

# Supply Chain Mapping and Postharvest Losses of Cabbage in Traditional and Modern Chains in Cebu, Philippines

Leif Marvin R. Gonzales, Maita L. Aban, and Antonio L. Acedo Jr.

**Abstract**—Assessing postharvest losses of fresh produce provides benchmark information for determining loss reduction interventions to increase profitability and competitiveness of farming and marketing ventures. This study was conducted to map the supply chain and determine losses from the farm to wet markets (traditional chain) and to supermarket (modern chain) of cabbages produced in Cebu, Philippines. In both chains, farmers dealt with commission agents of wholesalers at the trading post that covered the vegetable-producing areas within the municipality. From the trading post, wholesalers in the traditional chain brought the cabbages to the biggest wholesale-retail markets in Cebu City, about 60 km away. City market wholesalers disposed the produce to retailers within the market or to retailers in other provinces. In the modern chain, wholesalers brought the cabbages directly to supermarkets in the city. Postharvest losses did not differ much between the two chains (26-27%) but losses of farmers in the modern chain (13.2%) were higher due to more product rejection and trimmings to meet the more stringent quality requirements than that in the traditional chain (10%). In contrast, retailers in the traditional chain incurred higher losses (10%) than in supermarkets (7.2%). Wholesalers in both chains had losses ranging from 6-7%. Losses were mainly due to insect damage and rotting at the farm level and additionally, weight loss and physical damage at the wholesale and retail levels. Poor packaging and handling and lack of techniques were major reasons for loss in both chains. Also, retailers in traditional chain recognized high temperature and humid condition as leading causes of loss.

**Keywords**—Cabbage, postharvest loss, supply chain mapping, traditional and modern supply chain

## I. INTRODUCTION

**V**EGETABLES are high-valued crops grown in home gardens for family consumption and/or income generation as well as in large areas of land as commercial ventures which are usually dominated by smallholder farmers. According to the Bureau of Agricultural Statistics (3), total production of vegetables in 2011 reaches over 1.5

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million tonnes from an area of 193,728.58 hectares. In Central Visayas, vegetable production dropped between the years 2010 and 2011 (2). Vegetable production in Cebu for 2010 recorded 57,529 metric tons but decreased by 3.57% the following year with 55,478 metric tons (8).

Cabbage is the fifth leading vegetable and the number one leafy with production of 125,309.48 metric tonnes from an area of 8,549.63 hectares (3). However, cabbages have to be transported over long distances from the production areas to the market. Poor handling consequently results in significant product losses. The high perishability of cabbage exacerbates the problem. The extremely perishable nature of vegetables results in inability on the part of producers to manage supply in the assembling markets. Further, the long distances that separate the production area and markets, and the poor postharvest management contribute to the huge postharvest losses of vegetables estimated at an average of 30-40%.

To effectively reduce postharvest losses, it is always recommended to pursue a supply chain approach in which the whole supply chain is considered in determining appropriate interventions, in contrast to the piecemeal approach in which only one stage in the supply chain is being targeted for intervention. Supply chain starts from farm-gate collection of harvested produce, then processed or prepared, distributed, and finally displayed for retail to consumers (4). In many developing countries, the fresh produce industry is hampered by the lack of efficient and effective supply chains. In these countries, supply chains are generally not organized, are fragmented, and losses in product quality and quantity are usually high which are absorbed by farmers as reduced farm-gate price and by consumers as increased purchase price (1,7). For cabbages produced in Mantalongon, Dalaguete, Cebu which is the main growing area, the traditional and modern supply chains have not been assessed, hence this study was conducted to map the traditional and modern supply chains for locally produced cabbage and assessed postharvest losses in the traditional and modern chain in Cebu, Philippines.

## II. METHODOLOGY

### A. Supply Chain Mapping and Analysis

An upstream approach (from retailers to farmers) was employed (5), selected markets were Carbon Market, the biggest wholesale-retail market in the Visayas, for the

traditional chain, and selected supermarkets for the modern chain. A key-informant survey using reliable reference points (agricultural technicians and key traders/wholesalers, retailers and farmers) was conducted to construct the supply chain map. A detailed interview was then conducted using a pretested structured questionnaire. This approach enabled collection of qualitative and quantitative data (6). Following the sample size principle (9), 35 respondents (15 farmers, 5 collectors, 5 wholesalers and 10 retailers) were randomly selected for the traditional chain and 28 respondents (15 farmers, 5 traders/collectors, 5 wholesalers and 3 supermarkets) for the modern chain (farm to supermarkets).

**B. Data Analysis**

Survey results were analyzed using the SPSS program at 95% confidence level and was reported as frequencies and averages. Product losses were estimated at each stage in the supply chain.

**III. RESULTS AND DISCUSSION**

**A. Supply Chain Map**

Fig. I represents, the traditional and modern supply chain maps for cabbage are presented. Cabbages produced in Mantalongon, Dalaguete, Cebu and nearby barangays were transported to Mantalongon Trading Center and retailed at Carbon Market, Cebu City. The traditional supply chain involved five players; farmers in Mantalongon and nearby barangays, commission agents and wholesalers in Mantalongon Trading Center, wholesalers and retailers in Carbon Market. Farmers brought the harvested cabbages to the trading center, about 2.7 km away on average. Upon arrival, cabbages were weighed and dealt by commission agents to the wholesalers. The wholesalers arranged transport of packed cabbages usually by big truck and/or by mini bus from Mantalongon Trading Center to the retailers in Carbon Market, about 98 km away or 3.1 hours travel on average. Upon arrival at Carbon Market, wholesalers distributed the cabbages to retailers in the same market and nearby wet market in the city. Aside from Cebu City retailers, wholesalers also catered to retailers in other municipalities of Cebu province and other provinces outside Cebu.

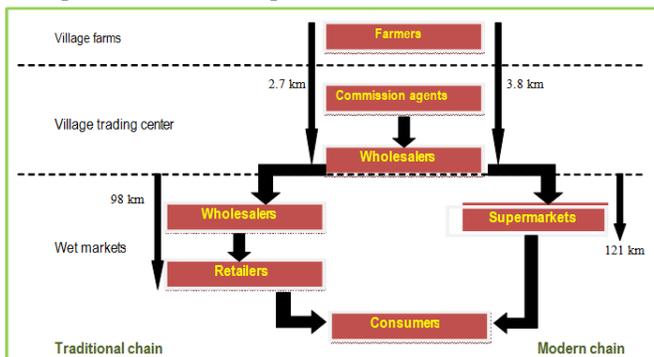


Fig. 3. Traditional And Modern Supply Chain Map Of Cabbage In Cebu, Philippines

The modern supply chain had four main players; the

farmers in Mantalongon and nearby barangays, commission agents and wholesalers in Mantalongon Trading Center, and supermarket within Cebu City. Farmers delivered the cabbages to the trading center over an average distance of 3.8 km away, usually packed by sack and bamboo basket with capacity of 125-130 kg and 90-120 kg respectively, and transported mostly by multicab, big truck, or carried by man and partly by motorcycle and tricycle. In the trading center, the commission agents handled the cabbages and sold them to the wholesalers who bought the cabbages for distribution to retailers in the city. The wholesaler shouldered the cost for trimming, cleaning, packaging, and transportation of the produce. The packed cabbages were delivered to the Carbon Market about 98 km away and about 2.9 hours on average. Upon arrival in Cebu City, trimming and sorting were done before the cabbages were individually wrapped with plastic film cling wrap. The wholesalers transported the cabbages to the supermarket using hired vehicle (public transport) about 2.3 km distance travel and 8.3 minute travel time from the Carbon Market on average (Fig. I).

**B. Demographics of Supply Chain Actors**

Farmers in both traditional and modern supply chains were female-dominated and had an average farm size of 0.7-1.02 hectares producing more than 5 tons of cabbage per cropping (Table I). Farmers in modern supply chain were older and had more farming experience but less educated than those in the traditional supply chain. On the other hand, commission agents, wholesalers and retailers in traditional chain were female-dominated, relatively younger, with college education or at college level, and had more business experience than those in the modern chain, except that supermarket retailers were college graduate. Commission agents traded the biggest volume of produce in both traditional and modern chain with about 2 tons/day because they dealt with a number of wholesalers. Retailers traded the smallest volume of produce at an average of 173.6 kg/day and 66.7 kg/day in the traditional and modern chain, respectively.

TABLE I  
DEMOGRAPHIC CHARACTERISTICS OF TRADITIONAL AND MODERN SUPPLY CHAIN ACTOR FOR CABBAGE IN CEBU, PHILIPPINES

Supply chain actor	Gender (male: female ratio)	Age, years	Education*							Years in farming/business	Farm size, hectare	Yield/ traded volume
			EG	EL	HSG	HS L	CL	CG	V N			
<b>Traditional supply chain</b>												
Farmers	27:73	48.5	20	53	7	20				22.1	1.02	6.6 tons/season
Commission Agent	20:80	45.8	60	20				20		23.2		1.9 tons/day
Wholesalers	20:80	43.6	40			40		20		23.4		310 kg/day
Retailers	40:60	45.6	60			30	10			11.4		173.6 kg/day
<b>Modern supply chain</b>												
Farmers	47:53	49.1	7	80		13				28.5	0.7	5.2 tons/season
Commission Agent	60:40	49.8	40	20		20			20	19.4		1.8 tons/day
Wholesalers	40:60	47.8	40			40		20		16.2		244 kg/day
Supermarket	100:0	23							100	16.3		66.7 kg/day

\*Education: EG-elementary graduate; EL-elementary level;

HSG-high school graduate; CL-college level; CG-college graduate; V-vocational; N-none

In the modern supply chain, commission agents and supermarkets/retailers were male dominated while wholesalers were female dominated. Commission agents and wholesalers were older and less educated (40% had not finished elementary) as compared to the supermarket retailers who were young (23 years old in average) and had finished college. The modern supply chain had been existing for about 16.2-19.4 years (Table I).

### C. Postharvest Practices

Harvesting cabbages was based on the age of the plant, firmness, or their combination (Table II). Harvesting was performed once cabbage reached their maturity age; however, cabbages were not harvested in one harvesting time, it stayed up to 4.1-4.5 days in the field, which causes over maturity and head cracking of cabbages. Harvesting was done by cutting the butt-end of cabbage with the use of ordinary knife. Frequency of harvesting did not vary greatly in both traditional and modern chain. However, traditional chain farmers harvested the cabbage more frequently (4.5 times) than modern chain farmers (4.1 times). Right after harvesting farmers in both chains directly sold cabbages in the trading center.

TABLE II  
POSTHARVEST PRACTICES OF FARMERS IN TRADITIONAL AND MODERN SUPPLY CHAINS OF CABBAGE (FREQUENCY, %)

Harvesting practices	Traditional supply chain	Modern supply chain
Harvest maturity index		
Firmness	47.6	42.9
Age of the plant	38.1	38.1
Combination of the above	14.3	19
Frequency of harvesting	4.5	4.1
Method of harvesting		
Use of knife in cutting the butt-end of cabbage	100	100
Sell cabbages after harvest	100	100

Postharvest operations in traditional and modern supply chain of cabbages include trimming/cleaning, sorting, packaging, storage and transport (Table III). In traditional chain, farmers in the field trimmed/cleaned (80%) and sorted (40%) the harvested produce before bringing them to the market. Trimming/ cleaning was done by the removal of all wrapper/outer leaves and butt-end of cabbage using ordinary knife. Cabbages were sorted based on freedom from pest damage and overmaturity and were sorted directly on the ground area, which could be a rich source for spoilage and human pathogens. After trimming/cleaning and sorting, cabbages were packed in 90-125 kg capacity bamboo baskets which were then delivered to the Mantalongon Trading Center using mostly motorcycle ('habal-habal') or tricycle, or manually carried by labor. Generally, no modern refrigerated vehicle was used in the operation in both traditional and modern chains. Upon arrival, the packed cabbages were weighed, serving as basis of payment to farmers. Commission agents then sold the produce to the wholesalers. There was no postharvest operation at the commission agent's level.

Wholesalers re-trimmed the cabbages by removal of

damage leaves and protruding butt and sorted them visually based on freedom from pest damage and physical damage. After trimming and sorting, cabbages were individually wrapped with newsprint, placed in bamboo basket or sack, and transport to Carbon Market by big trucks ('trak de karga'). Upon arrival in Carbon market, wholesalers either distributed the cabbages by the hired labor to retailers usually few meters from their stall or retailers purchased the cabbages from wholesalers and brought the produce to their respective selling area. Usually in retail market, cabbages were re-trimmed, packed using bamboo basket and sack, and stored under ambient condition while waiting for buyers.

In the modern supply chain, the same postharvest operations as that in traditional chain were done, trimming the butt, removing all wrapper/outer leaves, sorting based on freedom from pest damage and overmaturity, packing mostly in bamboo basket and in few cases in sack, and transporting to Mantalongon Trading Center by multicab, big truck or manually carried by man (Table IV).

Upon arrival, the cabbages were weighed and after the commission agents and wholesalers agreed on the, wholesalers re-trimmed the cabbages which were then wrapped individually with newsprint before packing in bamboo basket or sack. The packed cabbages were transported to Carbon Market by big truck. Refrigerated transport was absent.

Upon arrival, the cabbages were weighed and after the commission agents and wholesalers agreed on the, wholesalers re-trimmed the cabbages which were then wrapped individually with newsprint before packing in bamboo basket or sack. The packed cabbages were transported to Carbon Market by big truck. Refrigerated transport was absent.

TABLE III  
POSTHARVEST OPERATIONS OF TRADITIONAL SUPPLY CHAIN ACTORS (FREQUENCY, %) <sup>1</sup> AND DESCRIPTION OF OPERATION

Postharvest operation	Farmers	Commission Agents	Wholesalers	Retailers
Trimming/cleaning	80	0	100	100
	Trim butt, all wrapper/outer leaves removed		Trim butt, damaged leaves removed	Trim butt, damaged leaves removed
Sorting	40	0	62.5	40
	No pest damage (100%), overmaturity (33.3%)		No pest damage (60%), no physical damage (40%)	No pest damage (53.3%), no physical damage (46.7%)
Special treatments	0	0	0	0
Packaging	100	0	100	100
	Bamboo basket		Bamboo basket (60%), sack (40%), individually wrap newspaper(100)	Bamboo basket (40%), sack (60%)
Transport	86.7	0	100	100
	Motorcycle (33.3%), multicab (6.7%), big truck (6.7%), carry by man (33.3%), tricycle (20%)		Big truck (de karga)	Carry by man
Storage	0	0	0	100
				Ambient storage, wait until sold

<sup>1</sup> multiple responses

Upon arrival, the cabbages were weighed and after the commission agents and wholesalers agreed on the, wholesalers re-trimmed the cabbages which were then wrapped individually with newsprint before packing in bamboo basket or sack. The packed cabbages were transported to Carbon Market by big truck. Refrigerated transport was absent.

TABLE IV  
POSTHARVEST OPERATIONS OF MODERN SUPPLY CHAIN ACTORS  
(FREQUENCY, %) AND DESCRIPTION OF OPERATION

Postharvest operation	Farmers	Commission Agents	Wholesalers	Retailers
Trimming/cleaning	80 Trim butt, all wrapper/outer leaves removed	0	100 Trim butt, damaged leaves removed	100 Trim butt, damaged leaves removed
Sorting	53.3 No pest damage (100%), overmature (20%)	0	0	40 No pest damage (40%), no physical damage (60%)
Special treatments	0	0	0	0
Packaging	100 Bamboo basket (93.3%), sack (6.7%)	0	100 Bamboo basket (60%), sack (40%), individually wrap with newspaper (100)	100 Individual food wrap
Transport	93.3 Motorcycle (13.3%), multicab (26.7%), big truck (26.7%), carry by man (20%), tricycle (13.3%)	0	100 Big truck (de karga)	100 Public car
Storage	0	0	0	100 Refrigerated storage, wait until sold

<sup>1</sup>multiple responses

Both traditional and modern supply chains had no special treatments to control bacterial soft rot. In the Carbon market, wholesalers re-trimmed, re-sorted and re-packed the cabbages using individual plastic film wrap before delivery to supermarket usually by public transport. In supermarkets, cabbages were displayed for retail under refrigerated condition.

Cabbage prices were dictated by commissioners, wholesalers and retailers in both chains. No product quality standards were used as basis of pricing. Pricing was based only on whether the cabbages are of good quality with no damage, wilted and/or rotten parts or rejects with insect damage and rotting, weight loss and physical damage. For logistics issues, both traditional and modern chain employed transport using big truck, which contributed to high losses due to mechanical damage, weight loss and build up microorganism inside the package due to high temperature and humid conditions. A major marketing constraint was the poor infrastructures that contributed to huge losses of produce.

#### D. Postharvest Loss

The total loss of cabbage was almost similar in both

traditional and modern supply chains (26.4-26.5%) (Table V). However, farmers in modern supply chain incurred higher loss of 13.2% than traditional chain farmers of about 10.1 % loss. Losses were primarily due to pre-harvest origin, including insect damage and rotting/decay due to rain (Table V). No loss was recorded at the commission agent's level where no postharvest operation was performed since the cabbages were merely transferred from the farmers to the wholesalers at the trading post. Losses at the wholesalers to retailer's level differed with supply chain. In traditional chain, wholesalers incurred 6.8% loss due to weight loss and mechanical damage as a result of improper handling of fresh produce and poor packaging during transportation. Retailers incurred 9.6% loss on average, much higher compared to wholesaler's level due to physical damage and weight loss resulting from improper handling of fresh produce and poor temperature and humidity control. Loss may be in the form of trimmings or whole cabbage rejection at the farmer's level while at the wholesaler and retailer levels, trimming contributed more to losses.

In the modern chain, wholesalers and retailers incurred an average loss of 6% and 7.2% respectively (Table V). Poor transport was the main contributory factor to loss in both chains. Losses in wholesaler level were due to weight loss and mechanical damage as a result of improper handling of fresh produce and poor packaging during transportation. Physical damage and soft rot incidence were among the causes of loss at retailer's levels as a result of improper handling and lack of techniques.

TABLE V  
POSTHARVEST LOSS OF CABBAGE IN THE TRADITIONAL AND MODERN  
SUPPLY CHAINS IN CEBU, PHILIPPINES

Supply chain actor	Postharvest loss, %	Causes of loss*	Reason for loss*	Nature of loss*	Price of cabbage, Php
<b>Traditional supply chain</b>					
Farmers	10.1	Insect damage Rotting/decay	Lack of reliable maturity indices Unsuitable used of pesticides	Trimming/cleaning Whole-cabbage rejection	26.7
Commission Agent	0	0	0	0	27.7
Wholesalers	6.8	Weight loss Mechanical damage	Improper handling of fresh produce Poor packaging during transportation	Trimming/cleaning	37.7
Retailers	9.6	Weight loss Physical damage	Improper handling of fresh produce Poor temperature and humidity control around the produce	Trimming/cleaning	42.7
Total loss	26.5				
<b>Modern supply chain</b>					
Farmers	13.2	Insect damage Rotting/decay	Unsuitable used of pesticides	Trimming/cleaning Whole-cabbage rejection	27.3
Commission Agents	0	0	0	0	28.3
Wholesalers	6	Weight loss Mechanical damage	Improper handling of fresh produce Poor packaging during transportation	Trimming/cleaning	38.3
Retailers	7.2	Physical damage Soft rot	Improper handling of fresh produce No techniques	Trimming/cleaning	78.3
Total loss	26.4				

\*≥30% frequency

Cabbage prices along the chain varied greatly (Table V). Farm-gate price was slightly higher in the modern chain (27.3 Php/kg) than in the traditional chain (26.7 Php/kg). Commission agents in both chains got 1 Php/kg commission for produce dealt from growers to wholesalers without any postharvest operation. Wholesalers in both chain added about 11 Php/kg to the price given to commission agents; however, they shouldered the costs of postharvest operation and transport to retailers. Big discrepancy in price was obtained at retailer's level as the price in the traditional chain (42.7 Php/kg) was almost twice lower than that in the modern chain (78.3 Php/kg).

From the above results, it appeared that farmers got the lowest profit in both chains while the intermediaries received higher financial return. Postharvest losses of cabbages were about one-fourth of the total volume and these were usually passed on to farmers as low farm-gate price and to consumers as high retail price. Appropriate technological interventions reduce losses which should translate to high farm-gate price to increase the financial returns of farmers.

#### IV. CONCLUSION

Traditional chain was more complex than modern chain. Practices in both chains were far from desirable. Postharvest loss did not differ much between the two chains (26-27%) but the modern chain had more stringent quality requirements and about two times higher retail price than in the traditional chain.

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