

---

## **Factors Influencing on Perceived Post-Harvest Wastage of Vegetables and Fruit**

**Adhikari A. M. C. P.<sup>a\*</sup>, Herath H. M. T. S.<sup>b</sup>**

*<sup>a\*,b</sup> University of Kelaniya, Sri Lanka*

---

### **ABSTRACT**

The purpose of this study is to analyze the impact of transportation, packaging, excess supply, and a storage facility on perceived post-harvest wastage of vegetables and fruit in the Dambulla Dedicated Economic Center. This study adopted a quantitative research approach and thus, the study has addressed the survey type research method and a structured questionnaire was used to collect data and utilized a sample frame of farmers, whole-sellers, and retailers who enter the Dambulla Dedicated Economic Center and random sampling was used. To test the hypothesized relationships between the constructs, the multiple regression analysis was performed using SPSS 26.0 version. The results of the study discuss the 100% significant positive impact of transportation, 97% significant positive impact of packaging, 98% significant positive impact of a storage facility, and 99% significant positive impact of excess supply on post-harvest wastage of vegetables and fruit according to the Sri Lankan context. It is expected that the model will support the policymaking process regarding people keeping progress activities in economic centres and affecting increment of additional cost from farm to fork. This problem may affect families who depend on cultivation as well as final consumers who have to pay the additional cost. Therefore, ultimately this affects the development of Sri Lanka by increasing imports of the country. The unavailability of any mechanism to measure the number of people who visit the economic centre every day and there is a limitation of a proper mechanism to divide those people who visit the economic centre are farmers, wholesalers, or retailers. Through such policy implications, this study expects to eliminate the wastage of vegetables and fruit within the country and efficiently manage the wastage to utilize the country's resources well.

**Keywords:** Dambulla dedicated economic center, Excess supply, Packaging, Perceived post-harvest wastage, Sri Lanka

---

\* Corresponding author: amcpadhikari@gmail.com

## 1. Introduction

The post-harvest vegetable and fruit buying and selling system is the relationship between the processes of farm to fork. It means a combination of farmers, collectors, traders, distributors, customers, and facilitators that come together to sell and buy vegetables and fruit. When considering the process of farm to fork, there are different kinds of main functions like farming, delivering, packaging, warehousing, sharing information, pricing, etc. Due to the perishable nature of the vegetable and fruit, it has a high probability of damage and going to waste (Mattsson et al., 2018).

Around 80 different varieties of fruits and vegetables are grown in Sri Lanka's varied agro-climatic areas (Department of Agriculture Sri Lanka, 2022) and produce more than 1,019,000 and 2,962,000 metric tons of fruits and vegetables annually (Department of Agriculture Sri Lanka, 2022) and also exports 900,000 metric tons of both fresh and processed vegetables and fruits to any destinations in the world (Otto, 2022). In Sri Lanka, geographically cultivated vegetables and fruit are mainly and bulky distributed by using the dedicated economic centres to the wholesalers and retailers all around the Island. When considering dedicated economic centres in Sri Lanka there are 14 main dedicated economic centres islandwide (Dharmathilake et al., 2019). The first dedicated economics centre project was the Dambulla dedicated economic centre (DDEC) and it was established in 1999 with the vision of improving and encouraging the farmers in rural areas (Greshan & Kithsiri, 2022). DDEC is the main wholesale and retail vegetable and fruit distribution hub in Sri Lanka as well as the largest economic centre in Sri Lanka located in the centre of the country (Greshan & Kithsiri, 2022). It includes more than 150 stalls; the average volume of sales per week is 26,500 metric tons and the only economic centre that is working 24 hours in Sri Lanka (Greshan & Kithsiri, 2022).

When bearing in mind the entire planet approximately one-third of the comestible portion of the food made for human consumption is lost or wasted worldwide which is about 1.3 billion tons per year (food and agriculture organization of the United Nations, 2017). It was measured that the amount of food lost or wasted costs 2.6 trillion USD annually and it is more than enough to feed all the 815 million hungry people in the world, four times over (food and agriculture organization of the United Nations, 2017). Rendering to the FAO, high and low-income countries discard similar amounts of food around 670 and 630 million tonnes, respectively. However, there is a major difference in where and how that loss occurs. Food loss (that is, losses that occur before food reaches consumers) is more serious in developing countries while food waste (that is, losses that occur at the retail and consumer level) is more serious in developed countries (FAO, 2011). In developing countries, more than 40% of the vegetable and fruit loss occur at the post-harvest and processing level (food and agriculture organization of the United Nation, 2017). On average 30%-50% of what is produced is lost in the postharvest value chain of horticultural crops in developing countries before it reaches consumers (Kitinoja & Kader, 2015). Almost 95% of agricultural research investments go to the latter while there is very little investment in loss reduction (Kader & Rolle, 2004; Hodges et al., 2010).

Moreover, this study helps in identifying the factors influencing post-harvest wastage and how transportation, packaging, storage facility, and excess supply need to be implemented to reduce the loss or waste of the vegetables and fruits which can be used to fulfil the need of the people with insufficient nutrition. This research aims to benefit the farmers and final consumers. Food security means the situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (food and agriculture organization of the United

Nation, 2011). Food security is a worldwide concern at present and will remain a concern in the long term future. The world will need 70 to 100 per cent more food by 2050 (Godfray et al., 2010; Chakraborty & Newton, 2011). According to that, even though increased production; still, one in seven people suffers from insufficient nutrition (Godfray et al., 2010; Chakraborty & Newton, 2011). When it comes to Sri Lanka, 30 to 60% is the average food ratio, and the average daily kilocalories intake is around 2,200 (Dharmathilake et al., 2019). Therefore, it is important to concentrate on the country's food security in the future. National food security has to be handled with a combination of domestic food production and trade to ensure the country's food security in the future (Dharmathilake et al., 2019).

In Sri Lanka, there is no sufficient information about post-harvest wastage but it is estimated that more than 30% to 40% of wastage happens in Sri Lanka due to the lack of proper transportation, storage facilities, packaging systems, lack of information, and excess supply, etc (Minister of primary industry, 2017). In 2016, the article about vegetables and fruit wastage in DDEC was published in many newspapers that mentioned, "at the Dambulla economic centre, they had thrown away lakhs of worth vegetable to the Habarana forest" and also most of the farmers committed suicide because they could not sell their harvest and could not get sufficient income for their harvest (Minister of primary industry, 2017). In the recent past, DDEC faced a lot of problems with vegetable and fruit waste due to the COVID-19 pandemic and it was forecasted that around 40% of vegetables and fruit would waste and also it would differ from season to season (Greshan & Kithsiri, 2022). Despite vegetable and fruit wastage, people keep progress activities in economic centres which affects the increment of additional cost from farm to fork. This problem may affect families who depend on cultivation as well as final consumers who have to pay the additional cost. Therefore, ultimately this affects the development of Sri Lanka by increasing imports of the country. A possible cause of this problem is the cost and benefit of vegetables and fruit distribution (Greshan & Kithsiri, 2022). Perhaps a study, which investigates factors affecting post-harvesting wastage management by conducting a survey, could remedy the situation.

## **2. Literature review**

### **2.1. Post-harvest wastage of vegetables and fruit**

One of the theories related to post-harvest wastage of vegetables and fruits is the food supply chain theory (Negi, 2017). The food supply chain refers to the processes that describe how the vegetables and fruit on the farm end up on the table and involve processors such as production, processing, distribution, consumption, and disposal (Deif, 2016). Some other theories that can be involved in this study area are value chain analysis, cold chain logistics, etc. Value chain analysis refers to a process where a firm identifies its primary and support activities that add value to its final product and then analyzes these activities to reduce costs or increase differentiation (Minten, 2016). According to Zhang (2017), cold chain logistics refers to the cold chain that involves the transportation of temperature-sensitive products along a supply chain through thermal and refrigerated packaging methods and logistical planning to protect the integrity of these shipments. Moreover, some goods can be damaged by shockwaves while others can be damaged by excessive temperature variations (Zhang, 2017).

### **2.2. Transportation**

Hsiao et al., (2018) have done a study on last-mile distribution planning for the fruit-and-vegetable cold chain to formulate and solve a last-mile distribution plan problem with concerns regarding the quality of fruit and vegetable in the cold chain based on a heuristic approach. The study was done by conducting a survey in Taiwan, relying on two variables such as quality and

transportation of fruit and vegetable and states that a distribution plan including required fleet size, vehicle routing sequence, and quality level should be shifted out to account for the quality degradation during vehicle transportation (Alfiero, 2019). Those represented that there was a positive impact of transportation on wastage. Therefore, the following hypothesis can be derived.

**H1:** There is an impact of transportation on post-harvest wastage of vegetables and fruit.

### **2.3. Packaging**

In 2009, Sagheer et al., have conducted a theoretical study and the conclusion was that the framework comprises human and human components, human: national government, processors, and producers and non-human: Quality, regulatory scenarios. Negi (2017), has conducted similar research on wholesalers' perspectives on mango supply chain efficiency in India and stated that three factors were identified for high cost, namely, Operational Charges, Labour, and Resources, and four factors were identified for high lead time, namely, Operational issues, Labour, Resources, and Infrastructure, while four factors were identified for poor quality, namely, Operational issues, Infrastructure, Resources, and Poor Ambience. It was also found that the Operational factor was the most significant factor leading to supply chain inefficiency. Bansal, (2015) has conducted a study regarding waste disposal of fresh fruits and vegetables to evaluate consumers' latent need to serve society by participating in the "go green revolution" and contributing to proper disposal of waste and packaging of fruit and vegetables by consumer and retailer based on Consumer behaviour theory and corporate social responsibility. The main function of the packaging is to protect, facilitate handling, and communicate information about goods. In Sri Lanka, post-harvest wastage occurred due to overload in the packages and most of the time people used poly bags for the package of vegetables and fruit (consumer affairs authority, 2019). The above statement has emphasized that there was an impact and the hypothesis in the current study could be derived as below.

**H2:** There is an impact of packaging on post-harvest wastage of vegetables and fruit.

### **2.4. Storage facility**

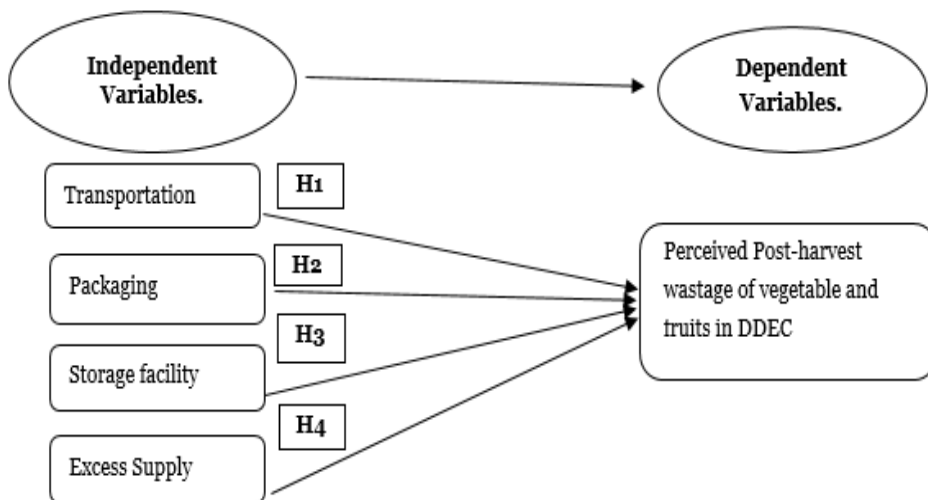
Osner in 1982 in the United Kingdom, has identified when and where food wastage occurs and discusses the way of reducing and utilizing waste and it stated wastage during storage, processing, distribution, and retailing and in consumption based on a theoretical view of the food supply chain analysis. However, it was concluded stating the greater the amount of food available, the higher the total waste. In 2016, Singh et al., have done research on packaging's role in sustainability: reusable plastic containers in the agricultural-food supply chains in organizing supply chain processes for sustainable innovation in the agri-food industry to explore the potential economic advantages and disadvantages of reusable plastic containers in the transport of press produce from growers to retail stores based on supply chain analysis TDABC analysis. In 2016, Minten has conducted research on wastage in food value chains in developing Countries which gathered evidence from the potato sector in Asia under food security in a food abundant world. After conducting a survey, in these countries, they have found that the total quantity of potato wastage is equal to 5.2% in the harvest period and 6.4% in the post-harvest period and the use of cold storage facilities can minimize the level of wastage (Minten, 2016). Thus, the above-mentioned studies have concluded that there was an impact of storage facility on wastage of fruit and vegetables.

**H3:** There is an impact of a storage facility on post-harvest wastage of vegetables and fruit.

## 2.5. Excess supply

Bonadonna et al., (2018) have done a study on farmer behaviour and perception regarding food waste and unsold food to analyze the farmer behaviour, considering their attitude towards food waste based on the food supply chain theoretical viewpoint. The survey has been conducted by using 35 farmers from the Porta Palazzo market, in Italy. However, it was stated that there is a high level of interest in the ethical and charitable aspects of food waste and unsold food. An identical study was conducted by Alfiero et al., (2019) regarding street food traders, farmers, and sustainable practices to reduce food waste in the Italian context to demonstrate how food waste management can affect both retail and distribution operators' performance and their ability to create value. In particular, optimizing food waste management characterizes best practices and favours the development of sustainability (Alfiero et al., 2019). Data envelopment analysis was used to evaluate the performance efficiency. Moreover, the results of this study state that farmers operate more efficiently than street food traders and that the traditional management of unsold food/food waste is an important competitive element in this sector. However, both of these studies were conducted in the same context and the same survey method was used to achieve the objectives. Those represented that there was a positive impact of transportation on wastage. Therefore, the hypothesis could be derived as below.

**H4:** There is an impact of excess supply on post-harvest wastage of vegetables and fruit.



**Figure 1: Conceptual Framework**

## 3. Methodology

### 3.1. Sample and data

The data for this study was collected at the individual level and ultimately it accessed the post-harvest wastage. The methodological approach of the study was quantitative and it used primary data to test the hypotheses. The sample of the study included only 105 people who entered the Dambulla Dedicated Economic Center to sell their vegetables and fruit. The reason for taking 100 people as the sample was based on prior literature which also used 100 to 300 samples since it was difficult to count the people who entered the DDEC day-to-day (Gunasekera, 2017). The

appropriate sampling technique was simple random sampling because that dedicated economic centre was full of people and a very busy place and it was difficult to divide the population exactly into farmers, retailers, or wholesalers. Therefore, the sample was selected from the individuals who enter the DDEC from 9 am to 4 pm. First, fifteen individuals who entered the DDEC every hour were selected as the sample. Accordingly, a total of 105 samples were selected for 7 hours. The sample consisted of all the parties as farmers, retailers, or wholesalers. The reason for selecting DDEC for conducting the study was Dambulla Dedicated Economic Center was the main hub of Sri Lanka for the other 13 Dedicated Economic Centers and that was the only Dedicated Economic Center, which is open for 24 hours.

### **3.2. Measurement of variables**

The current study consisted of five main constructs. Transportation, packaging, storage facility and excess supply were the main independent variables whereas the perceived post-harvest wastage was the only dependent variable of the study. In this study, all main independent variables were measured together to identify the post-harvest wastage in DDEC. All these variables were measured using a five-point Likert scale as originally proposed in the literature for each item, the respondent had to provide his/her level of agreement which ranged from 1= strongly disagree to 5= strongly agree (Dharmathilake et al., 2019).

### **3.3. Data analysis**

This study used both descriptive and inferential statistics for data analysis purposes. The main analytical technique used to test the said hypothesis was a regression model, a multivariate analysis. Further, multivariate analysis for hypotheses testing involves three steps such as assessing the measurement model through confirmatory factor analysis to assess how well-observed variables present the underline latent construction, assessing the direct effect on the relationship between transportation, packaging, storage facility, excess supply with the perceived post-harvest wastage of vegetables and fruits (H1 to H4). The data was analyzed using the software of Statistical Package for Social Sciences (SPSS).

### **3.4. Results and discussion**

Regression analysis was carried out to analyze the study and through SPSS 26 version, descriptive as well as inferential statistics were measured. Under inferential statistics, the study performed the tests regarding missing values at the very beginning and it resulted in zero missing values because the study considered the observations without missing values, and the observations with missing values were not considered when measuring the statistics. Then, the study considered the tests for outliers and there were no outliers found in the study which showed a better result. After running the tests for normality, it showed the normal distribution of the data set using the table as well as the histogram graphs and clearly showed the bell-shaped graph which represented the normal distribution clearly. Moreover, the Q-Q plot charts were also used to explain graphically the normal distribution of the data set. Then study performed the test for linearity which showed the linear relationship between variables and all the variables showed the linear relationship between each IV with the DV.

**Table 1: Tolerance & VIF Statistic**

Model	Collinearity Statistics	
	Tolerance	VIF
MEAN_TR	.880	1.136
MEAN_PA	.696	1.436
MEAN_SF	.725	1.380
MEAN_ES	.696	1.436

The dependent Variable is PPHW

After testing the multicollinearity of the study, it showed there was no correlation between the IVs', and tolerance and VIF were used to explain this further. The assumption of homoscedasticity of the study was accepted because of the equal variance which meant that the variance around the regression line was the same for all values of the predictor variable (X). The scatter plot showed it graphically for a clear understanding of the reader. Then the study measured the main hypotheses of the study and it showed the relationship between variables and the strength of the model. Perceived post-harvest wastage was carried out as the main dependent variable whereas transportation, packaging, storage capacity, and excess supply were considered independent variables.

**Table 2: Correlation**

		PPHW	Hypotheses
TR	Pearson Correlation	0.311	Accepted
	Sig.(2-tailed)	0.001	
	N	105	
PA	Pearson Correlation	0.306	Accepted
	Sig.(2-tailed)	0.001	
	N	105	
SF	Pearson Correlation	0.438	Accepted
	Sig.(2-tailed)	0.000	
	N	105	
ES	Pearson Correlation	0.245	Accepted
	Sig.(2-tailed)	0.012	
	N	105	

After conducting the analysis of the study, it showed moderate strength of relationships between the IVs of transportation, packaging and storage facility with the DV of perceived post-harvest wastage, and correlations were 0.311, 0.306, 0.438 respectively. The relationship between excess supply and the perceived post-harvest wastage was highly significant but showed a smaller correlation of 0.245. These were clarified as moderate and smaller correlations because the coefficients were below 0.5 (Moore, 2013). Therefore, it revealed the correlation for each IV with DV calculated and it showed a higher significance between each IV with the main DV with considerable correlation. The model summary showed the higher strength of the relationship between the model and the dependent variable which was more than 80%.

**Table 3: Model Summary Statistic**

Model	R	R Square	Adjusted Square	R Std. Error of the Estimate	Durbin-Watson
1	.914a	.836	.829	.22228	1.642

a. Predictors: (Constant), MEAN\_ES, MEAN\_TR, MEAN\_SF, MEAN\_PA

b. Dependent Variable: MEAN\_PPHW

**Table 4: ANOVA**

Model		Sum of Squares	of Df	Mean Square	F	Sig.
1	Regression	25.158	4	6.290	127.297	.000 <sup>b</sup>
	Residual	4.941	100	.049		
	Total	30.099	104			

a. Dependent Variable: MEAN\_PPHW

b. Predictors: (Constant), MEAN\_ES, MEAN\_TR, MEAN\_SF, MEAN\_PA

An analysis of variance (ANOVA) helped to examine the significant mean differences among more than two groups on an interval or ratio-scaled dependent variable and it showed 0.000 which represented a highly significant model. Moreover, the significance with each IV and DV showed lower than 0.05 level. Hence, the hypothesis H1 is accepted as there is a relationship between transportation and perceived post-harvest wastage with a 0.001 significant value. There is a relationship between packaging and perceived post-harvest wastage with a 0.001 significant value was the second hypothesis, hence the hypothesis H2 is accepted. There is a relationship between a storage facility and perceived post-harvest wastage with a 0.000 significant value, hence hypothesis H3 is accepted. There is a relationship between excess supply and perceived post-harvest wastage with a 0.012 significant value, hence hypothesis H4 is accepted.

Accordingly, the study yields the result that transportation, packaging and storage facility have a moderate relationship with perceived post-harvest wastage in DDEC whereas the excess supply has a smaller relationship with the perceived post-harvest wastage in DDEC. However, these factors are suitable to be considered, for a study conducted for the investigation of perceived post-harvest wastage since there is a significant relationship which showed the below 0.05 level.

When considering transportation with the perceived post-harvest wastage, previous literature shows some results which are similar to the result of the current study. A study conducted by Rakesh Raut and Bhaskar B. Gardas in 2017, concluded that transportation is a causal factor of post-harvest loss occurring in the Asian region. The results of the analysis highlighted that two factors, namely the non-availability of refrigerated vehicles, and excessive loading on the vehicles are the most significant barriers to sustainable transportation which are found to have the highest driving power. In 2018, a study conducted in Taiwan concluded that a distribution plan including required fleet size, vehicle routing sequence, and quality level should be shifted out to account for the quality degradation during vehicle transportation is generated (Hsiao, 2018). Therefore, it also concluded a similar result as the current study.

A separate study was conducted to promote on-farm and off-farm storage facilities and agro-processing technology. It focuses on the challenges of food availability and food insecurity in Africa and strategies for food security. When considering packaging, another study has been



conducted to explore the potential economic advantages and disadvantages of reusable plastic containers in the transport of press produce from growers to retail stores. The empirical investigation demonstrated that higher use of standardized packaging (RPCs) resulted in lower costs and reduced damage/waste. The results presented in this study are relevant to supply chains of similar products adopting RPCs within the same scope of the considered supply chain which explained the similar results in the current study. When concerning the excess supply empirical results, a study conducted in Italy conducting a survey of 35 farmers from Porta Palazzo market, has concluded that there is a high level of interest in the ethical and charitable aspects of food waste and unsold food which expresses the similar result to the current study. When considering the above-mentioned empirical results, each and every IV in the study has shown similar results to the current study.

#### **4. Conclusion & future direction**

When considering the final result of the research, transportation, packaging, storage facility, and excess supply positively impact the post-harvest wastage of vegetables and fruit and it creates big issues for farmers, wholesalers, retailers and customers as well as the entire economy of the country by increasing price and depression utilization level of the entire society. Based on this research, finally, some solutions have been identified for each and every variable. When considering transportation that wholesalers, farmers, and retailers used to come to DDEC, most of them used heavy vehicles such as lorries, trucks, tractors, etc and also they come from different provinces. Good transportation infrastructure should be developed around DDEC like controlling traffic jam, increasing parking facilities, building rest areas for drivers, and maintaining a better environment for the drivers and other people, increasing easy access to other services related to vehicles like service centre fuel stations and other regulatory facilities (Zhang, 2017). When discussing the packaging variable, it can be recommended to use environmental-friendly material such as wooden boxes, wooden baskets, coconut twig baskets and banana slices instead of ropes that help to maintain the moisture level of vegetables and fruit as well as can minimize the damages that may help to manage and reduce the wastage (Deif, 2016). The government encouraged farmers, retailers as well as wholesalers to use large size plastic boxes to package their products but most of them did not like to use them because of the higher cost, consumption of more space as well as difficulties in handling (Deif, 2016). However, that may help to manage and reduce wastage than the above-mentioned methods. Therefore, government should provide facilities and incentives to encourage suppliers to use these plastic boxes and policies should be implemented to ban releasing harmful material of packages into the environment and promote sustainable eco-friendly material for packaging in DDEC.

When considering a storage facility in DDEC, there were no proper ways to keep vegetables and fruit for more than one day. When the supplier brings their products to DDEC, they should sell these products on the same day because on the next day the new suppliers are coming. The reason is that there was no adequate capacity in DDEC to store vegetables and fruit. The cold storage facility will help to reduce the wastage of perishable products like upcountry vegetables and fruit than low-country vegetables and fruit (Zhang, 2017). Therefore, the government should allocate the capacities for storage in DDEC as well as the expansion of available stores. Adequate refrigeration equipment is needed to control the humidity and temperature level in DDEC to protect vegetables and fruit. Workshops and training programmes need to be conducted to increase awareness regarding the storage condition of various vegetables and fruit to suppliers as well as the effect on the handling of vegetables and fruits (Adeyeye, 2017). When the excess supply is the main problem that suppliers, as well as management, face every day because of the fluctuation of suppliers as well as customers who come to DDEC per

day. To manage the excess supply of vegetables and fruit, the perishable goods can be used as animal feeds, the government can promote biomass plantation by using the wastage of vegetables and fruit, then it may be an economical benefit to people as well as the entire country (Panghal, 2018). Complementary industries are essential to take benefit from the damaged vegetables and fruit such as jam, juice, source, etc. Also, government or DDEC can promote damaged vegetables to be used as organic fertilizers or to produce organic fertilizer as a business and it can be sold for a low price to farmers then can gain extra income through wastage (Bonadonna, 2018). Using organic fertilizer may help to protect human health also and can increase productivity as well as can reduce cost (Mishra, 2017). The government can conduct awareness programmes for farmers as well as suppliers regarding techniques that can be used during the seasons as well as any other weather conditions and also government can encourage an export-oriented environment to find customers from other countries and give facilities to enter the international market then excess supply did not become as wastage (Bansal, 2015). The current study identifies the factors by relying on empirical studies and then identifies the quantitative impact of the factors on perceived post-harvest wastage. Therefore, the results show that this is a critical issue and more studies should be conducted in the future to figure out qualitative influences for each and every variable in depth.

Therefore, according to the current study, transportation, packaging, storage facility and excess supply have significant importance. For a researcher who is going to conduct this type of research, these four independent variables can be taken into consideration along with the other relevant factors which impact perceived post-harvest wastage such as information and communication, geographical location, supply chain management, regional collectors, prices of the vegetables and fruit.

## References

- Adeyeye, S. A. (2017). The role of food processing and appropriate storage technologies in ensuring food security and food availability in Africa. *Nutrition & Food Science*, 47(1).
- Alessandro Bonadonna, A. M. (2018). Farmer behavior and perception regarding food waste and unsold food. *British Food Journal*.
- Alfiero, S. C. (2019). Street food traders, farmers and sustainable practice to reduce food waste in the Italian context. *British Food Journal*, 122(5), 1361-1380.
- Anil Panghal, D. Y. (2018). Post-harvest malpractices in fresh fruits and vegetables: Food safety and health issues in India. *Nutrition & Food Science*.
- Ashok K. Mishra, A. (2017). Assessing food security in rural Bangladesh: The role of a nonfarm economy. In *World Agricultural Resources and Food Securit.*, 241-257.
- Bansal, S. R. (2015). Waste disposal of fresh fruits and vegetables. *Management of Environmental Quality: An International Journal*, 26(5), 721 - 738.
- Bart Minten, T. R. (2016). *Wastage in food value chains in developing countries: Evidence from the potato sector in Asia*. 225-238.
- Batt, N. C. (2015). Consumer perceptions of food quality in Malaysia . *British Food Journal*, 117(3), 1168 - 1187.
- Bhatnagar, A. V. (2019). Multi-criteria clustering analytics for agro-based perishables in cold-chain. *Journal of Advances in Management Research*, 16(4), 563-593.
- Consumer Affairs Authority. (2019). Retrieved 26 June 2022, from <http://caa.gov.lk/>
- Dharmathilake, N.R.D.S., Rosairo, H.S.R., Ayoni, V.D.N., Herath, R.M., (2019). Implications of post-harvest losses and acreage response of selected up-country vegetables from Nuwara-Eliya district in Sri Lanka on sustained food security. *The Journal of Agricultural Sciences - Sri Lanka*, 88-100.

- Deif, J. S. (2016). Packaging's role in sustainability: Reusable plastic containers in the agricultural-food supply chains. *Organizing Supply Chain Processes for Sustainable Innovation in the Agri-Food Industry*.
- Department of Agriculture Sri Lanka (2022). Retrieved 24 June 2022, from <https://doa.gov.lk>
- Don Gunasekera, H. P. (2017). Post-harvest loss reduction in Asia-Pacific developing economies. *Journal of Agribusiness in Developing and Emerging Economies*, 7(3), 303-317.
- E, B. M. (14 Jan 2016). Wastage in food value chains in developing countries: Evidence from the potato sector in Asia. *In Food Security in a Food Abundant World*.
- Greshan, P., & Kithsiri, V. (2022). Perspectives of the farmers on collection of vegetables at Dambulla dedicated economic center in Sri Lanka. *International Journal of Scientific Research And Management*, 9(12), 2826-2833. doi: 10.18535/ijstrm/v9i12.em11
- Hao Zhang, B. Q. (2017). A new risk assessment model for agricultural products cold chain logistics. *Industrial Management & Data Systems*, 117(9), 1800-1816.
- Japan International Cooperation Agency System Science Consultants Inc. (2013). *Democratic socialist republic of Sri Lanka data collection survey on agricultural distribution network and marketing final report march 2013*.
- Koester, U. (2017). Food loss and waste as an economic and policy problem. *In World Agricultural Resources and Food Security*, 275-288.
- Linhai Wu, Q. H. (2017). Empirical analysis of the main factors influencing rice harvest losses based on sampling survey data of ten provinces in China. *China Agricultural Economic Review*, 9(2), 287-302.
- Mark Otto, a. (2022). EDB E-Service Portal. Retrieved 24 June 2022, from <https://www.edb.gov.lk>
- Mattsson, L., Williams, H., & Berghel, J. (2018). Waste of fresh fruit and vegetables at retailers in Sweden: Measuring and calculation of mass, economic cost and climate impact. *Resources, Conservation and Recycling*, 130, 118-126. doi: 10.1016/j.resconrec.2017.10.037
- Mu-Chen Chen, (2018). Optimal consolidation of fresh agricultural products in a multi-temperature joint distribution system. *The International Journal of Logistics Management*.
- Mu-Chen Chen, K. (2018). *Last-mile distribution planning for fruit-and-vegetable cold chains*.
- Rakesh Raut, B. B. (2017). Sustainable logistics barriers of fruits and vegetables: An interpretive structural modeling approach. *Benchmarking: An International Journal*.
- Sagheer S, Y. S. (2009). Developing a conceptual framework for assessing competitiveness of India's agrifood chain. *International Journal of Emerging Markets*, 4(2), 137-159.
- Saurav Negi, N. A. (2018). Wholesalers perspectives on mango supply chain efficiency in India. *Journal of Agribusiness in Developing and Emerging Economies*.
- Shriniwas Gautam, A. L. (2016). Volume and value of postharvest losses: The case of tomatoes in Nepal. *British Food Journal*.
- Shriniwas Gautam, A. L. (2017). Volume and value of post harvest losses: The case of tomatoes in Nepal. *British Food Journal*, 2547-2558.
- Srikanta Routroy, A. B. (2016). Agriculture supply chain: A systematic review of literature and implications for future research. *Agribusiness in Developing and Emerging Economies*.
- Srikanta Routroy, A. B. (n.d.). Agriculture supply chain: A systematic review of literature and implications for future research. *Journal of Agribusiness in Developing and Emerging Economies*.
- World Resources Institute. (2019). Retrieved 21 June 2019, from <https://www.wri.org/>

- Yu-Hsiang Hsiao, M.(2018). Last-mile distribution planning for fruit-and-vegetable cold chains. *The International Journal of Logistics Management*.
- Zhangyue Zhou. (2010). Achieving food security in China: Past three decades and beyond. *China Agricultural Economic Review*, 2(3), 251 – 2 .