

Postharvest Loss of Carrots: The Case of Benguet, Philippines

Ma. Cecilia R. Antolin¹, Edgar D. Flores² Cesar F. Neric³, Kenji David S. Estigoy⁴, Marvin S. Estimada⁵

^{1,2,3,4,5}Philippine Center for Postharvest Development and Mechanization (PhilMech)
CLSU Compound, Science City of Muñoz, Nueva Ecija, Philippines, 3120
Email address: macecilereyes@yahoo.com

Abstract— This paper examines the postharvest handling system of carrot and associated losses in the Benguet province. The study adopted the value chain analysis framework to have an in-depth understanding on the postharvest handling system, identify the key value chain actors, major market channels and assess both qualitative and quantitative losses from the farm to the retail market. The research employed a combination of survey methods, focus group discussions (FGD), key informant interviews (KII), case analysis, and literature searches to gather necessary primary and secondary data. Quantitative loss was determined through direct measurement of physical losses, while qualitative loss was evaluated using visual quality rating (VQR) based on an established quality profile (QP). The study was conducted in Benguet. Postproduction handling practices consisted of harvesting, hauling to the nearest barangay road and cleaning or washing before it is marketed. Postharvest losses from farm to market which is Barangay Catubong, Buguias to Benguet Trading Post were measured. Postharvest losses after harvest totaled 0.97 percent and after one (1) day, losses of 1.89 percent incurred which all emanated from weight loss, spillages and mechanical damages. After five to six days, the total losses at the wholesalers/retailers level were 35.4 percent due to post-harvest defects, physiological, pathogen and mechanical damages. After seven to eight days, the total losses were about 44.55 percent. Postharvest losses were particularly noticeable at the wholesaler-retailer level, where the causes of defects became evident.

Keywords— Carrots, value chain analysis, postharvest handling system, postharvest losses.

I. INTRODUCTION

Carrot (*Daucus carot* L.) is a crop primarily cultivated for their fleshy root, which is consumed as a vegetable. The root is noted for its richness in carotene, a precursor to Vitamin A, as well as containing notable amounts of thiamine, riboflavin, and sugar (Nastor and Reyes, 2003). Carrots have been said to promote resistance to blood and eye disorders due to their healthful and nutritional content (Hassan et al., 2005). The total area planted to carrots in the Philippines was 4,822.49 hectares with total production of 59,979.07 MT in 2023. The top producing region is Cordillera Administrative Region contributing 87.7 percent of the total production in the country. Benguet is the major producing province of carrot in the Philippines contributing 82 percent of the total production in the country (psa.gov.ph).

Carrot is one of the high value crops identified by the Department of Agriculture. High-value crops contribute significantly to the country's growth and development.

Around 24 percent of the country's labor forces are employed in the agriculture, forestry and fishery sector (NEDA Report, 2019). The government is pursuing to modernize the sector with the objectives of increasing productivity, ensuring food security and enhancing the well-being of farmers who are reliant on it. Addressing food losses offers a chance to bolster food security, curb wastage, and boost profitability in the production sector (Pera, T et al, 2023). Minimizing postharvest food losses inherently fosters sustainability. Waste reduction of already harvested food is a more sustainable approach than increasing production to offset postharvest losses (Goletti F and Wolf C., 1999). The financial gains from reducing postharvest loss become more significant as the value of the harvested commodity increases (Kaiya, 2014).

The estimated fruits and vegetables losses are around 27-42 percent (PSA, 2012). In the realm of agriculture, staying abreast with updated information regarding postharvest losses and its postharvest handling practices are pivotal in agricultural development. The effective interventions aimed at reducing postharvest losses necessitate access to comprehensive and detailed information.

This paper aimed to determine the postharvest handling system; and the magnitude and causes of losses from farm to market.

II. METHODOLOGY

The value chain approach was used as a guide in the conduct of study. The key players involved are producers/farmers, input suppliers, wholesaler, retailers, processors and consumers. Value chain refers to series of primary and support activities performed by an enterprise to transform inputs into value added outputs for its external consumers (Porter, 1985). It also refers to the different activities and services that are needed to bring products or services from the production to sale or final markets whether it is local, national, international or global.

A. Description of study area and time of study

Benguet is the major carrot producing province in the Philippines. The average area planted to carrot from 2015-2021 was 4,545 hectares with a production of 64939.75 MT (psa.gov.ph). The major growing areas of carrots in Benguet are Buguias and Atok. Buguias is the most prominent producer of high vegetables in Benguet. With 21,279 hectares,

Buguias is the fifth largest in all the province of Benguet. Majority of the inhabitants of Buguias are farmers making terraces on the mountainside for vegetable production. Commonly produced crops include lettuce, cabbage, potatoes, chinese cabbage, carrots, onion sleeks, cauliflower and broccoli. These vegetables find their way at the La Trinidad Trading Post and marketed to Manila and other urban centers of the country (philmech.gov.ph). The study was conducted in 2017-2020.

B. Framework of the study

Figure 1 shows the research framework of the study. The inputs of the study were gathered from primary and secondary data. The information on postharvest handling practices, value chain actors, specific roles, market flow, postharvest losses, strengths and weaknesses of the system were established using primary data. Primary data were gathered through the conduct of survey through focus group discussion (FGD) key informant interview (KII), actual loss assessment. Tracing method was also adapted to determine the major postharvest handling systems and stakeholders in the supply chain of carrots. The outputs of the project are information on systems of postharvest handling and level of postharvest losses of harvest per activity. Secondary data were gathered through desk research.

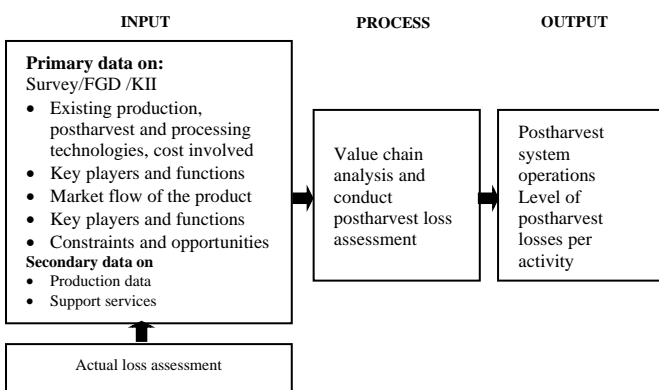


Figure 1. Framework of the study

C. Postharvest loss measurement

Postharvest losses were determined by quantitative and quality loss measurement. Quantitative loss is defined as the physical loss caused by reduction in product weight and volume. Quality loss is determined through visual quality rating and quality profile. The method and formulas used in the loss assessment was partly adopted from Ramos et.al (2009) and Maranan et al (1996).

The actual operations from production areas to the market were observed and noted. The following data were gathered during the conduct of the study: a) the initial/final condition and weight of the crop measured and assessed at the farm/market level; b) the final weight and c) quantitative and qualitative losses. Data on farm management practices and postharvest handling of the farmer-cooperators were also obtained.

Qualitative losses

Visual quality rating and quality profile were used in determining the quality loss. Visual quality rating (VQR) refers to the physical attributes of the commodity as affected by handling or mechanical damage during harvest and handling operations. The evaluations of the losses in quality were performed at the determined points of the commodity flow. For every sample, 5 to 10 percent of the total weight of fruits per container was subjected to the rating. Quality evaluation of the samples was performed by two to four trained researchers then average rating of samples was computed. The VQR scale used for actual handling trials was set based on the pre-identified defect types of carrots and quality standards of buyers, and consumers (Table 1).

TABLE 1. Scale used in visual quality rating (VQR) of carrot samples

Scale	Description
5	Excellent condition, fresh, no defects
4	Fair, with moderate or small defects (small lesions, cuts, dents or stains)
3	Minimum level of marketability (5 to 10% physical & physiological damaged)
2	Minimum level of edibility (11 to 20% physical damaged and/or visible pathogen damaged)
1	Non-edible (>20% physical and physiological damaged)

Quality profiling

Quality profile (QP) is a method of evaluation where the general quality of the produce is described by its frequency or percentage of defects or damage present. The degree, extent or description of the quality defects or damage (e.g. bruises, compressions, rotting) were defined and agreed by the trained evaluator. Table 2 shows the quality traits used in quality profiling.

TABLE 2. Quality traits used in describing quality profile (QP) of carrots

Pre-harvest	Postharvest		
	Mechanical Damage	Pathogen damage	Physiological defects
-Cracked	-Deep dents	-Soft rot	-Root splitting
-Insect damaged	-Compression damage	-Wilting	-Cavity spot
-Green spot	-Bruise	-Signs of disease due to mechanical damage	-Elongated roots-fork like structure
-Carrot disease infestation	-Puncture		
-Soft rot	-Cut		
	-Cracked		

Source: PNS/BAFPS38.2006

Quantitative losses

Quantitative loss referred to as physical loss caused by a reduction in product weight. The following formulas were used in the calculation of the different types of losses in the supply chain.

Pre-harvest losses (%PHL) refer losses to that are due to natural causes such as genetic, nutrient, cultural management and other environmental factors. This also includes pest and diseases at farm level of infestation.

$$\%PHL = \frac{wt.PHL}{Total.yield+wt.of PHL} \tag{1}$$

Harvesting and sorting loss are good marketable fruits that are left in the field ground during harvesting or fruits that are

accidentally thrown off as rejects but are marketable during sorting.

$$\% \text{Harv. loss} = \frac{\text{wt.of harvesting loss}}{\text{wt.of marketable fruits}} \quad (2)$$

$$\% \text{Sort. loss} = \frac{\text{wt.of sorting loss}}{\text{wt.of marketable fruits}} \quad (3)$$

Weight loss refers to losses that are due to transpiration and spillage.

$$\% \text{wt. loss} = \frac{\text{weightInitial} - \text{weightFinal}}{\text{weightInitial}} \quad (4)$$

Non-Marketable Rejects are fruits with physical and physiological defects that are removed during sorting and are not saleable.

$$\% \text{non - mktble.} = \frac{\text{Wt.of rejects}}{\text{weightInitial}} \quad (5)$$

Marketable rejects fruits that have market value and sold at a lower price due to minor defects.

$$\% \text{Marketable rejects} = \frac{\text{Wt.of mktble.rejects}}{\text{weightInitial}} \quad (6)$$

Physiological defects are due to unfavorable change in color or ripeness.

$$\% \text{Phys.defects} = \frac{\text{Wt.of phys.defects}}{\text{WeightInitial}} \quad (7)$$

System/handling Loss is the total loss incurred from harvesting down to retailers area.

$$\% \text{System loss} = \frac{\sum \text{Losses(start to end)}}{\text{Volume(start)}} \times 10 \quad (8)$$

III. RESULTS AND DISCUSSION

A. Postproduction Practices

Most of the farmers use maturity days of the carrots as an indicator when the carrot are ready for harvest. Maturity period is 100 to 120 days after planting. Maturity of carrots also depends on the variety planted, there are varieties that can be harvested 90 days after planting and others reach maturity at 120 days after planting. When carrots are already 9 to 15 cm they are ready for harvest.

Harvesting. Farmers harvested carrots between 5:00 a.m. to 8:00 a.m. Carrots are individually pulled by bare hands while others use stick to dig the soil and carrots are being uprooted. They harvest early in the morning to maintain the moisture of carrots.

Hauling. Harvested carrots are placed in wooden crates or clean sack. It is immediately prepared for delivery to trading post or market because it is perishable. The most common mode of transporting the produce from farm to the market is by means of jeepneys or if the harvest is plenty the consolidator provides truck. Hauling vehicle is park beside the farm for easy hauling.

Cleaning. Cleaning of carrot is done by soaking the carrots on a plastic drum, brushing it one by one to remove soil and other dirt on carrots. They are being dried after putting to transparent plastic. In some areas of Benguet detopping of leaves are practiced.

B. Major players of the industry and its functions

The roles of the different key players are vital in the development of carrot industry. Hereunder are their respective functions and activities:

Farmers. They are engaged in carrot production. They source-out funds for the purchase of seeds, fertilizers and pesticides,

care and maintenance of the crop. Facilitates and pays for harvesting, sorting and hauling and delivery of produce.

Input Suppliers. They supply seeds, fertilizers, pesticides and plastic mulch. Some of the input suppliers are seed companies, agri-input suppliers, traders and farmers associations.

Financers. They provide inputs to the farmers. They buy the produce or negotiate with wholesaler. They are supported by traders and banks for their working capital.

Agent/Middlemen. They purchase and/or procure carrots from trader/consolidators. They arrange hauling and transportation of carrots. They receive payments and incentives from wholesalers. They pay for communication expenses.

Traders. They provide financial support to farmers and engage in buying and selling of carrots.

Wholesaler - retailer. They pick carrots at delivery points/trading post. They hire laborers to sort and wash carrots every day or when necessary. They sell carrots and other highland vegetables to retailers and to provincial traders.

Retailers. They purchase carrots from wholesaler or “bodegeros”. They rent stalls in local markets.

Service providers. They provide trucking services.

Consumers. They purchase fresh carrots from local market retailers.

C. Flow of carrots from farm to final market

There are two trading posts in Benguet, Benguet Agri Pinoy Trading Center (BAPTC) and La Trinidad Vegetable Trading Posts (LTVTP). The LTVTP was established in 1980 and serves as area for business transactions for farmers and traders. The BAPTC was established in 2015 and was funded by DA’s Agri-Pinoy Trading Center. It was established to make farmers trade oriented.

Most of the carrots owned by the farmers interviewed were traded in La Trinidad Vegetable Trading Post, There are four major players involved in marketing carrots namely: 1) farmer-traders; 2) traders-wholesaler; 3) wholesaler-retailer; and 4) retailers.

Figure 2 shows the flow of carrots from farm to market. Farmers sold 100 percent of their produce to wholesalers based in La Trinidad Vegetable Trading Post. Wholesaler sold 80 percent of carrots purchased to traders operating in different major markets in Metro Manila (Balintawak -40%, Makati-38% and Divisoria- 14% and Urdaneta, Pangasinan-8%) while the remaining 20 percent were retained in the local market/retailers within the trading post. Marketing transaction starts at 5:30 AM and ends at 3:00 PM.

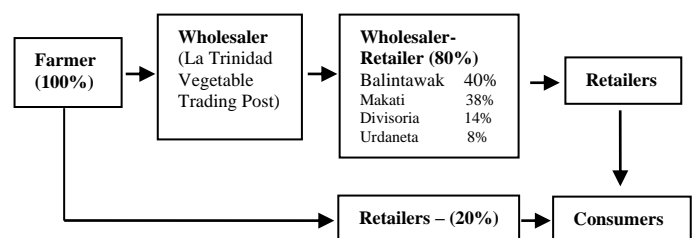


Figure 2. Market flow of carrots produced in Benguet, 2020
Sources: FGD and KII among wholesalers, retailers and traders, 2020

D. Loss Assessment

Loss assessment for carrot was conducted last November 13-22, 2019 in Barangay Catlubong, Buguias. The variety of the carrots harvested by the farmer-cooperator was Terracotta. The postharvest operations from the farm to market were observed and documented.

Twelve wooden baskets of carrots that contained 20-22 kilograms were randomly collected, weighed and tagged as samples. Two kilogram which is nine pieces of carrots for samples per basket was marked for visual quality rating (VQR) and quality profiling (QP). The carrots were transported from Buguias to La Trinidad Vegetable Trading, La Trinidad Benguet on November 14. On the following day, carrots were delivered to Balintawak, one of the major markets in Metro Manila.

Quantitative Losses

Table 3 shows the losses from farm (Barangay Catlubong Buguias) to market (Balintawak). Postharvest losses after harvest totaled 0.97 percent and after one (1) day, losses of 1.89 percent incurred which all emanated from weight loss, spillages and mechanical damages. After five to six days, the total losses at the wholesalers/retailers level were 35.4 percent due to post-harvest defects, physiological, pathogen and mechanical damages. After seven to eight days, the total loss was about 44.55 percent.

TABLE 3. Summary of postharvest losses at different stages in the supply chain of carrots, Benguet, 2019

Stages and activities	Type of Loss	Days after harvest	% Loss
Pre harvest and postharvest losses	.		
1. Farmer level of losses due	Over-mature, etc.		
• Harvesting	Transpiration/spillage/ uncollected fruits		
• Sorting and packing	Transpiration/spillage		
• Transportation	Transpiration/spillage/mechanical damages	0.5	0.97
Postharvest losses at farmer level to consolidator			
2. Consolidator/ trader level losses due to			
• Marketing & transportation: Consolidator to wholesaler	Transpiration/spillage/mechanical damages	1	1.89
Postharvest losses from consolidator to wholesaler			
3. Wholesaler-retailer level losses due		5-6 days	
• Re-sorting (washing)	Physiological defects	0.5	6.29
• Wholesale-retailer	Postharvest defects	5.5	15.9
	Pathogen defects	5.5	13.6
	Mechanical damage	5.5	5.8
Postharvest loss at wholesale level			35.4
Total quality defects (rejects)		7-8 days in storage/ retail	44.55

Qualitative losses

To determine the specific causes of losses, VQR and QP were done. Majority of the defects observed caused by mechanical and pathogen damages. The average rating score at the first day was 4.78 and dropped to 1.66 on the 9th day. Postharvest defects were high at first and second day. Mechanical and pathological defects exhibited high losses from fourth to ninth day, as shown in Table 4 and described in Figure 3.

TABLE 4. Visual quality rating and quality profiling, Buguias to Balintawak, 2019

Defects (%)	Day								
	1	2	3	4	5	6	7	8	9
Postharvest defects	17.59	31.48	-	0.93	-	-	-	-	-
Bruise	2.78	1.85	9.26	22.2	7.08	3.70	-	-	-
Cut	19.44	20.37	2.78	-	8.85	-	-	-	-
Mechanic cut	-	-	32.41	9.26	4.42	-	-	-	-
Mechanical bruise	-	-	-	2.78	-	-	-	-	-
Removed leaves	-	-	4.63	-	0.88	-	-	-	-
Rot	-	-	-	3.70	21.24	4.63	0.93	15.74	2.78
soft	-	-	-	0.93	57.52	13.89	-	8.33	-
Average VQR	4.78	4.68	4.39	4.18	3.85	3.55	2.83	1.85	1.66

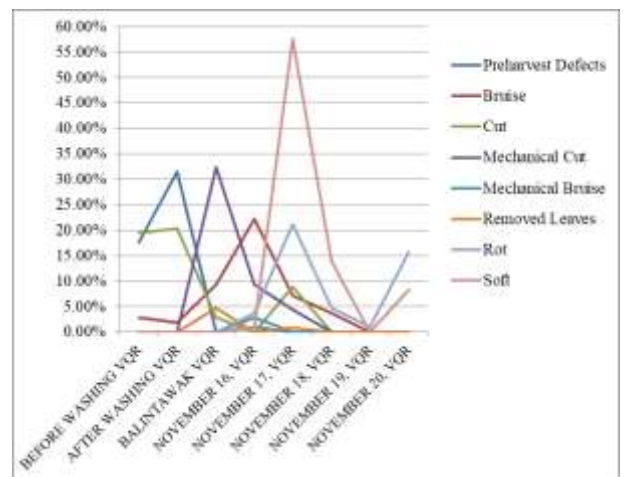


Figure 3. Visual quality rating and quality profiling

IV. CONCLUSION AND RECOMMEDATION

Carrot is one of the high value crops identified by the Department of Agriculture. The carrot industry is faced with challenges such as high postharvest losses, continuous increase in the cost of inputs, high incidence of pest and diseases, short shelf-life of carrots and low buying price especially during peak season.

Carrots are harvested early in the morning at around 5:00 a.m. to 8:00 a.m. This process is primarily carried out manually, with individuals using their bare hands to carefully uproot the carrots from the soil. Some farm laborers utilize sticks or tools to aid in digging around the carrots and facilitating their removal from the ground. The harvested carrots are placed in wooden crates or clean sacks and delivered to the local consolidating area. At this location, carrots are washed and placed in polyethylene bags. Packed

carrots are delivered to Balintawak and Divisoria market in Metro Manila.

Given this practice, postharvest losses totaled 0.97 percent immediately after harvest. On the first day, losses increased to 1.89 percent, attributed to weight loss, spillage, and mechanical damage. At day 5-6, losses at the wholesalers' and retailers' level reached 35.4 percent due to postharvest defects, physiological issues, pathogens, and mechanical damage. After seven to eight days, total losses were around 44.55 percent.

The following measures are recommended to reduce losses: a) implementation of good agricultural practices (GAP) to prevent or minimize pest and disease attacks; b) conduct of training courses and seminars focused on promoting good agricultural practices and integrated pest management (IPM) strategies among farmers; c) provision of adequate storage facilities such as refrigerated storage to maintain the quality and freshness of harvested carrots; d) proper storage conditions can help prevent spoilage and extend the shelf life of the produce; and d) conduct of seminars and training sessions on carrot processing techniques to farmers and stakeholders. These measures can enhance the quality of carrots and promote sustainable practices within the agricultural sector.

REFERENCES

- [1] Baron, J and Stein C. (2017), Mapping Actors along Value Chains: Integrating Visual Network Research and Participatory Statistics into Value Chain Analysis. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Research Program on Water, Land and Ecosystems (WLE). 24p. (WLE Research for Development (R4D) Learning Series 5). doi: 10.5337/2017.216
- [2] Expanding Economic Opportunities in Agriculture, Forestry, and Fisheries. (2019) Retrieved from: <https://neda.gov.ph/wp-content/uploads/2019/07/SER-Chapter-08.pdf>
- [3] Goletti F and Wolf C. (1999). The Impact of Postharvest Research. MSS Discussion Paper No. 29. Retrieved from: <https://core.ac.uk/download/pdf/6242073.pdf>
- [4] Hassan I. Bakhsh K. Salik M.H. Khalil M.And Ahmad N. 2005: Determination of factors contributing towards the yield of carrot in Faisalabad (Pakistan). *International Journal of Agriculture and Biology*. 7: 323-324.
- [5] Kiaya, V (2014). Post-harvest Losses and Strategies to Reduce Them. Retrieved from: https://www.actioncontrelafaim.org/wp-content/uploads/2018/01/technical_paper_phl_.pdf
- [6] Maranan, C.L. R.R. Paz, and R.S. Rapusas. 1996. National postproduction loss assessment for rice and corn. Science City of Muñoz, Nueva Ecija: Bureau of Postharvest, Research and Extension
- [7] Nastor, J. and V. Reyes, 2003: Carrot Production Guide. Department of Agriculture; Bureau of Plant Industry. <https://library.buplant.da.gov.ph/images/1638346445Carrot%20Production%20Guide.pdf>
- [8] NEDA report: Expanding Economic Opportunities in Agriculture, Forestry, and Fisheries. (2019) <https://neda.gov.ph/wp-content/uploads/2019/07/SER-Chapter-08.pdf>
- [9] Pera T, F. Rocha, and J. Filho (2023). Tracking Food Supply Chain Postharvest Losses on a Global Scale: The Development of the Postharvest Loss Information System. Special Issue Recent Innovations in Post-harvest Preservation and Protection of Agricultural Products—Series II). Retrieved from <https://www.mdpi.com/2077-0472/13/10/1990>
- [10] Philippine National Standard PNS/BAFPS 38:2006 Fresh vegetables – Carrots (*Daucus carota* L.) – Specification. Bureau of Agriculture and Fisheries Product Standards (BAFPS). https://bafps.da.gov.ph/bafps_admin/admin_page/pns_file/2022-10-20-Fresh%20vegetable-Carrots-
- [11] PSA [Philippine Statistics Authority]. 2023 OpenSTAT-Agriculture, Forestry, Fisheries Database. Available at: <http://openstat.psa.gov.ph>
- [12] PSA (Philippine Statistics Authority), 2012. Overview of Philippine Agriculture. <http://www.psa.gov.ph> accessed June 29, 2015.
- [13] PORTER, M.E. 1985. *The Competitive Advantage: Creating and Sustaining Superior Performance*. NY: Free Press.
- [14] RAMOS MA. E. et al (2009) Qualitative and Quantitative Loss Assessment of Selected High Value Food Crops, Bureau of Postharvest Research and Extension, Department of Agriculture
- [15] VAN DEN BERG, L. and LENTZ, C.P. 1973. High humidity storage of carrots, parsnips, rutabagas and cabbage. *Journal of the American Society for Horticultural Science* 98: 129–132.