



RESEARCH ARTICLE

Impact of COVID-19 pandemic lockdown on post-harvest management of fruits and vegetables in three districts of Andhra Pradesh

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Received: 13.12.2022

Accepted: 21.02.2023

ABSTRACT

The spread of COVID-19 pandemic has forced nations to remain in lockdown and stopped all essential activities all over the world. In these circumstances, India is not only plagued by this pandemic, but the emergencies due to COVID-19 have adversely affected the supply chain, and trade of fruits and vegetables. In the present study, impact of COVID-19 pandemic lockdown on postharvest management of fruits and vegetables was studied using a quantitative research design. A sample size of 120 fruit and vegetable farmers were selected from Andhra Pradesh, India. The information was collected through telephonic interviews with the aid of a semi structured questionnaire. The collected data was statistically analyzed using descriptive statistics and Chi-square (χ^2) testing of hypotheses was used to find out the association between variables. Findings showed that there was a significant statistical association ($p < 0.05$) between the farming experience, type of pre-treatments selected and maturity indices adopted for the produce. Type of packaging material and incurred transportation losses to produce were also found to be significantly associated. Results disclosed that most of the farmers lack formal knowledge of on-farm practices, despite their farming experience and hence resulted in post-harvest losses. There was no significant association found between farming experience and postharvest losses. The major postharvest losses occurred at the transportation and marketing phase of the supply chain irrespective of the lock down situation.

Keywords: COVID-19 pandemic lockdown, post-harvest losses, post-harvest management

Citation: Sravani, G., Supriya, S., Lazima, R., Alisha, P., and Srijaya, M. 2023. Impact of COVID-19 pandemic lockdown on post-harvest management of fruits and vegetables in three districts of Andhra Pradesh. *Journal of Postharvest Technology*, 11 (2): 102-112.

INTRODUCTION

Fruits and vegetables play a vital role in the diet of individuals by imparting health benefits as they are rich in vitamins, minerals, phytochemicals and fibers. Regular consumption of fruits and vegetables help to cure diseases such as cancer, heart diseases, stroke and cataract formation (Dastagiri et al., 2020). As per the statistics published by the National Horticulture Board, Ministry of agriculture and farmers welfare and Govt. of India during 2018 -2019, the estimated production of fruits in Andhra Pradesh was 17614.67 million tonnes and vegetables 7091.37 million tonnes. Post-harvest management is a process of handling, storage and transportation of agricultural produce after harvest which not only determines quality and safety but also ensures competitiveness among produce for marketing. Losses occurring at each post-harvest stage affects value distribution, thereby

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determining the gap between consumer and farmer prices of the produce (Ladaniya, 2008). COVID-19 outbreak had enforced nations to endure lockdown and all the types of activities around the globe were ceased (Almazan et al., 2020). COVID-19 had severely affected the horticulture sector as they are seasonal and highly perishable in nature. News reports of horticulture said that 65% of the farmers agreed that there were post-harvest losses of fruits and vegetables in many districts of Andhra Pradesh. Overall, the pandemic lockdown posed challenges to horticulture which might have further implications. The main reasons for postharvest losses are disruption of supply chain and constricted opening of mandis and shops (Singh et al., 2020).

The study was carried out in order to obtain first source information from farmers regarding the do's and don'ts of the horticulture produce and the challenges they face in times of glut and possibilities of reducing them. In this respect, the main objective of the study was to assess the knowledge of farmer's on-farm practices and impact of COVID-19 pandemic lockdown on post-harvest management of fruits and vegetables. The specific objectives were to assess the knowledge of farmers regarding general on-farm practices and post-harvest handling practices of fruits and vegetables and to identify the causative factors that influence the post-harvest losses of fruits and vegetables due to COVID-19 pandemic lockdown. Further, the impact of these losses on the economic status of farmers was observed.

MATERIALS AND METHODS

Study area

The study was conducted in three districts of Andhra Pradesh, India. Andhra Pradesh is located in the southern part of the country and it lies between 12°41' and 19.07°N latitude and 77° and 84°40' E longitude. A preliminary base line information was conducted during the first few months of study regarding horticulture production status and type of crops cultivated in the state. Formal sample survey was adopted to identify fruit and vegetable growers in three districts of Andhra Pradesh. Details of the place and contact numbers of the farmers were collected during this period.

Sampling procedure

The study type was a quantitative research design and for the study, a sample size of 120 fruits and vegetables farmer growers were selected from Vizianagaram, Srikakulam, and Anantapur districts of Andhra Pradesh. The criteria for the selection of the districts were as per the access and convenience of the investigators.

Data collection

The primary data was gathered through telephone-based interviews with the aid of semi structured questionnaire comprising open ended and closed ended questions. Telephonic survey approach was selected in place of field survey as it was inconvenient to visit farmers directly due to the COVID-19 pandemic situation. The questionnaire comprising three sections was developed to collect information.

Statistical analysis

Statistical analysis was done using Microsoft Office Excel (2019). Descriptive statistics such as frequency distributions and percentages were computed for all responses. Chi-square test of independence was used for determining the associations between data categories viz., socio-economic variables (level of education, farming experience and share of the income) and on-farm practices followed by farmers.

RESULTS AND DISCUSSION

Socio-economic and demographic characteristics

The total number of respondents were 120 from three districts of Andhra Pradesh. Majority of the respondents involved in the study belong to the 30 - 50 years of age group. Based on gender, 91.7% respondents belong to male category and the remaining 8.3% were female farmers. Predominantly, farmers had acquired a higher secondary level of education which constituted 37% of the respondents. Respondents with elementary education were 19.2% followed by 18.3% with post-graduation and 15.0% with graduation. Around 10.0% of the farmers did not have any formal education. In terms of income share from fruits and vegetables, about 85.5% of respondents shared 25 percent of their income majorly from fruits and vegetables, while 9.2% farmers shared 25 -50 percent, 4.2% of them share around 50-70 percent and 0.8% farmers had around 70-100 percent income share for the fruits and vegetables (Table 1). Out of 120 farmers, 31.9% had 30-40 years of farming experience, 26.9% farmers had 10-20 years, 8.4% had 20-30 years and 33.3% farmers had less than 10 years of farming experience. It was observed that the majority of farmers involved in horticultural production had at least 10 years of experience. The area covered under fruits and vegetables cultivation was 2 acres by majority of the respondents (43.3%) followed by 1 acre for 34.2% respondents. Among all the respondents, 96.7% of farmers adopted conventional methods of farming (Table 2). The predominant horticulture produces grown in farms were tomato (25%), beans (16.6%), chilies (16.6%), brinjal (14.1%), banana (9.17%), papaya (7.5%), grapes (6%) and pears (5%).

Table 1. Socio-economic and demographic characteristics of respondents

Characteristic	Category	Frequency	Respondents (%)
Age (Years)	20-30	17	14.2
	30-40	40	33.3
	40-50	43	35.8
	50-60	14	11.7
	More than 60	6	5.0
Gender	Male	110	91.7
	Female	10	8.3
Level of education	No education	12	10.0
	Elementary education	23	19.2
	Higher secondary	45	37.5
	Graduation	18	15.0
	Post-graduation	22	18.3
	Diploma	No Response	0
	Others	No Response	0
Share of income	Up to 25%	103	85.5
	25-50%	11	9.2
	50-70%	5	4.2
	70-100%	1	0.8

Table 2: Farming experience and type of farming of respondents

Characteristic	Category	Frequency	Respondents (%)
Farming Experience(years)	Less than 10	40	33.3
	10-20	32	26.9
	20-30	10	8.4
	30-40	38	31.9
Total area of farmland(acres)	1 acre	41	34.2
	2 acres	52	43.3
	5 acres	11	9.2
	8 acres	8	6.7
	10 acres	6	5.0
	30 acres	3	1.7
Types of farming	Organic	4	3.3
	Conventional	116	96.7

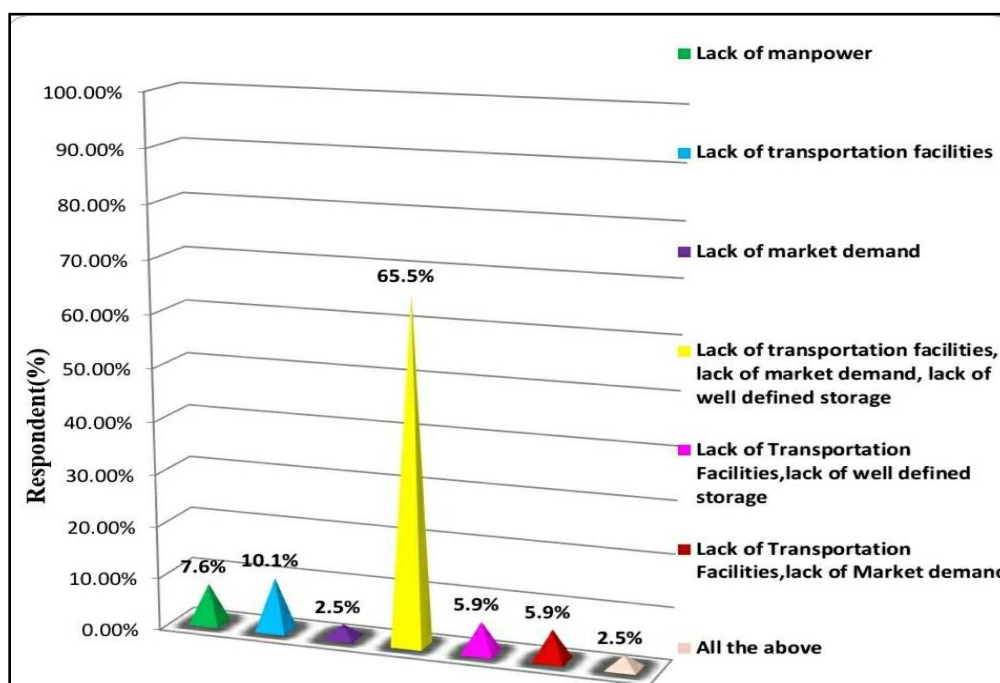


Figure 1. Factors contributing to post harvest losses during COVID-19 pandemic lockdown

Factors contributing to post harvest losses during Covid-19 lock down

Irrespective of pandemic lock down, the respondent observations for the regular losses occurring in fruits and vegetables were, lack of well-defined storage accounting for 65%, followed by lack of transportation facilities (10.1%), lack of manpower (7.6%), lack of transportation facilities along with well-defined storage (5.9%), lack of transportation facilities and market demand (5.9%), lack of only market demand (2.5%) and influence of all the above identified factors accounting to 2.5% (Figure 1). Data suggests that the major contributing factors for post-harvest losses were lack of transportation facilities, well-defined storage, manpower

and demand. These results are in line with the findings of Joshi et al. (2020). The observational study identified that shortage of labor and improper market timings increased the post-harvest losses. Added to these, the fall in prices of the produce (6.5 - 6.6%) due to lack of well-defined storage and transportation facilities, made farmers sell their produce at lower price. Similar results were also observed by Ceballos et al. (2020) in their study.

Challenges encountered in marketing of fruits and vegetables during lockdown

Figure 2 depicts the respondent observations regarding losses during lock down. It was noted that 70.6% of the respondents had encountered perishability problems having lack of transportation facility and variation in transportation costs as the main challenge in the marketing of the produce during the COVID-19 pandemic lockdown. Around 9.2 % of the respondents expressed perishability and lack of transportation facility as major issues, 6.7% for perishability and transportation cost, 4.2% for only transportation cost, 3.4% for perishability, 3.4% for lack of transportation facility and 3.4% of them reported to have all the aforementioned challenges including seasonality of the produce as major impediments for marketing. Due to lock down there were no proper transportation facilities and farmers could not deliver the produce in time to consumers. Most of them expressed that their produce was ready for harvest and due to poor transportation facilities during lock down resulted in on farm losses. Vegetable produce was at higher risk because of lack of manpower to harvest and were more liable to pre harvest spoilage.

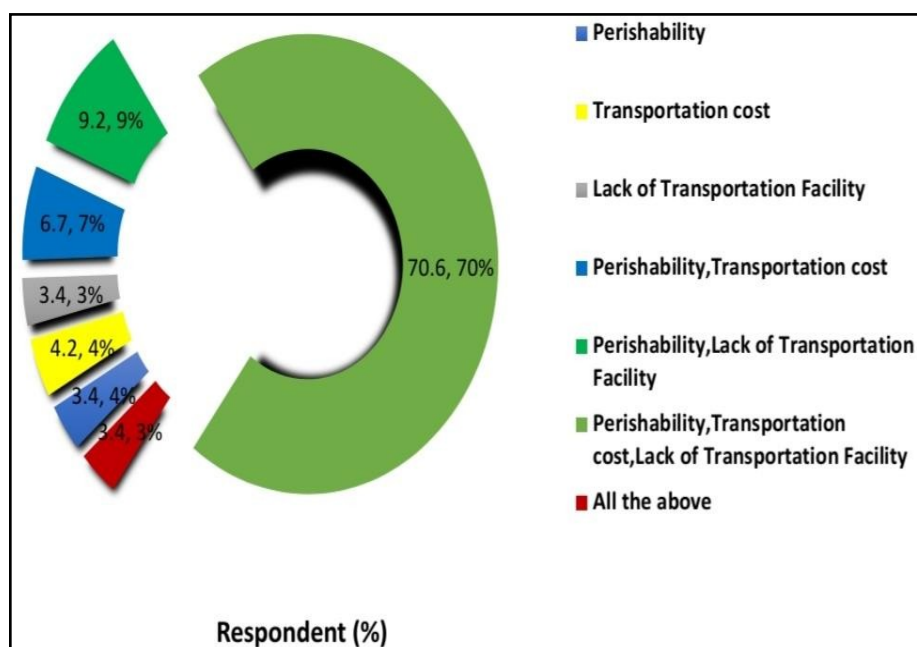


Figure 2: Challenges encountered in marketing of fruits and vegetables during COVID-19 pandemic lockdown

Hampers in delivery had an impact on farmers who were forced to damage their crops or had distress sales at a lesser price. Lockdown mostly impacted quality and marketing of watermelon, muskmelon, chilies and tomatoes as it was the harvesting period for most of the produce. Siddiqui and Khan (2020) have reported that lack of manpower was one of the major challenges because during the lockdown migrant workers returned to their hometown and one who was available demanded higher wages.

Respondents in the study also suggested the measures to be taken up by the Government for horticultural produce during situational crisis as follows: Majority of the respondents (55.5%) said availability of cold storage system, provision of transport vehicles, buying the produce at reasonable cost could be the practical solution to handle such situations, followed by 12.10% of

them suggesting provision of transport vehicles and availability of cold storage system, around 10.1% recommended for viability of cold storage system nearby , 9.2% for provision of transport vehicles, and remaining mentioned for either of the measure (Table 3).

Table 3: Measures to be taken up by the government as suggested by respondents

Characteristics	Category	Frequency	Respondents (%)
Measures as suggested by respondent	Availability of cold storage system	12	10.1
	Provision of transport vehicles	11	9.2
	Buying the produce at reasonable cost	4	3.4
	Provision of transport vehicles, availability of cold storage system	15	12.6
	Provision of transport vehicles, Buying the produce at reasonable cost	10	8.4
	Availability of cold storage system, Buying the 2 produce at reasonable cost	2	1.7
	All the above	66	55.5

Association between selected variables

Association between farming experience and type of pre- treatments applied, type of maturity indices adopted and difference found in losses before and during the pandemic. The Chi-square analysis was employed to determine the significant association between selected variables. Farming experience was significantly associated with the type of pre-treatments applied ($X^2=53.122$, $P=0.004$) and maturity indices adopted for fruits and vegetables ($X^2=52.968$, $P=0.001$) at 5% level of significance. The association implies that farmers who have more farming experience, have the understanding to select or adopt pre-treatment techniques or identify suitable maturity indices, thereby minimizing the occurrence of forthcoming post-harvest losses. This result is consistent with the findings of Alidu et al. (2016) suggesting that farmers who were more experienced showed lesser quantity loss of fruits and vegetables.

However, during pandemic lock down, farming experience was not significantly associated to differences found in post-harvest losses before and during the COVID-19 lockdown ($X^2=4.988$, $P=0.288$). This indicates that though farmers were experienced, the impact of uncertain conditions on the post-harvest supply chain resulted in heavy losses of fruits and vegetables. The resultant losses during lockdown could be due to improper management affecting the overall quality of the produce. Olayemi et al. (2010) reported that poor management affects post-harvest quality of fruits and vegetables, especially produce having high moisture content, viz. tomato. Added to it, Muhammad et al. (2012) inferred that the post-harvest losses might also be due to lack of sufficient knowledge and facts about proper on-farm and post-harvest handling practices, despite having years of farming experience.

Association between level of education and type of packaging selected

The level of education of respondents in the study was not significantly associated with the type of packaging materials selected for produce during transportation ($P < 0.05$); ($X^2 = 24.837$, $P = 0.207$) (Table 4). This result is quite opposite to the findings of Abera et al. (2020); Alemayehu et al. (2018) and Amanullah et al. (2020). The studies have reported that literacy is a determinant factor to lower post-harvest losses, because appreciation and usage of locally available and suitable post-harvest technologies are only possible with farmers having knowledge to read and write.

Table 4: Chi-square testing of hypothesis

	Variables	d.f.	X² value	Table value	P-value	Decisions
	Farming experience					
Set-1	Type of pre- treatments applied	12	53.122	21.03	0.004*	Reject H ₀
	<u>Farming experience</u>					
Set-2	Type of maturity indices adopted	24	52.968	36.42	0.001*	Reject H ₀
	<u>Farming experience</u>					
Set-3	Difference found in losses before and during the pandemic	4	4.988	9.49	0.288**	Failed to Reject H ₀
	<u>Level of education</u>					
Set-4	Type of packaging selected	20	24.838	31.41	0.207**	Failed to Reject H ₀
	<u>Transportation losses (%)</u>					
Set-5	Effect on share of the income	2	0.066	5.99	0.94**	Failed to Reject H ₀
	<u>Difference found in losses before and after the pandemic</u>					
Set-6		6	5.472	12.6	0.48**	Failed to Reject H ₀
	<u>Factors contributed to the losses</u>					
Set-7	Type of packaging used	5	164.232	11.1	<0.001*	Reject H ₀
	<u>Transportation losses (%)</u>					

*Significant at 5% level of significance
 **Not Significant at 5% level of significance
 H₀= Null hypothesis, no significant association between selected variables

The present results might suggest that education is not only the criteria for effective post-harvest management of fruits and vegetables. Having formal knowledge and experience on post-harvest handling practices, viz. selection of packaging material also helps farmers to some extent in post-harvest management of fruits and vegetables. The current study data also illustrated the fact that the respondents acted similarly irrespective of their education and experience. Farmers might have received the formal knowledge by practicing what fellow-farmers practice or through word of mouth.

Association between transportation losses (%) and effect on share of the income

There was no significant association found at 5% level between losses incurred while transporting the produce during the lockdown and problem encountered in the share of the income for the same 176 ($X^2=0.066$, $P=0.94$).

Association between difference found in losses before and after the pandemic and factors contributed to the losses

It was also seen from the investigation that there was no significant association observed between post-harvest losses of fruits and vegetables before and during the Covid -19 pandemic lock down and factors contributing to the same viz., lack of manpower, transportation facilities, lack of market demand and lack of well-defined storage ($X^2=5.472$, $P=0.48$).

Ceballos et al. (2020) stated that horticulture farmers spent most of their money on labor for harvesting. Added to this, distress selling was more widespread due to lack of a good procure system that resulted in income problems for the farmers. Joshi et al. (2020) opined that lack of infrastructure and storage facilities contributed to the losses. On the other hand, selection of appropriate packaging material and employment of good on-farm practices, viz. maturity indices might have benefitted in the transportation phase for the produce (Rajapaksha et al., 2021).

From the present study it can be inferred that transportation was not only the factor that contributed to post- harvest losses, but also the factors like supply chain disruptions, shortage of labor, lack of market functioning, lack of market demand and price fluctuations would have resulted in losses thereby problems encountered in share of the income. This implies to the fact that the factors like economic background of farmers, inaccessibility, low supplies, transportation and purchase costs of pesticides, insecticides and fertilizers that also would have contributed to these losses (as 117 farmers out of 120 of them are conventional farmers) to some extent. Similar observations were suggested by Workie et al. (2020) towards losses incurred for fresh produce. Added to this, the influence of extraneous factors like climate and weather conditions, basic knowledge, attitude and practices of the farmers for harvesting and handling also would have contributed to the cause, disease and pest animals might have affected the produce externally (Muhammad et al., 2012; Rajapaksha et al., 2021).

On the other hand, in the present survey it was observed that small scale production of the produce in the study area would not have caused farmers to find a difference between losses that happened before and during the pandemic lock down (the average cultivation land is 2 acres).

Association between type of packaging used and transportation losses (%)

The type of packaging materials used ($X^2=164.232$, $P=<0.001$) was significantly associated with incurred transportation losses during the lockdown period. This implies that, selection of packaging material for the fresh produce depending on its nature is very important to withstand the mechanical damage that results during transportation. The results in the study are consistent with the findings of Aba et al. (2012). The present study depicted those fruits which were in direct contact with the wall and floor of the traditional basket got severely bruised as most of the farmers, nearly 50%, from the study area reported using traditional baskets. It was observed that the friction between the fruits and surface of the packaging container was more resulting in injury to the commodity. According to the findings of Rajapaksha et al. (2021), mechanical damage is also caused by rough handling, where poor packaging and distribution aggravate the problem. Vegetables that are forcibly packed into polypropylene sacks encounter a lot of damage due to insufficient ventilation that will increase in both toughening and senescence.

It can be inferred from the present survey that the lack of good transportation facilities and delays in the transportation during the pandemic could be the main factors causing postharvest losses in terms of quality and quantity. Vursavus and Ozguven, (2004) reported that road roughness, traveling speed, distance, truck characteristics such as suspension and the number of axles and packaging influence the product quality. On the other hand, transportation delays added to the cause; as the time spent in the vehicle prolongs, the degree of damage will also proportionally increase. Thus, the product deteriorates in quality, gets bruised and infected by pathogens (Rajapaksha et al., 2021).

CONCLUSION

The key findings of the present study reveal that there were price fluctuations in fruits and vegetables during the COVID-19 pandemic lockdown. The contributing factors for postharvest losses were lack of well-defined storage facilities, lack of transportation facilities, and manpower. Fresh produce perishability coupled with lack of transportation facilities added the challenges in marketing fresh fruits and vegetables during the lockdown. Most of the farmers lack formal knowledge of on-farm and post-harvest handling practices despite their farming experience. The study revealed that preparedness for the crisis is of paramount importance to deal with post-harvest losses of fresh fruits and vegetables during future catastrophes such as the COVID-19 pandemic.

REFERENCES

- Aba, I. P., Gana, Y. M., Ogbonnaya, C., and Morenikeji, O. O. 2012. Simulated transport damage study on fresh tomato (*Lycopersicon esculentum*) fruits. *Agricultural Engineering International: CIGR Journal*, 14(2), 119-126.
- Abera, G., Ibrahim, A. M., Forsido, S. F., and Kuyu, C. G. 2020. Assessment on post-harvest losses of tomato (*Lycopersicon esculentum* Mill.) in selected districts of East Shewa Zone of Ethiopia using a commodity system analysis methodology. *Heliyon*, 6(4), e03749.
- Alemayehu, M., Abera, M., and Bizuayehu, S. 2018. Determinants and extent of pre-and postharvest losses of fruits in Northwestern Ethiopia. *International Journal*, 5(4), 68-75.
- Alidu, A. F., Ali, E. B., and Aminu, H. 2016. Determinants of Post-Harvest Losses among Tomato Farmers in The Navrongo Municipality in The Upper East Region. *Journal of Biology, Agriculture and Healthcare*, 6(12), 14-20.
- Amanullah, A., Nawi, N.M., Kamarulzaman, N.H. and Shamsudin, M.N. 2020. Factors influencing post-harvest losses of apples among growers in Paktia, Afghanistan. *Food Research*, 4(6), 2313-2321.
- Ceballos, F., Kannan, S., and Kramer, B. 2020. Impacts of a national lockdown on smallholder farmers' income and food security: Empirical evidence from two states in India. *World Development*, 136, 105069.
- Dastagiri, M. B., Sindhuja, P. V., Naik, M. R., Rakesh, S., and Praneetha, Y. 2020. Global Fruits Foreign Trade Research during WTO Regime: World Trading Signals and Policies.
- Directorate of economics and statistics. 2020. Agricultural statistics at glance 2019-20 Andhra Pradesh. Govt. of Andhra Pradesh
- FAO (Food and Agriculture Organization of the United Nations). 2020. Responding to the impact of the COVID-19 outbreak on food value chains through efficient logistics [Online]. <http://www.fao.org/3/ca8466en/CA8466EN.pdf>. Accessed on Apr. 24, 2020.

- FAO (Food and Agriculture Organization of the United Nations). 2020a. Policy responses to keep input markets flowing in times of COVID-19 [Online]. <http://www.fao.org/3/ca8979en/CA8979EN.pdf>. Accessed on May 8, 2020.
- FAO (Food and Agriculture Organization of the United Nations). 2020b. COVID-19 and the risk to food supply chains: How to respond? [On-Line]. <http://www.fao.org/3/ca8388en/CA8388EN.pdf>. Accessed on Apr. 3, 2020.
- FAO (Food and Agriculture Organization of the United Nations). 2020c. COVID-19 and smallholder producers' access to markets [Online]. <http://www.fao.org/3/ca8657en/CA8657EN.pdf>.
- India, T. H. (2017, July 16). Anantapur emerging as fruits hub of AP. Anantapur Emerging as FruitsHub of AP [Online]. www.thehansindia.com. <https://www.thehansindia.com/posts/index/Commoner/2017-07-16/Anantapur-emerging-as-fruits-hub-of-AP/312739?infiniteScroll=1>.
- ITC (International Trade Centre). 2020. Unsung Heroes: How Small Farmers Cope with COVID-19[Online]. https://www.intrance.org/uploadedFiles/intracencorg/Content/Publications/Unsung_Heroes_Low-ress.pdf.
- Joshi, P., Kulkarni, U., Munje, S., and Kulkarni, S. (2019). Impact of COVID-19 pandemic on Indian fruits and vegetables export, postharvest management supply chain and future strategies. *AgricINTERNATIONAL*, 6(2), 4-8.
- Ladaniya, M. 2008, *Citrus Fruit Biology, Technology and Evaluation*. Elsevier Inc. London inistry of food processing industries. (2020). Annual Report 2019-20. Retrieved from <https://www.mofpi.nic.in>
- Muhammad, R. H., Hionu, G. C., and Olayemi, F. F. 2012. Assessment of the post-harvest knowledge of fruits and vegetable farmers in Garun Mallam LGA of Kano, Nigeria. *International Journal of Development and Sustainability*, 1(2), 510-515.
- Olayemi, F. F., Adegbola, J. A., Bamishaiye, E. I., and Daura, A. M. 2010. Assessment of post-harvest challenges of small-scale farm holders of tomatoes, bell and hot pepper in some local government areas of Kano State, Nigeria. *Bayero Journal of Pure and Applied Sciences*, 318(2), 39-42.
- Rajapaksha, L., Gunathilake, D. M. C. C., and Pathirana, S. M. 2021. Reducing post-harvest losses in fruits and vegetables for ensuring food security–Case of Sri Lanka. *MOJ Food Process Technols*, 9(1), 7-16.
- Saha, T., and Bhattacharya, S. 2020. Consequence of lockdown amid COVID-19 pandemic on Indian agriculture. *Food and Scientific Reports*, 1(special issue), 47-50.
- Santacoloma, P., Röttger, A., and Tartanac, F. 2009. Course on agribusiness management for producers' associations. Training Materials for Agricultural Management, Marketing and Finance (FAO).
- Siddiquei, M. I., and Khan, W. 2020. COVID 19: challenges for vegetable production in India. *International Journal of Vegetable Science*, 1-3.
- Singh, A. K., Singh, L., and Kumar, S. 2020. Impact of COVID-19 on agriculture and alliedsectors. *Journal of Community Mobilization and Sustainable Development Vol*, 15(1), 8-16.


Vursavuş, K. K., and Özgüven, F. 2004. Determining the effects of vibration parameters and packaging method on mechanical damage in golden delicious apples. *Turkish Journal of Agriculture and Forestry*, 28(5), 311-320.

Wikipedia contributors. 2021. Geography of West Bengal. Wikipedia
https://en.m.wikipedia.org/wiki/Geography_of_West_Bengal

Workie, E., Mackolil, J., Nyika, J., and Ramadas, S. 2020. Deciphering the impact of COVID-19 pandemic on food security, agriculture, and livelihoods: A review of the evidence from developing countries. *Current Research in Environmental Sustainability*, 100014.



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