3349.88	-2368.49	4546.68
28-08-2020	1262.35	-1005.09	3529.80	-2205.40	4730.11
29-08-2020	1459.69	-814.40	3733.79	-2018.23	4937.62
30-08-2020	35.15	-2245.55	2315.86	-3452.89	3523.19
31-08-2020	2290.00	2.68	4577.32	-1208.16	5788.15
01-09-2020	233.15	-2060.74	2527.04	-3275.06	3741.36
02-09-2020	2309.50	9.03	4609.97	-1208.76	5827.76
03-09-2020	1442.35	-864.66	3749.35	-2085.91	4970.61
04-09-2020	95.10	-2218.44	2408.64	-3443.15	3633.36
05-09-2020	1008.54	-1311.50	3328.59	-2539.66	4556.74
06-09-2020	893.90	-1432.64	3220.45	-2664.24	4452.04
07-09-2020	1110.84	-1222.17	3443.85	-2457.19	4678.87
08-09-2020	1063.01	-1276.46	3402.48	-2514.91	4640.92
09-09-2020	1019.54	-1326.36	3365.44	-2568.21	4607.29
10-09-2020	-184.19	-2536.52	2168.14	-3781.77	3413.38
11-09-2020	1704.84	-653.89	4063.56	-1902.52	5312.20
12-09-2020	1308.51	-1056.61	3673.63	-2308.62	4925.64
13-09-2020	1071.64	-1299.84	3443.12	-2555.23	4698.50
14-09-2020	1224.91	-1152.92	3602.75	-2411.67	4861.50
15-09-2020	838.24	-1545.93	3222.40	-2808.03	4484.50

16-09-2020	29.01	-2361.47	2419.50	-3626.92	3684.94
17-09-2020	1578.73	-818.05	3975.52	-2086.83	5244.30
18-09-2020	445.51	-1957.56	2848.58	-3229.66	4120.69
19-09-2020	1178.73	-1230.60	3588.07	-2506.02	4863.49
20-09-2020	1333.11	-1082.47	3748.70	-2361.21	5027.44
21-09-2020	1538.03	-883.79	3959.85	-2165.82	5241.89
22-09-2020	88.42	-2339.63	2516.46	-3624.96	3801.79
23-09-2020	965.73	-1468.51	3399.98	-2757.12	4688.59
24-09-2020	848.32	-1592.12	3288.75	-2884.01	4580.64
25-09-2020	1293.23	-1153.37	3739.83	-2448.53	5034.99
26-09-2020	1429.02	-1023.75	3881.78	-2322.16	5180.19
27-09-2020	-8.27	-2467.17	2450.63	-3768.83	3752.30
28-09-2020	2033.82	-431.21	4498.85	-1736.12	5803.75
29-09-2020	969.33	-1501.81	3440.47	-2809.95	4748.61
30-09-2020	1416.32	-1060.92	3893.55	-2372.29	5204.92
01-10-2020	1363.83	-1119.48	3847.14	-2434.07	5161.73
02-10-2020	1357.72	-1131.66	3847.10	-2449.46	5164.90
03-10-2020	1639.63	-855.80	4135.06	-2176.80	5456.06
04-10-2020	153.42	-2348.05	2654.89	-3672.25	3979.09
05-10-2020	2141.83	-365.66	4649.32	-1693.04	5976.70
06-10-2020	1404.12	-1109.38	3917.62	-2439.94	5248.18
07-10-2020	1541.03	-978.46	4060.52	-2312.20	5394.25
08-10-2020	1553.12	-972.35	4078.59	-2309.25	5415.49
09-10-2020	1535.13	-996.30	4066.56	-2336.36	5406.62
10-10-2020	102.32	-2435.06	2639.70	-3778.27	3982.92
11-10-2020	1799.93	-743.39	4343.25	-2089.74	5689.60
12-10-2020	1711.22	-838.02	4260.46	-2187.51	5609.95
13-10-2020	1116.63	-1438.53	3671.78	-2791.14	5024.39
14-10-2020	1388.02	-1173.03	3949.07	-2528.76	5304.81
15-10-2020	1769.73	-797.20	4336.66	-2156.05	5695.51
16-10-2020	158.42	-2414.38	2731.22	-3776.33	4093.18
17-10-2020	1758.13	-820.53	4336.78	-2185.58	5701.84
18-10-2020	1122.72	-1461.77	3707.22	-2829.92	5075.37
19-10-2020	1697.63	-892.70	4287.95	-2263.93	5659.18
20-10-2020	1142.42	-1453.72	3738.56	-2828.03	5112.88
21-10-2020	889.63	-1712.32	3491.57	-3089.70	4868.95
22-10-2020	54.92	-2552.81	2662.65	-3933.26	4043.11
23-10-2020	1163.43	-1450.08	3776.93	-2833.59	5160.44
24-10-2020	1369.62	-1249.65	3988.90	-2636.21	5375.46
25-10-2020	1321.03	-1304.00	3946.05	-2693.60	5335.65
26-10-2020	1267.82	-1362.94	3898.59	-2755.58	5291.23
27-10-2020	1408.53	-1227.96	4045.02	-2623.64	5440.69
28-10-2020	236.82	-2405.38	2879.03	-3804.08	4277.73
29-10-2020	1343.83	-1304.08	3991.73	-2705.80	5393.45
30-10-2020	1132.72	-1520.87	3786.32	-2925.60	5191.05
31-10-2020	1440.53	-1218.75	4099.80	-2626.48	5507.53

Figures

Figure 1

Potential cities from where potato is arrived every year to Azadpur mandi, Delhi

Figure 2

The institutional channels involved in potato supply chain at Azadpur mandi (Delhi NCR)

Figure 3

The private channels involved in potato supply chain at Azadpur mandi (Delhi NCR)

Figure 4

(Left)a: Linear trend of Potato Price (per quintal) over time Jan 2018-April 2020 at Azadpur mandi (Delhi NCR) (Right)b: Yearly trend (Jan 2018-April 2020) of Potato Price (per quintal) at Azadpur mandi (Delhi NCR)

Figure 5

Residual plot for Arima model of Potato Price (per quintal) in India (Jan 2018-April 2020)

Figure 6

Forecast plot based on Arima model of potato price (per quintal) trend in India (Forecast from 16th April 2020- 1st October 2020)

Figure 7

(Left) a: Linear trend of Potato arrivals (in tonnes) over time Jan 2018-April 2020 at Azadpur mandi (Delhi NCR) (Right) b: Yearly trend (Jan 2018-April 2020) of Potato Arrivals (in tonnes) at Azadpur mandi (Delhi NCR)

Figure 8

Residual plot for Arima model of Potato Arrivals (in tonnes) in India (Jan 2018-April 2020)

Figure 9

Forecast plot based on Arima model of potato arrivals (in tonnes) trend in India (Forecast from 16th April 2020- 1st October 2020)