

Impact on the Pune City's Food Accessibility During a Rare, Disastrous Event: A Case of the COVID-19 Lockdown in India

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Abstract

Undoubtedly, the COVID-19 outbreak caught the world off guard, exposing the unpreparedness to mitigate such biological disastrous event and its's impact on the socio-economic life. Amidst the pandemic the management of healthcare infrastructure was the prime focus across the globe, many countries had to extend social assistance programs to mitigate the impact on food security caused by unavailability due to mobility restrictions, and inaccessibility due to loss of income to buy food. This research provides empirical evidence of the implications of the COVID-19 national lockdown on Pune city's food supply chain, daily food inflows and prices; derived from the local market level data and field insights. The implications are quantified by comparing three scenarios which are predominantly considered while addressing any disaster namely before, during, and after the national lockdown. There is sufficient evidence to affirm that not only the restricted food miles resulted in a sudden-sharp dip in the food inflows and higher fluctuations in the prices, but also resulted in evolution of a parallel resilient supply chain making the local markets redundant. This calls for an inclusion of mitigation and response plan for such mobility restriction led disaster in the District Disaster Management Plan in consultation with policy makers, regional planners and business owners to strategically harness the food self-sufficiency opportunities.

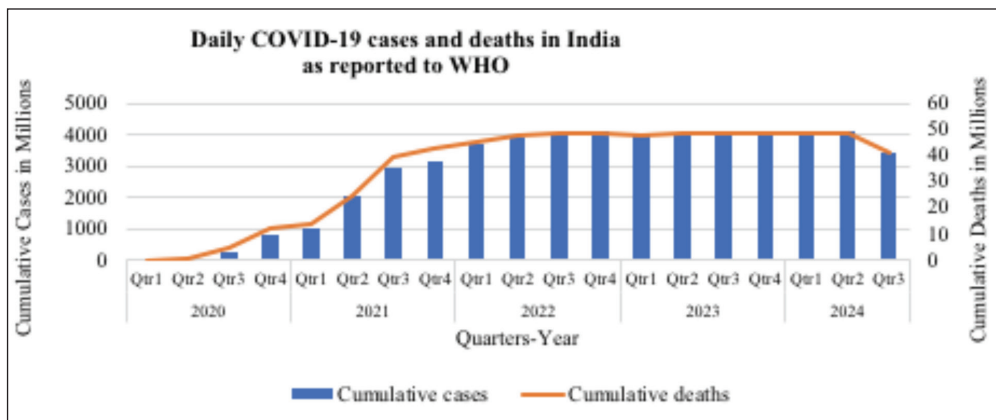
Keywords: COVID-19-Lockdown, Disaster Mitigation, Food Security, Food Supply Chain, Self-sufficiency

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1. Introduction

The COVID-19 outbreak has caught the world off guard and continued to have an unprecedented impact on the health, economic, and social sectors threatening the lives and livelihoods (Nundy et al., 2021; Ranjbari et al., 2021; UN, 2020), which has made the achievement of Sustainable Development Goals even more challenging. Moreover, for developing countries like India, the agony in achieving SDGs, predominantly, the second SDG focusing on zero hunger, continues to decline further as the pandemic has become an additional threat to food security, especially for poor households (Fan et al., 2020; Food Security Information Network, 2020; Reardon et al., 2020). The mobility restrictions and the sudden non-availability of migrant labor disrupted the harvesting activities during the nationwide lockdown (Dev, 2020; Gray, 2020), leading to a reduction in purchasing power, supply shortage, and price fluctuation in the market thus the food security (Siche, 2020). While most of the literature highlighted the disruptions in the food supply chain in mainly the distribution phase, there were very few studies highlighting the food inadequacy and nutrition deficiency due to quarantine period (Elsahoryi et al., 2020; Madzorera et al., 2021)



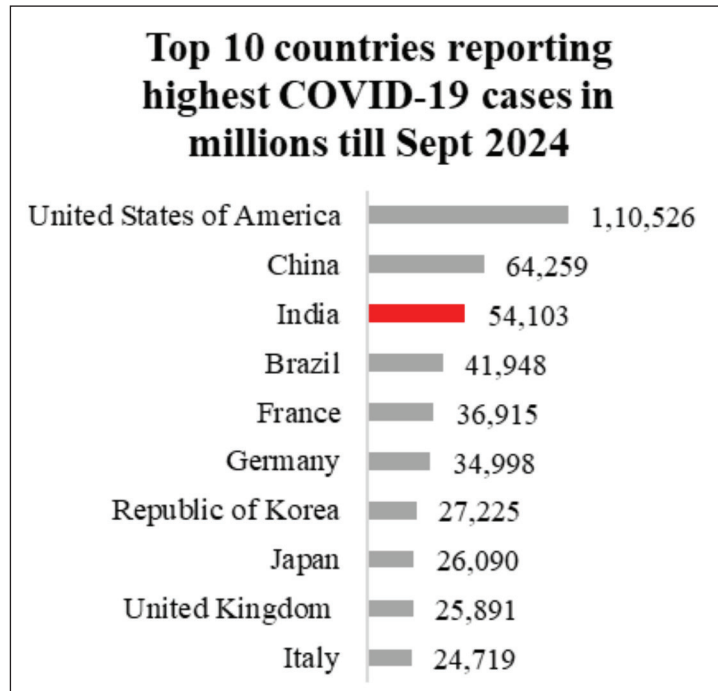


Figure 1 (a): The COVID-19 cumulative cases and deaths in India; and (b) comparison of top 10 countries in daily cases as of 28th September 2024

Source: (WHO, 2024)

India recorded its first COVID-19 case on 30th January 2020 and on 24th March 2020 the national lockdown was announced which lasted till 8th June 2020 followed by the unlock phase 1. The research focuses on the food inaccessibility during the first wave of the pandemic in India (30th January 2020 to 31st August 2020) when mobility restrictions were maximum. The trajectory of India and the Pune city selected for the research has been presented in Figure 1. In response, the Government of India constituted 11 empowered groups⁴ on 29th March 2020 for taking informed decisions, in which one

⁴ Eleven empowered groups constituted by the Government of India are: (i) medical emergency planning, (ii) availability of hospitals, isolation and quarantine facility, disease surveillance and testing, (iii) ensuring availability of essential medical equipment, (iv) augmenting human resource and capacity building, (v) supply chain and logistics management, (vi) coordination with private sector, (vii) economic and welfare measures, (viii) information, communications and public awareness, (ix) technology and data management, (x) public grievance and (xi) strategic issues related to lockdown

of the group was focusing on the on supply chain and logistics management specific to mobility of food and pharma industry during the nationwide lockdown (PIB, 2021). Mohamed Shaluf, (2007) suggests three broad categories of disaster namely natural, man-made, and hybrid disasters covering all the possible types of disasters. Unlike other disasters such as flood management, drought management (Tirivangasi, 2018) where strategies for prevention and mitigation are already in place through various policies and agencies on national, state and local level; however the first wave of the COVID-19 lockdown allowed response and recovery strategies only. Although after the first wave, the pandemic lockdown did give some time to the government to prepare action plan for the 1st line of response but unpreparedness and lack of mitigation strategy towards such events initially did amplify impact. Thus, this research categorises lockdown kind of situation where mobility restrictions are imposed as an aftermath of biological disaster and aims at assessing in-accessibility of food in such situations.

2. Data and Method

The presented research provides empirical evidence of the impact of the COVID-19 lockdown on the food security of one of the worst-pandemic-hit cities in India, that is Pune city, which is highly dependent on the longer food miles to cater its humongous urban food demand. The research uses three scenarios namely before, during, and after the national lockdown to build the empirical evidences for (1) alteration in the food supply chain due to the mobility restrictions amidst the COVID-19 lockdown using the insights from field and literature by comparing the before and during COVID-19 lockdown food supply chains; and (2) sudden inaccessibility of bare essential food items due to the altered food supply chains amidst the COVID-19 lockdown, using the daily food inflow data for bare essential food groups concerning the optimum food security, by comparing fluctuations in the average monthly inflows and prices for the three scenarios namely, pre-COVID-19, during-COVID-19-lockdown, and during-COVID-19-unlock. The period before the 23rd March 2020 is considered as the pre-lockdown phase, hereafter mentioned as pre-COVID-19; from 23rd March 2020 to 8th June 2020 is the lockdown phase, hereafter mentioned as during-COVID-19-lockdown, and post 8th June 2020 to 31st August 2020 is the unlock phase, hereafter mentioned as during-COVID-19-unlock. The research also maps the food miles for the Pune city to highlight the dependency on the food travel from longer distances to cater its daily

food demands, followed by the impact on food supply chains and daily food inflows for which the summary of the data and method is given in Figure 2.

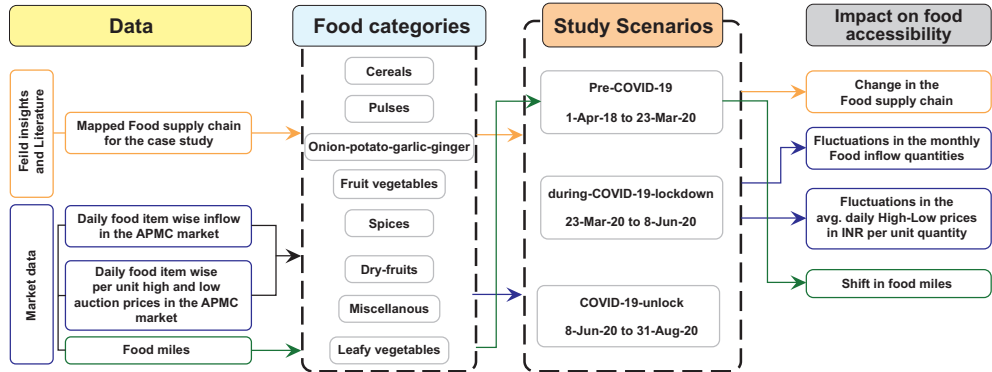


Figure 2: Summary of data and methodology

The lockdown and unlock terms used in this research are as per the timely guidelines (Ministry of Home Affairs, 2020) issued by the Ministry of Home Affairs during the pandemic period. The food supply chain for the Pune city was acquired from (Garud & Rao, 2018a) for the pre-COVID-19 scenario and for the during-COVID-19-lockdown scenario insights on the food supply alterations were collected through field observations and newspaper articles. The daily food inflow data from April 2018 to August 2020 was acquired daily from the Pune APMC's bulletin website (APMC, n.d.) and was documented systematically with reference to the food groups. The data ranging from 1st April 2018 to 31st August 2020 is analysed totalling to 884 days, of which the daily food inflow data for 703 days (79.5%) was available, and the auction prices for 519 days (58.71%) were available as shown in Table 1.

Table 1: Month and year wise summary of the APMC daily inflow data used for the research

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	----->			Y	Y	Y	Y	Y	YY	YY	YY	YY
2019	YY					YY	YY	YY			YY	YY
												●

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	YY	YY	YY	YY	YY	YY	YY	YY				
	●	●	during COVID-19 lockdown			COVID-19-unlock			←-----			
<p><i>Y: only daily inflow data available; YY: both inflow and high and low rate data available</i></p> <p>● World's first COVID-19 patient; ● India's first COVID-19 patient; ● Pune's first COVID-19 patient;</p> <p>Lockdown: 25th March – 8th Jun; Unlock: 8th Jun – 31st Aug</p>												
Number of total days in the period considered from 1 st April 2018 to 31 st Aug 2020										884		
Number of days for which daily inflow data is available										703 (79.5% of the total days)		
Number of days for which both daily inflow and high and low prices data is available										519 (58.71% of the total days)		

Note: The data comprised of the quantity coming into the market with its maximum and minimum per-unit price offered for that day by the producers to the local vendors. The ultimate price, inclusive of the supply chain costs, where the vendors sell the food items to the consumers, varies according to the variety, quality and location and has not been considered in this research. The food items considered for the research are grouped under eight categories, namely, cereals, pulses, onion-potato-garlic-ginger, fruit-vegetables, leafy-vegetables, spices, dry fruits, and miscellaneous.

3. Results and Discussion

A) Impact on Food Miles

The accessibility of food is essentially about the functioning food flows in the food supply chain and therefore, 'food miles' can be considered as a measure to assess accessibility. 'Food miles' as a concept advocating the local foodshed concept has been discussed widely in the literature by the developed countries. However, actual mapping of the food miles with respect to food groups and food items for an Indian city is a novel contribution of this research. For the calculation of food miles, the place at which

food was produced was considered as an origin, while the Pune APMC which receives food was considered as a destination, and by estimating the origin-destination distance in kilometres (travel distance by road estimated using google maps), the average food miles for overall food groups (presented in Figure 3) were derived. In Figure 3, the y-axis is the distance in kilometres while the x-axis the food groups are given. The whisk plot shows the longest food mile for dry fruits and miscellaneous items. It can be seen that the spices, which are mainly place specific specialities, have longer food miles. The food miles for dry-fruits show an outlier, which is especially because of the dates imported from Iraq. Interestingly, in the case of fruits, the food miles vary as per the variety due to the consumer's preference for a particular geographic variety of the produce. Overall, the food groups which cater to the bare essential dietary preference like cereals, vegetables, and pulses show comparatively lesser food miles than the other food groups, leafy-vegetables with the least food miles of all. The food miles for the date dry fruit is the highest (food mile of 3053km), and the only food item procured from out of the country; followed by the tea from Aasam and West Bengal (food miles of 1893km); rice from Haryana, Uttar Pradesh, Rajasthan, Andhra Pradesh, Karnataka,

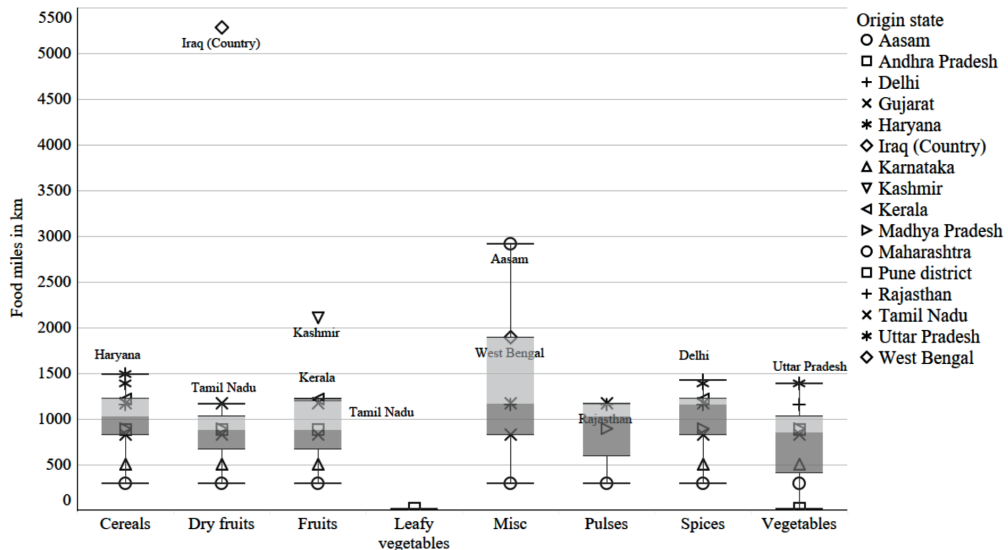


Figure 3: Food miles for Pune city as on 26th November 2019

and Maharashtra (food mile of 1021km); and for wheat from Uttar Pradesh, Rajasthan, Andhra Pradesh, Gujarat, Karnataka, and Maharashtra (food mile of 880km). Thus, it can be understood that lesser the food miles, lesser time will be required to mitigate the impact on food security and having longer food miles increases vulnerability in the disaster kind of situation.

Note: For every incoming food produce, the origin of food produce, the quantity of the produce and vehicle details are recorded at the entrance of the APMC market. The data inventory for daily food inflow with respect to its origin for the considered time frame was huge and the authority did not agree to give access for the same. Hence, the food miles mapped here are only for 26th November 2019.

B) Impact on food supply chain

The food supply chain for Pune was derived from the food supply chain mapped for the Pune Metropolitan Region (Garud & Rao, 2018b). The food supply chain essentially consists of the production links, supply links and market links, which vary with the food category. The food categories were broadly classified into perishable and non-perishable items. The perishable items consist of vegetables, fruits, milk, meat, and poultry, whereas the non-perishable include cereals, pulses, and oilseeds. The food supply chain prior to the COVID-19 for cereals, pulses, spices, vegetables, fruits, and dairy for Pune has been given in Figure 4 (a). The local, regional and wholesale markets in the PMR region play an important role in ensuring the functioning of the regional food supply chains. The city's daily dairy supply chain was predominantly catered by regional cooperative societies from Gujarat to southern Maharashtra. The Mumbai-Bangalore (NH4) highway has made the dairy supply chain least interrupted during the lockdown period. However, one of the changes observed in the dairy supply chain was that the sanitization of the packaged milk became a standard practice during the COVID-19 outbreak. In the Pune Metropolitan Region, from the field insights, it is seen that all the census towns have a local market that serves the nearby villages. In the case of vegetables, farmers from nearby villages around the city prefer to go directly to the urban areas and sell their produce. This concept can be seen as a direct farm to the fridge; though, the number of such farmers is low. All the large farmers approach the regional APMC's with their produce in order to get a better price with optimum transport. The markets at the APMC level usually serves as a platform for daily auction

for the local vendors. However, during the COVID-19 lockdown, the large farmers or mediators or vendors (food providers) seem to have taken an advantage and skipped the usual supply chain by approaching the consumers through electronic medium and served at their doorstep or at the entrance gate in case of the gated communities.

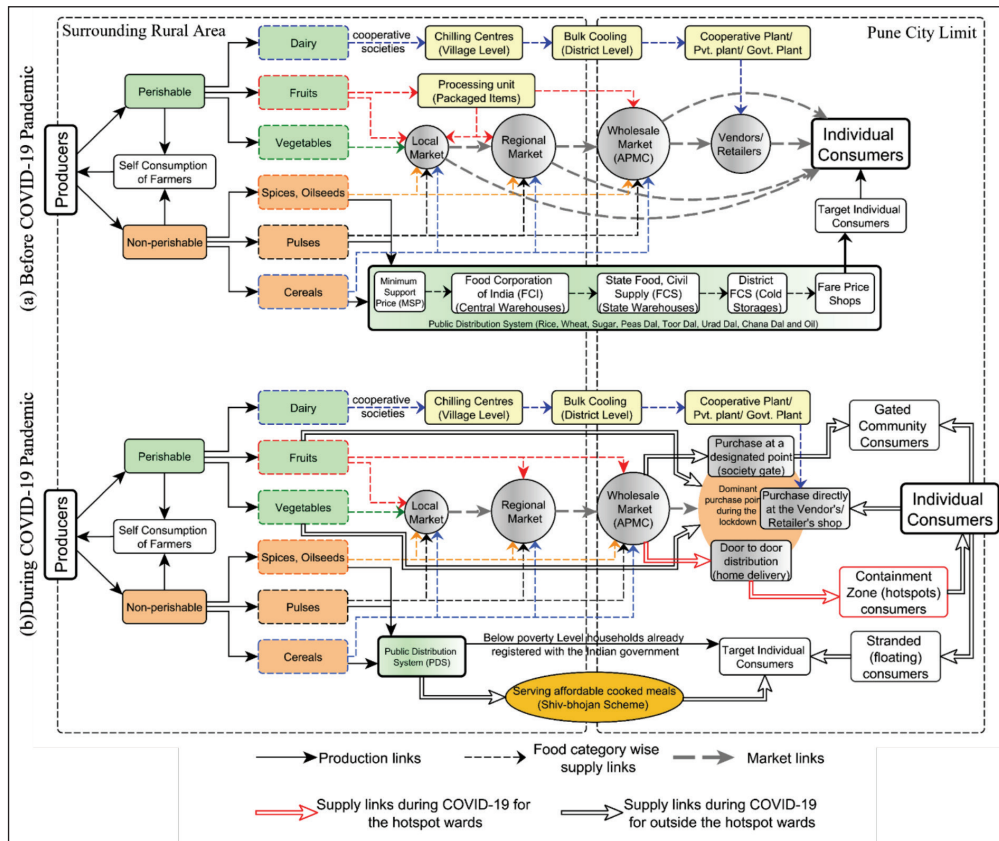


Figure 4: Food group-wise food supply chain for the Pune Metropolitan Region before and during the COVID-19 lockdown

Source: Pune- Agriculture Produce Market Committee and (Garud & Rao, 2018b)

This resulted in the prices of the items shooting up as there was no monitoring from the government with providers claiming increased costs of transportation and limited supply for the price escalation. The adapted food supply chain has been mapped in Figure 4(b), which shows a supply links during COVID-19 for the hotspot wards, and

for non-hotspot wards in the city. On comparing the before and during COVID-19 supply chains, it is seen that the consumers during the COVID-19 were divided into four major categories namely, consumers from the gated communities, consumers from the hotspot areas (containment zones), consumers stranded due to mobility restrictions, and target consumers identified under the PDS. This categorization of the consumers led to the inception of parallel contingent supply links during the COVID-19 lockdown. Otherwise, the two categories dominant in the region before COVID-19 lockdown were individual consumers and target consumers identified under the PDS. In the non-perishable items, such as cereals, pulses, and oilseeds, the central government agencies usually play an essential role with the minimum support price driving the supply chain. The large farmers directly approach the local and regional markets to fetch a higher price, while the small and marginal farmers prefer the minimum support price to shield from market vulnerabilities and cover their initial investments with a marginal profit which becomes a part of the Public Distribution System (PDS) and is distributed under two flagship schemes, namely Antodaya Anna Yojana (AAY) and Priority Households (PHH).

During the COVID-19 national lockdown, the two important interventions introduced were firstly, for the lockdown period the central government announced an additional support of 2 kilograms foodgrains per person for 3 months starting from 26th March 2020 for India, and secondly the Maharashtra government channelized the 'Shiv-Bhojan' flagship scheme through which instead of distributing raw food grains, a basic Indian meal was served twice a day. As per the AePDS⁵ -Maharashtra data, the maximum number of plates served for Pune city were 4500 per day⁶. As the scope of the research was to study produce and not cooked meals, the data for actual daily plates served was not studied. Also, the scheme seems to cater to daily emergencies hungry rather than household's food security; hence, to what extent the problem of food security during the lockdown period was catered through the Shiv-Bhojan scheme is not discussed further.

⁵ Aadhaar enabled Public Distribution System - AePDS portal for Maharashtra is available on <http://mahaepos.gov.in/index.jsp> On this portal stock receipts and details of the fair price shops are maintained.

⁶ The Shiv-Bhojan plates allotted for the Pune city i.e. Pune FDO were 4500 plates per day, and for rural Pune district i.e. Pune DSO were 7150 plates per day.

C) Impact on the daily food inflows

The food inflow data for the studied eight categories have been plotted in Figure 5 where months and years are on the x-axis, a total summation of the daily inflows for a particular month are along the primary y-axis and average per day maximum and minimum price fetched, per respective unit of the inflow, are along the secondary y-axis. The during-COVID-19-lockdown time frame has been marked on every graph so that the visual comparison of the three scenarios, namely, pre-COVID-19, during COVID-19-lockdown, and during COVID-19-unlock, is easy.

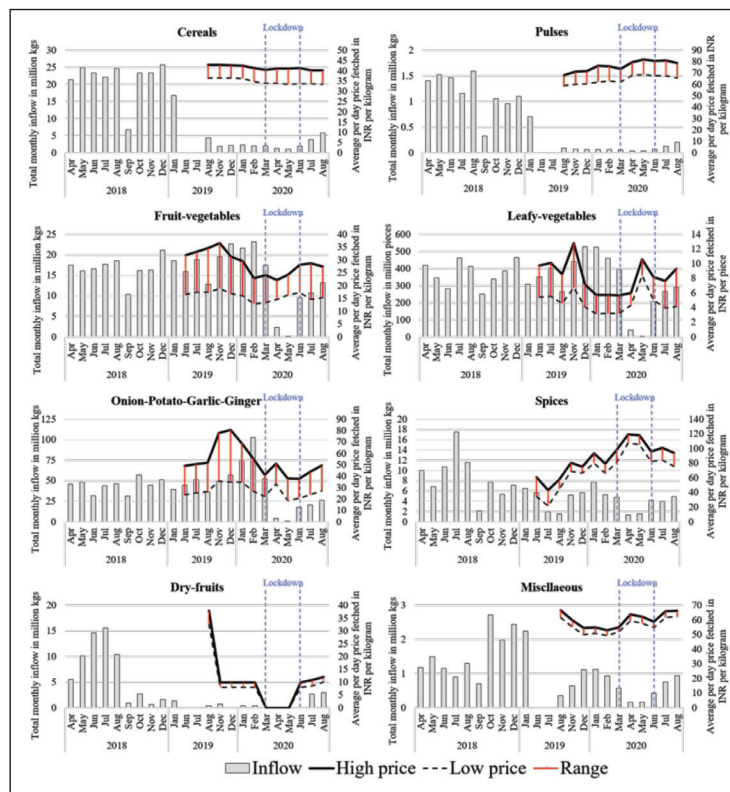


Figure 5: Food category type-wise graphs showing monthly inflow on the primary Y-axis and on along the secondary Y-axis, high and low prices fetched per kilogram for all the food categories except for vegetables which are per piece, received and auctioned at the APMC

Source: Data accessed from the Pune-Agriculture Produce Market Committee.

It was observed that prior to the COVID-19 lockdown, cereals and pulses had a seasonal inflow depending upon the harvesting cycles and onion-potato-garlic-ginger, fruit-vegetables, and leafy-vegetables showed continued monthly inflow. Also, on the prices front, the per-unit prices fetched by all the food categories have recorded a decrease in overall prices (from pre-COVID-19 to during-COVID-19-unlock), except for pulses and miscellaneous items, because of their longer shelf life. As the COVID-19 national lockdown was announced in the end of March 2019, there was a considerable sudden decline in the prices for cereals, pulses, onion-potato-garlic-ginger, and leafy-vegetables food groups which can be linked to the confounded market conditions amidst the first phase of the lockdown. Further, food group wise implications on the inflow and prices have been discussed below, and a comparative summary for the three scenarios has been represented in Table 2.

Impact on inflows of Cereals and Pulses

For the considered time frame in the research, the cereals and pulses inflows in 2018 are much higher than the average monthly inflows during the 2019 and 2020. The decline in the inflows can be linked to the heavy rains in August-September 2019 and the COVID-19 outbreak in 2020. The average monthly inflow in the pre-COVID-19 scenario (period from April 2018 to 23rd March 2020) for cereals and pulses was around 13.28 and 0.69 million kilograms, respectively. During the lockdown (period from 23rd March 2020 to May 2020), the average monthly inflow for cereals and pulses went down to 1.50 and 0.04 million kilograms amounting to a deficit of approximately 88.69% and 93.66% in the inflow, respectively. The recorded deficit was the second-highest deficit among the food categories (dry fruits being the first-highest deficit recorded) considered in this section. On the other hand, in the during-COVID19-unlock scenario, amidst the partial lockdown (June 2020 to August 2020), when the market started opening slowly, there was a steady increase of 2.44 million kilograms in the inflow of the cereals, and interestingly, pulses recorded a decrease of 0.09 million kilograms. In the during-COVID19-lockdown scenario, cereals have recorded a decrease of ₹1.59/kilogram and pulses an increase of ₹5.61/kilogram in the high average price per kilogram, which was due to the supply shortages. The shortage in supply may have happened because of the travel restrictions and unavailability of the daily labour due to the strict nationwide lockdown, which also happened to be the harvest season for pulses.

Impact on onion-potato-garlic-ginger

The onion-potato-garlic-ginger category is an essential category for a typical household's daily food consumption preference in India as well as study area. These are usually bought in bulk as their shelf life is more than a week at a normal temperature, and consumed more frequently after cereals and pulses than other food items. The onion-potato-garlic-ginger category's average monthly inflow in 2018 and 2019 i.e. pre-COVID-19 scenario, ranged between 32 to 57 million kilograms. However, in 2020, the inflow for the month of January and February was much higher amounting to 75 and 103 million kilograms for onion-potato-garlic-ginger category. This unexpected rise in the local market inflow in February was because India halted its onion export since the last quarter of 2019 which in turn was due to a severe supply shortage in the domestic market following the heavy flooding in western Maharashtra. The average monthly inflow in the pre-COVID-19 scenario for onion-potato-garlic-ginger was around 50 million kilograms, and during-COVID19-lockdown scenario, the average monthly inflow went down to approximately 19 million kilograms which is a deficit of approximately 62%. The onion-potato-garlic-ginger food group witnessed a substantial dip in the inflow quantities to the APMC as many providers preferred to sell their produce directly to the consumers with a shorter and adapted supply chain that incorporated the lockdown conditions. In the during-COVID19-unlock scenario, there was a slight increase of average 2.6 million kilograms per month in the inflow. The average inflow in the unlock scenario for July and August 2020 was 21.6 million kilograms. The average daily price fetched per kilogram for onion-potato-garlic-ginger, in the pre-COVID-19 scenario, ranges between ₹29.75 to ₹62.11, which was reduced to ₹24.77 to ₹43.33 in the during-COVID19-lockdown scenario. The price drop might have happened because of the alternate parallel food supply chain amidst the lockdown; hence consumers were served directly by the providers avoiding the APMC channel.

Impact on fruit-vegetables

The inflow of the fruit-vegetables in the pre-COVID-19 scenario was 17.85 million kilograms, which went down to 6.64 million kilograms in the during-COVID19-lockdown scenario and again revived to 11.15 million kilograms during-COVID19-unlock scenario. The fruit-vegetables have comparatively a longer shelf life than leafy-vegetables, thus, in the during-COVID19-unlock scenario, they seem to have a fair number of inflows in the APMC market. The month of May 2020 has recorded an increase in the prices

for fruit-vegetables and leafy-vegetables as the supply was not able to meet the demand. The per kilogram prices for fruit-vegetables in the pre-COVID-19 was ranging between ₹16.59 to ₹31.45, which was reduced to ₹14.79 to ₹23.51 in the during-COVID19-lockdown scenario and improved in the during-COVID19-unlock scenario to ₹15.71 to ₹28.11 as the inflow of the fruit vegetables in the APMC market increased by 67.94%.

Table 2: Food group-wise comparative summary of the inflows and prices calculations for pre-COVID-19 and during-COVID-19-lockdown and during-COVID-19-unlock scenarios

Note: Column heads I: Monthly inflow in a million kilograms/number*; H: Average high price fetched by the produce in INR per kilogram/piece; L: Average low price fetched by the produce in INR per kilogram/piece;									
(a) Comparison of the food inflows and prices as per the record for the three scenarios									
Food Categories	Pre-COVID-19			During-COVID-19-lockdown			COVID-19-unlock		
	(Apr 2018 to Feb 2020)			(March 2020 to May 2020)			(June 2020 to Aug 2020)		
	I	H	L	I	H	L	I	H	L
Column Reference	a	b	c	D	e	f	g	h	i
Cereals	13.28	₹ 42.53	₹ 36.19	1.50	₹ 40.94	₹ 33.82	3.94	₹ 40.64	₹ 33.72
Pulses	0.69	₹ 72.71	₹ 61.02	0.04	₹ 78.32	₹ 66.11	0.14	₹ 80.10	₹ 66.97
Onion-otato-Garlic-Ginger	50.43	₹ 62.11	₹ 29.75	19.00	₹ 43.33	₹ 24.77	21.62	₹ 43.53	₹ 23.97
Fruit Vegetables	17.85	₹ 31.45	₹ 16.59	6.64	₹ 23.51	₹ 14.79	11.15	₹ 28.11	₹ 15.71
Spices	6.99	₹ 70.23	₹ 54.87	2.55	₹ 111.96	₹ 97.92	4.39	₹ 97.21	₹ 80.83
Dry Fruits	3.87	₹ 15.57	₹ 12.91	0.00 [#]	₹ 0.00 [#]	₹ 0.00 [#]	1.89	₹ 11.01	₹ 8.89
Miscellaneous	1.20	₹ 57.75	₹ 53.45	0.30	₹ 60.38	₹ 56.29	0.71	₹ 63.72	₹ 59.77
Leafy Vegetables (no)*	3.90*	₹ 8.55	₹ 4.67	1.46	₹ 7.42	₹ 5.32	2.54	₹ 8.38	₹ 4.38

(b) Differences calculated for food inflows and prices between the three scenarios

Food Categories	Difference between During-COVID-19-lockdown and Pre-COVID-19			Difference between COVID-19-unlock and During-COVID-19-lockdown			Difference between COVID-19-unlock and Pre-COVID-19		
	I	H	L	I	H	L	I	H	L
Column Reference	$j = (d)-(a)$	$k = (e)-(b)$	$L = (f)-(c)$	$m = (g)-(d)$	$n = (h)-(e)$	$o = (i)-(f)$	$p = (g)-(a)$	$q = (h)-(b)$	$r = (i)-(c)$
Cereals	-11.78	-₹ 1.59	-₹ 2.37	2.44	-₹ 0.30	-₹ 0.10	-9.34	-₹ 1.89	-₹ 2.47
Pulses	-0.64	₹ 5.61	₹ 5.09	0.09	₹ 1.78	₹ 0.87	-0.55	₹ 7.39	₹ 5.95
Onion-Potato-Garlic-Ginger	-31.43	-₹ 18.78	-₹ 4.99	2.62	₹ 0.20	-₹ 0.80	-28.81	-₹ 18.59	-₹ 5.79
Fruit vegetables	-11.21	-₹ 7.94	-₹ 1.80	4.51	₹ 4.60	₹ 0.92	-6.70	-₹ 3.34	-₹ 0.89
Spices	-4.44	₹ 41.73	₹ 43.05	1.84	-₹ 14.75	-₹ 17.08	-2.60	₹ 26.98	₹ 25.96
Dry fruits	-3.87	-₹ 15.57	-₹ 12.91	1.89	₹ 11.01	₹ 8.89	-1.98	-₹ 4.56	-₹ 4.02
Miscellaneous	-0.89	₹ 2.63	₹ 2.84	0.41	₹ 3.34	₹ 3.47	-0.48	₹ 5.97	₹ 6.31
Leafy vegetables (no)*	-2.45	-₹ 1.12	₹ 0.65	1.09	₹ 0.96	-₹ 0.93	-1.36	-₹ 0.17	-₹ 0.29

(c) Percentage fluctuation in food inflows and prices for the three scenarios

Food Categories	Percentage fluctuation between During-COVID-19 lockdown over Pre-COVID-19			Percentage fluctuation between During-COVID-19 unlock over Pre-COVID-19			Percentage fluctuation between During-COVID-19 unlock over During-COVID-19 lockdown		
	I	H	L	I	H	L	I	H	L
Column Reference	$s = (j/a)\%$	$t = (k/b)\%$	$u = (L/c)\%$	$v = (p/a)\%$	$w = (q/b)\%$	$x = (r/c)\%$	y	z	aa
Cereals	-88.69%	-3.73%	-6.54%	-70.30%	-4.44%	-6.82%	162.56%	-0.74%	-0.31%

Pulses	-93.66%	7.71%	8.34%	-80.15%	10.17%	9.76%	213.03%	2.28%	1.31%
Onion- Potato- Garlic- Ginger	-62.32%	-30.24%	-16.76%	-57.13%	-29.92%	-19.44%	13.77%	0.45%	-3.23%
Fruit vegetables	-62.79%	-25.24%	-10.87%	-37.52%	-10.62%	-5.34%	67.94%	19.55%	6.21%
Spices	-63.53%	59.41%	78.45%	-37.23%	38.41%	47.32%	72.11%	-13.17%	-17.45%
Dry fruits	-100.00%	-100.00%	-100.00%	-51.10%	-29.30%	-31.14%	100.00%#	100.00%#	100.00%#
Miscellaneous	-74.48%	4.56%	5.31%	-40.30%	10.34%	11.81%	133.94%	5.54%	6.17%
Leafy vegetables (no)*	-62.66%	-13.16%	13.80%	-34.85%	-1.96%	-6.19%	74.50%	12.90%	-17.57%
*Units for leafy vegetable is in number (no.) The color coding used is - Red: Deficit; Green: Surplus; Yellow: Moderate # if a or d or g=0, then s,v,y=100% in other words, if the inflow is 0 for any scenario, then the percentage fluctuation for the next consecutive scenario will be 100%.									
Note: The colour coding used is - Red: Deficit; Green: Surplus; Yellow: Moderate; # if a or d or g=0, then s,v,y= 100%, in other words, if the inflow was 0 for any scenario, then the percentage fluctuation for the next consecutive scenario will be 100%.									

Impact on spices

Spices are a food category, though in smaller quantity are consumed daily in the Indian diet, irrespective of the season. The demand for spices often increases prior to the festival seasons, when varieties of dishes prepared and consumed are comparatively higher. It was evident that, in the year 2018, there was a spike in inflows of the spices for July, October, December, and January, as these months are known for the most celebrated festivals in the locality, namely, Ganpati, Dussehra, Diwali and Christmas holidays respectively. The average monthly inflow of the spices pre-COVID-19 was around 6.9 million kilograms, and during-COVID-19-lockdown, it reduced to 2.55 million kilograms, a reduction by 63.5% which increased in the during-COVID-19-unlock scenario by 72.1% to 4.39 million kilograms. The per kilogram average price for spices, in the pre-COVID-19 period, was ranging between ₹54.87 to ₹70.23, in the during-COVID-19-lockdown period between ₹97.92 to ₹ 111.96. This increase in the price was limited to the lockdown period as there was a supply shortage. However, as

the markets started to open in the during-COVID-19-unlock phase, the average per kilogram prices are ranging between ₹80.83 to ₹97.21. The highest price increase during the lockdown period was for the spices category amongst all other categories.

Impact on inflows of Dry-fruits

The dry-fruit items are majorly imported which depend mostly on the buyer's preferences and well-known varieties from specific location plays an important role, for example, dates from the Middle East, cashews from the Konkan area, walnuts from Northern States. The average monthly inflow of dry-fruits in the pre-COVID-19 scenario was around 3.87 million kilograms, during-COVID-19-lockdown it was null, and in the during-COVID-19-unlock phase, it was 1.89 million kilograms. The average prices for dry-fruits in the pre-COVID-19 scenario was ₹12.91 to ₹15.57, and in the during-COVID-19-unlock phase, ₹8.89 to ₹11.01. The reason for the inflow of dry-fruits during the lockdown period being null might be due to the ban on international and national imports.

Impact on leafy-vegetables

The average monthly inflow for leafy-vegetables in the pre-COVID-19 scenario was 3.90 million, which declined to 1.46 million in the during-COVID19-lockdown scenario. The unlock phase did better in terms of the inflows, with an increase of 74.05% within just two months. The per piece higher and lower prices for leafy-vegetables in the pre-COVID-19 was ranging between ₹4.67 to ₹8.55, which fell down to ₹5.32 to ₹7.42 in the during-COVID19-lockdown scenario and improved to ₹4.38 to ₹8.38 in the during-COVID19-unlock scenario, which are closer to the pre-COVID-19 prices. The short-term increase in the prices in the during-COVID19-lockdown scenario was due to the supply shortage of 62.66%.

Impact on miscellaneous food items

The miscellaneous category included varieties of peanuts and jaggery, which are essential in cooking a typical local meal for the Pune district and usually bought in bulk for a month's consumption. The average monthly inflow for the miscellaneous items was 1.20 million kilo-grams, 0.30 million kilograms, and 0.71 million kilograms for the pre-COVID-19, during-COVID-19-lockdown, and during-COVID-19-unlock period, respectively. The average monthly prices for the miscellaneous items were around

₹53.45 to ₹57.75 during the pre-COVID-19 scenario and increased to ₹56.29 to ₹60.38 in the during-COVID-19-lockdown scenario, which further continued to increase to ₹59.77 to ₹63.72 in the during-COVID-19-unlock scenario, as the inflow in the market saw an increase of 133.94% as the festive seasons for the region were approaching.

4. Conclusion and Recommendations

Overall, this research focusing on the sudden in-accessibility of food due to the COVID-19 pandemic quantitatively established the deficit in the daily food inflows and decline in the prices in Pune's APMC market. For this decrease in the inflows, two evident reasons were first, the 2019 heavy monsoon and flooding as the majority of the agricultural field and produce were ruined and the supply chains during this period were badly affected which followed by the COVID-19-lockdown resulting in sudden mobility restrictions. The inter-state restrictions in the first phase of the lockdown and uncertainty of the lockdown situation impacted the food inflow from other states resulting in short term food insecurity from March 2020 onward and this constraint on the supply side led to a short-term escalation in the prices. However, it is still unclear if this price escalation was a result of supply shortage because of the sealed city limits or because of the limited daily time-frame granted for consumers for purchasing as per the issued lockdown guidelines or due to the increased demand because of the citizen's food hoarding panic behaviour. It was also evident how the local markets become redundant when such a pandemic hit, as the producers (food providers) preferred direct interaction with the consumers. The food supply chains of the perishable items were quick in adapting themselves to a shorter supply chain compared to the non-perishable items. However, the logistics constraints for establishing a quick short supply chain may not be viable and feasible for small farmers; hence, they may have failed to gain any additional profit which large farmers gained during the lockdown condition. The way food supply chains of the perishable items adapted themselves to a shorter supply chain shows a high potential of the region to become locally self-reliant and avoid unnecessary mediators in the supply chain. This pandemic has surely put forth the high dependency of the city on the food imports for catering its food demands with even a brief shutdown of the local market impacting severely on the city's food security. However, the potential of local farmers and mediators in responding quickly

to mitigate the implications of the market shutdown gives an opportunity for planning local strategies for food self-sufficiency achieving food miles.

Table 3: Stage wise Recommendations to mitigate food in-accessibility disaster due to mobility restriction

Disaster: Food in-accessibility due to mobility restrictions				
		Policy Makers	Regional Planners	Business Opportunities
DISASTER MANAGEMENT CYCLE	PREVENTION	Policies concerning emergency rationing system allowing equitable access to food for all Setting up Food Miles benchmark for emergency situation	Mobilize Local Food Production and encourage Urban Farming, community Gardens, Targeted planning efforts on Food Self-sufficient community	Digital Smart Inventory Management Tool for real-time monitoring of food availability and supply chains
	MITIGATION	Policies streamlining emergency food supply chain bare minimum bureaucratic control	Identification of Food clusters based on populations' food demand and agriculture resource scenario,	Investing in Cluster wise Contract Farming
	PREPAREDNESS	Multi-Stakeholder Task force ensuring representation from Citizens. Policy Makers, Producers and Distributors	Establishing Network between local food cooperatives for quick 1st line response	Human Centric Application development to quickly collect demographic data in the cluster
	RESPONSE	Food vouchers in case of loss of livelihood, Extending Public Distribution System benefits		Digital Delivery Systems ensuring continuous Food Accessibility
	RECOVERY	Post-Disaster Needs Assessment study and indicators for resilient recovery of local food security		Cluster wise Partnership with private grocery stores, wholesalers, and food distributors to rebuild supply chain

In conclusion, when the five stages of the Disaster Management Cycle (Ngcamu, 2023) are evaluated against the Food in-accessibility disaster caused due to mobility restrictions during COVID-19 Lockdown, more focus has to be given to the Mitigation, Preparedness, Response and Recovery. Recommendations for policy makers, regional planners and entrepreneurs based on the insights drawn from the research have been given in Table 3. Outlining policies for Prevention would be very difficult as the mobility restriction disaster would happen because of some other major disastrous event. As a Mitigation strategy, regional clusters for food self-sufficiency to be identified under the District Disaster Management Plan keeping the regions' bare minimum food demand in focus and a committee consisting of representatives from Citizens, local government, regional food producers and distributors to be formed for to monitor distribution and prices for that cluster. Necessary provisions for cluster identification and management should be made under the District Disaster Management Plan. As a Response strategy, the at the doorstep delivery model seem to have worked very well. Thus, developing a digital tool for lodging the demand and identifying which cluster consumer belong to would add certainty to the consumers. Additionally, the presented research could be extended to develop a framework for assessing post-disaster impact and indicators for resilient recovery of local food security is the future.

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6. Conflict of Interest

The authors declare that they have no actual or potential conflict of interest in relation to this article.

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