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Analyzing the existing value chains of fruits and vegetables in selected upazilas of Bangladesh

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A B S T R A C T

Reducing postharvest losses of fruits and vegetables is a major pathway to food and nutrition security in Bangladesh. A survey was conducted in 30 selected upazilas of Bangladesh from February to October 2021 to explore the nature and magnitude of postharvest losses. This study assessed the knowledge gap, attitudes and practices of the value chain's key actors, and the status of market opportunities in the country. A total of 515 farmers and 295 traders were interviewed from selected upazilas of the country. The findings of this study revealed that 50-70% of growers showed a positive attitude toward good agriculture practices (GAP), maturity indices, and the role of good packaging in keeping the products safe for consumers. More than 41% of farmers aggregated their harvested commodities beside the field on direct soil contact under open sunlight. Only 27% of farmers and traders washed fruits and vegetables before marketing, of which 32% used unsafe water found in the canal or ditches. On average, 86.91% of farmers and traders sorted out their products before marketing for a better price. More than 56% of farmers and traders used jute or nylon sac for packaging fresh fruit and vegetables. Nevertheless, only 20.2% of farmers and 24.41% of traders used plastic crates as packaging containers. Generally, the farmer used different local vehicles, including three-wheeler van, rickshaw, bi-cycle, tempo, etc. In contrast, the traders transported their produce to the wholesale market using a truck and pick-up van. The average postharvest losses were estimated 12.5% at the farm level, whereas 6.7% at trader's level up to the wholesale market.

Keywords: Postharvest, Knowledge, Practices, Losses, Quality, Fresh produce

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Introduction

Fruits and vegetables play a significant role in human nutrition, especially as sources of vitamin C, folate, β-carotene, potassium, iron, zinc, and calcium (Shetty *et al.*, 2015; Van Jaarsveld *et al.*, 2014). In addition, they are high in dietary fiber, bioactive substances, and antioxidants (Khandpur and Gogate, 2015; Wadhwa *et al.*, 2015). Bangladesh currently consumes about 346 grams of fruits and vegetables per person per day, less than the recommended minimum of 400 grams per day (WHO, 2018). Due to postharvest losses and ineffective marketing strategies, even if global food production has increased noticeably, half of the population in third-world nations still lacks access to sufficient food supply (Khatun and Rahman, 2019).

According to estimates from Hassan *et al.* (2010) and Kaysar *et al.* (2016), postharvest losses of fresh fruits and vegetables in Bangladesh range from 16.7 to 43.5%, which accounted for BDT 34,420 million each year, with an average of 31% between production and consumption. In order to increase food availability for the expanding population, reduce the amount of land needed for production, and protect natural resources, techniques for reducing postharvest losses should be implemented. The application of improved postharvest technology on horticultural crops is important for improving food and nutrition security and raising farmers' income (Affognon *et al.*, 2015; Kiaya, 2014). At the level of growers and other stakeholders, understanding pre and postharvest management of fruits and vegetables is crucial for preventing postharvest losses and guaranteeing food security. In order to create the best plan for reducing postharvest losses and ensuring the quality and safety of fresh fruits and vegetables in Bangladesh, it is necessary to identify the current status of production and postharvest handlings, including sorting, grading, washing, packaging, transportation, and marketing of harvested commodities.

Methodology

Study area selection

The survey was conducted in 30 selected upazilas, namely Savar, Kapasia, Shibpur, Belabo, Raipura, Chandina, Mirsarai, Khagrasori, Sreemongal, Dakkhin surma, Delduar, Madhupur, Muktagacha, Islampur, Nokhla, Kishoregonj sadar, Boraigram, Godagari, Naogaon, Shibgonj, Bogura sadar.

Sampling procedure

For conducting baseline surveys at the field and market levels, pre-tested structured questionnaires for farmers and traders were developed by consulting with respective scientists of the Economic Division of BARI. All enumerators were trained on data collection procedures at field and market levels. A complete list of farmers and traders of fruits and vegetables was prepared in each upazila with the help of DAE personnel. It was planned to interview 600 farmers and 300 local traders working in the fruit and vegetable value chains (i.e., 20 farmers and 10 traders from each of the 30 upazilas). Still, due to the unavailability of some key actors, the actual number of farmers' sample size was 515, and traders were 295. All value chain actors were randomly selected and interviewed from farmers' common interest groups (CIGs), locally assembled, and retail markets. Trained enumerators and SAO collected data and information for this study.

Analytical techniques

Data were captured on pre-prepared Microsoft Excel at the end of the data collection period. Mostly tabular method of analysis was followed to provide a comprehensive picture of the existing value chains of fruits and vegetables in Bangladesh. Collected data were processed and summarized using descriptive statistics. Merlin Statistical Software was used to analyze the quantitative data.

Results and Discussion

Crop production status following GAP for quality and safety assurance

Quality of fruits and vegetables focuses on the nutritional value, safety, sensory, physical appearance, and shelf life (Barrett *et al.*, 2010; Francis *et al.*, 2012), which is largely determined by pre-harvest production factors, postharvest handling, storage, and processing (El-Ramady *et al.*, 2015; Rehman *et al.*, 2015). Among the respondent farmers, 56.3% told that they follow GAP in producing fruits and vegetables, out of which 60-61% applied balanced fertilizer with the recommended dosage and judicially used pesticides to prevent their crops from insect pests and diseases (Table 1).

Table 1. Measures taken to produce quality and safe fruits and vegetables.

Type of measures	Farmers	
	No. of respondents (n=515)	% of responses
A. Do you follow GAP to produce safe and hygienic fruits and vegetables?		
Positive response	290	56.31
Negative response	225	43.69
B. What methods do you follow?		
Apply balanced fertilizer	174	60.00
Apply recommended pesticide in proper dose	179	61.72
IPM	123	42.41
ICM	25	8.62
Other methods	13	4.48

On the other hand, 42.4% and 8.6% of the respondent farmers got awareness about IPM and ICM practices, respectively, in crop production. The usage of sex pheromone traps is gaining popularity in Bangladesh as a part of IPM practices, which is effective in controlling insect pests in, particularly fruit flies and *Tuta absoluta,* for both fruits and vegetables (Bachmann *et al.*, 2015; Retta and Berhe, 2015).

Maturity indices of fruits and vegetables

Harvesting of cops at the proper maturity stage is important for attaining desirable quality and shelf life. The level of maturity helps in selecting storage methods, estimating postharvest shelf life, and choosing processing operations for value addition (Dhatt and Mahajan, 2007). Table 2 shows that about 69.5% respondents harvest well-matured fruits and vegetables from the field. On the other hand, 32.04% farmers harvest their produce based on the market demand for a better price. In that case, they usually did not consider the proper maturity stages of the crop.

Table 2. Perception of the farmers on maturity indices of fruits and vegetables at harvest.

Maturity stages of the crop at harvest	Farmer	
	No. of respondents (n=515)	% of responses
Immature	5	0.97
Well matured	358	69.51
Over matured	20	3.88
Based on the market demand	165	32.04

Harvesting time and method of fruits and vegetables

Harvesting of fruits and vegetables at the right time of the day and in the right way maximizes crop yield and minimizes crop losses and quality deterioration. The findings of this study showed that more than 60.4% farmers harvest their produces early in the morning, whereas 28.3% farmers harvest in the afternoon (Table 3). On the other hand, 88.3% farmers harvest their crops by hand pulling, which might cause partial damage to the crops and mother plants (Table 4). Nevertheless, 11.26% farmers used scissors or knives to detach the crop from the plant.

Table 3. Farmer's perception of harvesting time of the day.

Harvesting time	Farmer	
	No. of respondents (n=515)	% of responses
Early morning	311	60.39
After Sunrise	47	9.13
Afternoon	146	28.35
Any time of the day	40	7.77

Table 4. Harvesting method of fruits and vegetables from the mother plant.

Harvesting method	Farmer	
	No. of respondents (n=515)	% of responses
Hand pulling	455	88.35
Harvesting with scissors/knife	58	11.26
Other methods	2	0.39

Aggregation of harvested fruits and vegetables

Harvested produce should be aggregated in such a place to reduce transpiration loss and microbial contamination of the produce. Irrespective of fruits and vegetables, 42% farmers accumulated their harvested commodities on the ground under the open sunlight beside the field (Table 5), which enhanced the rate of transpiration and respiration losses and finally deteriorated the product quality and shelf life. Nevertheless, about 31.8% of farmers aggregated the harvested fruits and vegetables under a tree shed near the field, and more than 26% of farmers gathered the harvested produce in a shady place like a hut or open house near the field.

Table 5. Aggregating places of harvested fruits and vegetables near the field.

Aggregation site after harvest	Farmer	
	No. of respondents (n=515)	% of responses
Beside the field	164	31.84
Under a tree shade	214	41.55
Other shady places	137	26.60

Causes of postharvest losses of fruits and vegetables at farm levels

Harvested fruits and vegetables are metabolically active, undergoing ripening and senescence, which must be controlled to maintain quality and increase shelf life (Mahajan *et al.*, 2014). Improved postharvest handling practices should be followed to reduce damage and bruises of fresh fruits and vegetables (Kitinoja, 2013). On average, the postharvest loss of fruits and vegetables at the farm was 11 % of the total production (Table 6).

Table 6. Factors contributing to the postharvest losses of fruits and vegetables at farm levels.

Causes of postharvest losses	Farmers		
	No. of respondents (n=515)	% of responses	Postharvest loss (%)
Insect infestation	421	81.7	4.2
Diseases infection and rotting	429	83.3	4.5
Cracking, abrasion or bruising damage	362	70.3	2.3
Total	-	-	11.0

The maximum number of growers (82-83%) mentioned that most losses occurred due to disease and insect infestation, accounting for 4.5 and 4.2%, respectively. On the other hand, more than 70% farmers mentioned that 2.3% of the harvested produce was lost due to cracking and abrasion damage. These findings agree with Khatun and Rahman (2019), who reported that the postharvest loss of brinjal was 13.9% at farm level, and the main reasons for that loss were insect pests and disease infection. At the farmers' level, damaged produces caused by insect and disease infection, cracked and rotten fruits were usually discarded from good ones through sorting.

Mode of transportation and distance of local assemble market from the farm

Farmers are the key actors in the fresh produce's value chain. They used different local vehicles to transport fruits and vegetables from the production areas to the nearby local assemble markets (LAM). The use of vehicles varied from farmers to farmers and the distances of destination markets. Farmers transported their produce using local carriers like bicycles, rickshaws, three-wheeler vans, and tempo, auto-rickshaws (Table 7). Sometimes they carry their small amount of produce by head also. Most of the farmers (70%) used a three-wheeler van, and the rest of them used tempo, auto-rickshaw, and manually pulled rickshaw to carry fruits and vegetables from the field to the assemble markets (Table 7).

Table 7. Mode of transport, local market distance, packaging volume and postharvest losses of fruits and vegetables during marketing by the farmers.

Type of transport vehicles	Farmers		Avg. distance of LAM (km)	Avg. unit packaging volume (kg)	Loss due to packaging and transportation (%)
	No. of respondents (n=456)	% of responses	No. of respondents (n=492)	No. of respondents (n=456)	No. of respondents (n=437)
By head	25	5.48	3.2	85.0	1.5
Auto rickshaw	15	3.29			
Rickshaw	12	2.63			
Van	319	70.0			
Tempo	70	15.3			
Bi-cycle	68	14.9			

The average distance of the local assembled market (LAM) was 3.2 km from the field. The packaging volume of fruits or vegetables prepared by a farmer ranged from 10 to 200 kg, which averaged 85 kg (Table 7). Farmers usually used bamboo baskets lined with or without newspaper, jute or plastic sacks, and reusable plastic crates as packaging containers for fruits and vegetables. Most of the farmers opined that the postharvest loss accounting of 1.5% occurred due to wrong packaging and transportation of the produces to the LAM.

Awareness of farmers on food safety issues of fruits and vegetables

The major contributing factors making fruits and vegetables unsafe for human consumption were reported to be the indiscriminate use of pesticides, use of ripening chemicals, washing with dirty water, and use of more chemical fertilizers for growing crops, as mentioned by 74.7%, 30%, 19.2%, and 10.8% respondents, respectively (Table 8).

Table 8. Perception of farmers on different factors making fruits and vegetables unsafe to consumer's health.

Hazardous Factors	Farmers	
	No. of respondents (n=515)	% of responses
Indiscriminate use of pesticide	385	74.7
Fruit ripening with chemicals	196	30.0
Use of chemical fertilizer to grow crops	56	10.8
Washing of fruit and vegetable with dirty water	99	19.2
Insect and diseases	33	6.4

The findings of this study are in agreement with Damalas and Eleftherohorinos (2011), who stated that the misuse of chemical pesticides could lead to adverse effects on human health and the environment.

Marketing channels for fruits and vegetables

The process of fresh produce marketing started with the growers and continued through certain channels until the produce reached the final consumers. A number of intermediaries, such as local small traders, large traders, wholesalers, and retailers, were involved in the transaction. Among them, large traders in the LAM played an important role in determining the price of fresh fruits and vegetables in the study area. On the other hand, wholesalers in the big cities play their role as commission agents.

Sorting and grading of fruits and vegetables

Sorting is usually done by hand to remove the fruits and vegetables, which are unsuitable for market or storage due to damage by mechanical injuries, insects, and diseases, immature, over-mature, distorted, etc. In this study, more than 91.8% farmers and 78.3% traders usually sorted their produces before marketing (Table 9). Among the respondents, 58.5% farmers and 78.3% traders mentioned that up to 5% of the harvested produce was sorted out due to different damages like mechanical injuries, insect pest and diseases infections, immature or over maturity, etc.

Table 9. Sorting of fruits and vegetables by growers and traders before marketing.

Particulars	Farmers		Traders		Total	
	No. of respondents (n=515)	% of responses	No. of respondents (n=295)	% of responses	No. of respondents (n=810)	% of responses
A. Do you sort out rotten, insect-infested and diseased ones from the produce lot?						
Positive response	473	91.84	231	78.31	704	86.91
Negative response	42	8.16	64	21.69	106	13.09
B. How much of the fruits or vegetables sorted out?						
Up to 5 %	277	58.5	181	78.35	458	65.05
6-10 %	171	36.1	43	18.61	214	30.4
11-15 %	20	4.2	7	3.00	27	3.83
16-20 %	5	1.0	0	0	5	0.71
20 % +	0	0	0	0	0	0

In case of grading, about 74.76% farmers and 76.95% traders said that they marketed their products without grading (Table 10). Nevertheless, 25.24% farmers and 23.05% traders graded their products, most of whom practiced it based on the shape and size of fruits and vegetables.

Table 10. Grading of fruits and vegetables by growers and traders before marketing.

Grading criteria	Farmers		Traders		Total	
	No. of respondents (n=515)	% of responses	No. of respondents (n=295)	% of responses	No. of respondents (n=810)	% of responses
A. Do you perform grading of fruits and vegetables?						
Positive response	130	25.24	68	23.05	198	24.44
Negative response	385	74.76	227	76.95	612	75.56
B. What is the basis of grading?						
Size and shape	354	91.95	217	95.59	571	93.30
Maturity stages	66	17.14	31	13.66	97	15.85
External Colour	39	10.13	16	7.05	55	8.99
Others	3	0.78	0	0	3	0.49

Washing of fruits and vegetables before marketing

Washing of fresh fruits and vegetables is very important to remove external soil, debris, and microbes, including *E. coli* and *Salmonella*, from the surface of the products. Thus, it is always advisable to wash most fruits and vegetables with sanitizers like hypochlorites, hydrogen peroxide, trisodium phosphate, organic acids, electrolyzed water, and calcium solution before marketing them to ensure clean and safe products for the consumers (Tapia *et al.*, 2015). Among the respondents in this study, about 79.60% farmers and 61.02% traders stated that they marketed their products without washing or cleaning with water or other means (Table 11). Nevertheless, 20.30% farmers and 38.98% traders practiced washing fresh produce before packaging and subsequent marketing. Among the positively stated respondents, 48.50% farmers and 85.20% traders mentioned that they usually used tube-well or tap water for washing the produces.

Table 11. Awareness of farmers and traders on washing fruit and vegetable before marketing.

Water sources	Farmers		Traders		Total	
	No. of respondents (n=515)	% of responses	No. of respondents (n=295)	% of responses	No. of respondents (n=810)	% of responses
A. Do you wash fruits and vegetables before packing?						
Positive response	105	20.30	115	38.98	220	27.17
Negative response	410	79.60	180	61.02	590	72.83
B. What source of water do you use to wash them?						
Canal or ditchwater	34	32.30	10	8.72	44	20.00
Tube-well/tap water	51	48.50	98	85.2	149	67.20
River water	20	19.00	7	6.67	27	12.20

Packaging of fruits and vegetables by the farmers and traders

Appropriate packaging of fresh produce and optimum volume is important for maintaining product quality during transport and subsequent handling (Esguerra *et al.*, 2016). In this study, most respondent traders agreed that good packaging is crucial in maintaining product quality and attracting consumers. About 53.90% traders in this study used 51-100 kg packages to transport the produce to the wholesale markets, whereas 21.36% traders used 26-50 kg packages (Table 12).

Table 12. Packaging volume of fruits and vegetables for transporting to the wholesale market.

Unit packaging volume	Traders	
	No. of respondents (n=252)	% of responses
Up to 25 kg	51	17.29
26 - 50 kg	159	21.36
51- 100 kg	63	53.90
100+ kg	22	7.46
Mean Score (kg)	60.40	

Table 13 shows the types of packaging containers used by farmers and traders to market fresh fruits and vegetables. About 54.00% farmer and 60.00% traders usually use jute or nylon sacks as packaging containers for marketing the produces. Due to the lower cost and locally available, 36.50% farmer and 23.05% small traders used bamboo baskets with paper lining as packaging containers for fruits and vegetables (Table 13). On the other hand, more than 20.20% farmers and 24.41% traders used reusable plastic crates as packaging containers. However, most of the respondents opined that a plastic crate was the best packaging container that could maintain product quality to a great extent during the transportation and handling of fresh produces. This judgment supported the statement made by Rapusas and Rolle (2009), who stated that plastic crates as packaging containers should be used to supply safe and high-quality fruits and vegetables to consumers. In another study, Rahman *et al.* (2019) reported that the postharvest loss of brinjal could be reduced by 88.7% by integrating improved postharvest management practices; including using plastic crates as packaging containers.

Table 13. Packaging containers used for fruits and vegetables.

Type of packaging containers	Farmers		Traders		Total	
	No. of respondents (n=515)	% of responses	No. of respondents (n=295)	% of responses	No. of respondents (n=810)	% of responses
Jute or plastic sacks	278	54.00	177	60.00	455	56.17
Bamboo basket	188	36.50	68	23.05	256	31.60
Plastic crate	104	20.20	72	24.41	176	21.73
Others	18	3.50	22	7.46	40	4.94

Mode of transport at trader's level

Low-cost vehicles like rickshaws, three-wheelers vans and tempo were common in the study areas, mainly used by small traders to carry produce from the garden to the assemble markets (Table 14).

Table 14. Mode of transport for sending fruits and vegetables to the wholesale markets.

Types of transport vehicles	Traders		Avg. distance of wholesale markets (km)	Produce vol. loaded in a truck (kg)	Produce loss at reaching the wholesale market (%)
	No. of respondents (n=257)	% of responses	No. of respondents (n=273)	No. of respondents (n=254)	No. of respondents (n=271)
Truck	150	58.37	135.1	5481.0	5.2
Bus roof	21	8.17			
Rickshaw	9	3.50			
Van	81	31.52			
Tempo	30	11.67			

However, the big traders usually used trucks for transporting fruits and vegetables to the wholesale markets. Data from the present study revealed that more than 58.37% traders used trucks to transport fresh produce from the local assembles market to the distant wholesale markets. In contrast, 31.52% of small traders used three-wheelers van to carry fresh produce from the field to the LAM. The average distance of the wholesale destination market from the LAM was about 135 km, and the average volume of fruits and vegetables of 5,481 kg loaded in a truck of three-ton capacity (Table 14).

Postharvest losses of fruits and vegetables at the wholesale level

The postharvest losses of fresh fruits and vegetables at the wholesale level in the value chain are presented in Table 15. Among the respondents, the maximum number (61.60%) told that the postharvest loss at the wholesale level was estimated at 5%. However, about 26.20% traders informed that it was up to 6-10%. However, the average loss was recorded by 6.7% at the wholesale level. The findings of this study are partially corroborated with the results of Hossain *et al.* (2016), who reported that the damage of cabbage and cauliflower was about 12% at the wholesale level.

Table 15. Postharvest loss of fruits and vegetables at reaching the wholesale market.

Postharvest loss (%)	Traders	
	No. of respondents (n=271)	% of responses
Up to 5	167	61.60
6-10	71	26.20
11-15	17	6.27
16-20	10	3.69
≤20	6	2.21
Mean Score = 6.7%		

A significant portion of the products got partial damage in the form of compression, bruising or abrasion during transporting to the wholesale market, which could be sold at reduced prices. All the damages seemed to occur from inappropriate large packaging in jute sacks and transportation in uncovered ordinary trucks without any control of temperature or humidity.

Causes of postharvest losses of fruits and vegetables during marketing

The usage of postharvest technology intends to slow down ripening and senescence changes, thereby minimizing crop spoilage and microbial growth (James and Zikankuba, 2017). In this study, 52.20-56.95% traders said that rough handling and overloading were the major causes of postharvest loss of fresh produces (Table 16). On the other hand, about 47.12% of the respondents opined that inappropriate bulk packaging was the main reason for huge postharvest losses while transporting fruits and vegetables to the wholesale market.

Table 16. Factors contributing to postharvest losses of fresh produces during transportation to the wholesale markets.

Factors of postharvest losses	Traders	
	No. of respondents (n=295)	% of responses
Inappropriate bulk packaging	139	47.12
Overloading	154	52.20
Rough handling during loading and unloading	168	56.95
Insect and disease problems	24	8.14
Others	2	0.68

Conclusion

Assuring quality and safe food for consumers is pivotal nowadays. The findings of this study revealed that most of the farmers expressed positive attitudes towards proper harvesting and improved postharvest management practices for assuring the quality and safety of fruits and vegetables. However, many of them did not practice these improved postharvest management technologies due to faulty marketing systems prevailed in the country, lack of facilities at LAM for applying improved PHM practices, lower prices of fruits and vegetables at the farm level, unavailability and higher price of plastic crates, delayed sale and lack of buyers. However, to meet the challenges of global quality and safety requirements, necessary steps should be taken throughout the value chain from *'farm to plate'* to maintain the quality and safety of fruits and vegetables to stay healthy and to be competitive both in the domestic and export markets.

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References

Affognon, H., Mutungi, C., Sanginga, P. and Borgemeister, C. 2015. Unpacking post-harvest losses in sub-Saharan Africa: A meta-analysis. *World Dev.* 66: 49–68. https://doi.org/10.1016/j.worlddev.2014.08.002

Bachmann, G.E., Segura, D.F., Devescovi, F., Juarez, M.L., Ruiz, M.J., Vera, M.T., and Cladera, J.L. 2015. Male sexual behavior and pheromone emission is enhanced by exposure to guava fruit volatiles in *Anastrepha fraterculus*. *PloS One*. 10(4): e0124250. https://doi.org/10.1371/journal.pone.0124250

Barrett, D.M., Beaulieu, J.C. and Shewfelt, R. 2010. Color, flavor, texture, and nutritional quality of fresh-cut fruits and vegetables: desirable levels, instrumental and sensory measurement, and the effects of processing. *Crit. Rev. Food Sci. Nutr.* 50: 369–389. https://doi.org/10.1080/10408391003626322

Damalas, C.A. and Eleftherohorinos, I.G. 2011. Pesticide exposure, safety issues, and risk assessment indicators. *Int. J. Environ. Res. Public Health*. 8: 1402–1419. https://doi.org/10.3390/ijerph8051402

Dhatt, A.S. and Mahajan, B.V.C. 2007. Horticulture Post-harvest Technology: harvesting, handling and storage of

horticultural crops. Punjab Horticultural Post-harvest Technology Centre, Punjab Agricultural University Campus, Ludhiana.

El-Ramady, H.R., Domokos-Szabolcsy, E., Abdalla, N.A., Taha, H.S. and Fari, M. 2015. Post-harvest management of fruits and vegetables storage. pp. 65–152. *In: Sustainable agriculture reviews*, New York, NY: Springer. https://doi.org/10.1007/978-3-319-09132-7_2

Esguerra, E.B., Rolle, R. and Rahman, M.A. 2016. Post-harvest management of tomato for quality and safety assurance, Extension Brochure. FAO Regional Office for Asia and the Pacific. Bangkok 10200, Thailand. 44p.

Francis, G., Gallone, A., Nychas, G., Sofos, J., Colelli, G., Amodio, M. and Spano, G. 2012. Factors affecting quality and safety of fresh-cut produce. *Crit. Rev. Food Sci. Nutr.* 52: 595–610. https://doi.org/10.1080/10408398.2010.503685

Hassan, M.K., Chowdhury, B.L.D and Akhter, N. 2010. Post-harvest loss assessment: a study to formulate policy for loss reduction of fruits and vegetables and socio-economic uplift of the stakeholders. National Food Policy Capacity Strengthening Programme, Final Report PR#8/08, Food Planning and Monitoring Unit, Ministry of Food. Government of the People's Republic of Bangladesh. 188p.

Hossain, M.A., Bokshi, A.I., McConchie, R., Islam, M.N., Rahman, M.A., Arfin, S. and Uddin, M. 2016. Survey on post-harvest losses of vegetables in two selected areas of Bangladesh. *Acta Hortic.* 1128: 237-242. https://doi.org/10.17660/ActaHortic.2016.1128.36

James, A. and Zikankuba, V. 2017. Post-harvest management of fruits and vegetables: A potential for reducing poverty, hidden hunger and malnutrition in sub-Sahara Africa. *Cogent Food Agric.* 3(1): 1312052. https://doi.org/10.1080/23311932.2017.1312052

Kaysar, M.I., Mia, M.S., Islam, M.S. and Kausar, A.K.M.G. 2016. Post-harvest loss assessment of brinjal in some selected areas of Bangladesh. *Int. J. Bus. Manag. Soc. Sci.* 02(02): 118–124. https://doi.org/10.18801/ijbmsr.020216.13

Khandpur, P. and Gogate, P.R. 2015. Effect of novel ultrasound-based processing on the nutrition quality of different fruit and vegetable juices. *Ultrason. Sonochem.* 27: 125–136. https://doi.org/10.1016/j.ultsonch.2015.05.008

Khatun, M. and Rahman, M.S. 2019. Quantifying post-harvest loss of brinjal: A farm level study in Bangladesh. *J. Bangladesh Agril. Univ.* 17(4): 454–460. https://doi.org/10.3329/jbau.v17i4.44605

Kiaya, V. 2014. Post-harvest losses and strategies to reduce them. New York, NY: Action Contre la Faim (ACF International). 25p.

Kitinoja, L. 2013. Innovative small-scale post-harvest technologies for reducing losses in horticultural crops. *Ethiop. J. Appl. Sci. Tech.* 1: 9–15.

Mahajan, P.V., Caleb, O.J., Singh, Z., Watkins, C.B. and Geyer, M. 2014. Post-harvest treatments of fresh produce. Philos. *Trans. R. Soc. A: Math. Phys. Eng. Sci.* 372: 20130309. https://doi.org/10.1098/rsta.2013.0309

Rahman, M.A., Islam, M., Begum, M.M. and Arfin, S. 2019. Technical and economic feasibility of improved post-harvest management practices in enhancing the eggplant value chain of Bangladesh. *Int. J. Agril. Res. Innov. Tech.* 9(2): 35-41. https://doi.org/10.3329/ijarit.v9i2.45408

Rapusas, R.S. and Rolle, R.S. 2009. Management of reusable plastic crates in fresh produce supply chains-a technical guide. FAO Regional Office for Asia and the Pacific, Thailand, 42p.

Rehman, A., Alam, M.W., Malik, A.U., Ali, H. and Sarfraz, B. 2015. Preharvest factors influencing the post-harvest disease development and fruit quality of mango. *J. Environ. Agric. Sci.* 3: 42–47.

Retta, A.N. and Berhe, D.H. 2015. Tomato leaf miner-*Tula absoluta* (Meyrick), a devastating pest of tomatoes in the highlands of Northren Ethiopia: A call for attention and action. *Res. J. Agril. Environ. Manage.* 4(6): 264-269.

Shetty, A.A., Magadum, S. and Managanvi, K. 2015. Vegetables as sources of antioxidants. *J. Food Nutr. Disor.* 2: 1–5.

Tapia, M., Gutierrez-Pacheco, M., Vazquez-Armenta, F., Aguilar, G.G., Zavala, J.A., Rahman, M.S. and Siddiqui, M.W. 2015. Washing, peeling and cutting of fresh-cut fruits and vegetables. pp. 57–78. *In: Minimally processed foods*, Springer. https://doi.org/10.1007/978-3-319-10677-9_4

Van Jaarsveld, P., Faber, M., van Heerden, I., Wenhold, F., van Rensburg, W.J. and van Averbeke, W. 2014. Nutrient content of eight African leafy vegetables and their potential contribution to dietary reference intakes. *J. Food Composit. Anal.* 33: 77–84. https://doi.org/10.1016/j.jfca.2013.11.003

Wadhwa, M., Bakshi, M. and Makkar, H. 2015. Wastes to worth: value added products from fruit and vegetable wastes. CAB International, Wallingford, United Kingdom. pp. 1–25. https://doi.org/10.1079/PAVSNNR201510043

WHO. 2018. Increasing fruit and vegetable consumption to reduce the risk of non-communicable diseases. World Health Organization, E-Library of Evidence for Nutrition Actions (eLENA) World Health Organization, Geneva, Switzerland.