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Losses and waste of tomato and red chilli along the supply chain

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Abstract. Tomatoes and red chilli are horticultural products commonly used by customers in Indonesia, and Sukabumi is one of the highest tomato and red chilli producing areas in West Java Province. The number of losses and waste estimation was done by interview method to the key actors entering the supply chain that started from the farmers in Perbawati village. The interview of losses estimation was conducted to the farmers who planted tomatoes and red chilli, followed by the middleman, while for the waste amount estimation interview was conducted on tomatoes and red chilli sellers in the wet market and the customers. The results of the interviews on the actors involved along the supply chain stated that tomato products at the farmer level had estimated losses of 11.17%, 10% losses at middlemen level, while the estimated amount of waste at the seller level was 20.63% and at the customer level was 11.36% with total estimation of 53.16% in along of tomatoes supply chain. Unlike red chilli which had total loss estimation of 29.32% with details of losses estimation at farmer level of 2.33%, 5% losses at middleman level, while waste estimation at seller level was 10.80%, and customer level was 11.18%. Different percentages of food losses and waste estimation between tomatoes and red chilli caused by different of treatments, natural characteristic of products, handling by the actors, seasons and different economic value of the product.

1. Introduction

Tomatoes and red chilli are horticulture products that are very commonly used by people in everyday life both at home or business scales. In addition, tomatoes and red chilli as horticultural products are products required by humans to fulfill the needs of vitamins and minerals in the human body [1]. Horticultural products also have a particular taste and organoleptic properties that cannot be found in other food products [2].

Horticultural products have long stages to reach consumers in which the product ready to be consumed. In general, the postharvest stages that must be carried out are collecting, sorting, grading, packaging, transportation, and distribution [3]. Those stages can be the cause of losses by mechanical and physiological damage due to improper handling and treatment then waste generated at the storage stage by the seller and at the consumer level [4].

Food loss is defined as a decrease in the quantity and quality of food products at the postharvest handling stage. Meanwhile, food waste is disposed on purpose at the seller or at the consumer levels. Food waste is recognized as a different part of food loss due to the different causes and solutions [5].



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Every year, it is estimated that one-third of all agricultural products produced for human consumption are sustained losses or even turns into. Food waste per capita at the consumer level in Europe and North America is approximately 95-115 kg/year, while in sub-Saharan Africa and South/Southeast Asia is around 6-11 kg/year [6]. It is estimated that food waste in the world is one-third of food produced every year for human consumption, about 1.3 billion tons of quantity became loss and waste [6]. To provide an estimation of losses and waste of a product in particular place, a field assessment is required and followed by estimation, therefore the data on losses and waste levels can be obtained, also the existing problems can be analysed.

The problems described conclude that losses and waste are still high in many regions with various sources and causes. Likewise in Sukabumi as a region that has high horticultural productivity in West Java Province [7], there are still high losses and waste particularly in conventional postharvest handling and those are marketed in traditional markets or wet markets. This can be seen from the amount of waste coming from parts of horticultural products scattered on the streets and landfills which are dominated by fresh agricultural products.

This study aimed to analyse more about the estimation of losses and waste in horticultural commodities, especially tomatoes and red chillies in Sukabumi through postharvest assessments and further analyse the sources, problems, and causes of losses and waste.

2. Methods

Data collection of respondents was located in the Sukabumi area namely Perbawati as one of an area that has a high productivity of tomato and red chilli in West Java. This area was chosen by purposive sampling which farmers who cultivated tomatoes and red chilli and farmers who represent different productivity based on planting area, then continues to the middlemen and wet market which has operational locations in Selabintana, Gunungpuyuh, and Gunungparang by snowball sampling method.

Furthermore, respondents were interviewed by a questionnaire to identify opportunities for waste which was a household-scale consumer. The above respondents are people who are directly involved or who are considered to have the ability and understand waste-related problems. Determination of respondents (consumers) was carried out using a snowball sampling method, they were consumers who bought the products in related wet markets. The number of respondents who participated in this study shown in Table 1.

Table 1. Number of respondents along the supply chain.

Number of respondents based on commodities		Number of respondents based on supply chain	
Tomato	102	Farmer	36
Red chilli	102	Middleman	2
		Wet market seller	22
		Consumer	144
		Total	204

Snowball sampling can be defined as a sampling that does not follow mathematical probability (non-probability) guide where each respondent interviewed was asked for suggestions about other next respondents who can be interviewed later. Data were collected by observation in the fields how postharvest products handled by the actors or stakeholder, also interviewed the respondents with questionnaires about postharvest handling used a qualitative method, then quantitative method for a calculated number of harvests, number of products that could not be sold and estimation losses and waste.

After the interview was completed on the farmers, middlemen, sellers, and consumers, data would be processed particularly on the estimation of losses and waste provided by the respondent. It was also identified sources and causes of losses and waste based on information given by respondents.

Furthermore, based on each given estimation, a average of losses and waste at each level of the supply chain was calculated to obtain a total estimate of losses and waste along the supply chain.

3. Results and Discussion

3.1. Supply chain

In general, tomatoes, red chilli, and other horticultural products in Perbawati Village have two types of supply chains. Total of the harvest, 100% would be taken by the one and only middleman in Perbawati Village. Furthermore, the middleman would distribute those horticultural products to wholesalers who enter the first chain, whereas, in the second supply chain, middleman directly distribute tomatoes to retailers.

According to the middleman, the first supply chain would be applied if the harvest was plentiful, thus the harvest can be sent to wholesalers. The wholesalers are the main market in Jakarta. Whereas the second supply chain is applied only to the retail market around the Sukabumi area where middleman sends the products to retailers or retailers pick the products up at the middleman store. Overall, middlemen only sell the products of Perbawati Village in traditional markets without selling to the supermarket. Furthermore, consumers bought tomatoes and red chilli through retailers in traditional markets.

3.2. Estimated losses and waste tomatoes

3.2.1. Farmer level

This study found that on farmer level tomato was loss 0.25%-30%. Then averaged, estimated loss at this level was 11.17% per harvest, while tomatoes have a harvest frequency of about 10-15 times. Losses were caused by pests and diseases yet still harvested. At the postharvest time, losses can also be due to mechanical damages when tomatoes are packed into crates. For example, when the tomato crates are not properly closed or have cracks in the crates, thus the tomatoes are easily squeezed and cracked by other tomatoes although the surface of the crates. At this level, tomato losses may reach 32.9% due to overripe, decay, mechanical damage, using excessive force in packaging to the crate [8] or can even reach 62.5% due to unfavorable packaging [9].

This study found that parameters of harvesting tomatoes have to harvest with colors green, green-yellowish or reddish intended to make tomatoes last longer during distribution. But in the real application, farmers still harvest tomatoes which were red and relatively mature, then it would be more susceptible to damage due to the lower level of tomato hardness compared to tomatoes which are green, yellowish green or reddish green [10]. For the distribution, tomatoes have to be harvested while still green, which can maintain the shelf life of tomatoes along the supply chain. Harvesting tomatoes when it almost ripens will make shorten the shelf life.

If the farmers found that tomatoes got mechanically damaged or unsuitable when put in tomatoes by pouring tomatoes quickly from sacks into crates, farmers usually separate the rotten tomatoes from healthy tomatoes in crates. However, if farmers did not find it, then the rotten tomatoes would be left in the crate because farmers rarely do special grading in this level.

The handling of tomato losses that can be done at the farmer level by discard the rotten tomatoes because tomato has a low price. This study found that these losses are due to poor cultivation systems and poor management of pests and diseases. Losses that happen due to pests and disease in tomatoes can cause losses up to 20% [11]. The factors causing the losses revealed by Perbawati farmers were inappropriate packaging and the absence of sorting and grading. Farmers hope that in the future can implement modernization or better packaging and applied good postharvest handling practices.

3.2.2. Middleman level

This study found that the losses at the middleman level had a percentage of 10% due to rotten and mechanically damaged of tomatoes during transportation. In this level, the middleman intensively sorts out before the products are sent to retailers. Simple postharvest handling, such as sorting and

grading, may reduce tomato losses at least 10% compared to un-sorted and un-graded products. This can be due to reduced contamination and transfer of diseased tomatoes to healthy tomatoes [12].

The problem often faced by middlemen was, when tomatoes were transported from farmers until products distributed. All vehicles used were open vehicles, such as trucks or pick-ups so that the product directly expose by sunlight during transport. Therefore, the heat would transpire the water of tomatoes and made the weight or quantity losses. One of the critical points regarding with qualitatively and quantitatively of tomatoes were when transported because tomatoes mostly contain water and damaged easily. Some simulation of transporting tomatoes for four hours may cause bruising on tomatoes ranging from 37.50 to 45% of the total amount of tomatoes in the package [13].

In addition, for long distant distribution, particularly to Jakarta, with long distance conditions, also congestion due to vehicles factory loading, traffic-jam, potholes may cause a delay on the distribution. In addition, respondents said that there had been traffic-jam from Sukabumi to Jakarta for approximately 6-8 hours which made horticultural products including tomatoes to be discarded during the trip. Tomatoes became rotten and damaged due to exposure to sunlight that was longer than usual. The middlemen do not sell tomatoes that are not worth selling, thus the rotten tomatoes are immediately discarded.

3.2.3. Traditional market or wet market level

This study found that waste was estimated in tomatoes about 6% to 25% of the total tomatoes purchased from middlemen. The average waste estimation at this level was 20.63%. Sellers in the market always sorting their products on a daily basis. According to respondents, the cause of waste in tomatoes is rottenness, bruising, mechanically damages and unpurchased by consumers. Generally, sellers dispose of tomatoes that were unsuitable for sale to the dump or carelessly dumped around their store. According to respondents, tomatoes are unsuitable for sale if more than four days and if the storage and display times are shorter, it would reduce the chance of tomatoes becoming waste [12]. Four days is a common time as tomatoes display limit on the market [8].

3.2.4. Consumer level

About 76.39% of consumers claimed that they were thrown the tomatoes that unsuitable for consumption. In percentage, respondents estimated tomato waste ranging from 5% to 50%. Meanwhile, the average waste estimation was 11.36%. Overall, respondents thrown it into the trash bin, the consumers gave a statement that habit of throwing tomatoes is a common thing. In general, respondents thrown tomatoes away because tomatoes were rotten and unsuitable for consumption. Respondents also reported that they bought too many tomatoes, and recommended the buyers to buy tomatoes as they needed to minimize habit of throwing.

The habit of using plastic bags when storing the tomatoes may cause rot easily and even become waste. The result of previous research that tomatoes storage using plastic bags is unrecommended, it may even cause quantitative losses of 1.02% and compared to storage using special containers that are tightly closed [14].

3.2.5. Total of loss and waste

If all estimation of losses and waste gave by the respondents are summed, the estimation of total losses and waste was 53.16% along the supply chain with details at the farm level was 11.17%, the middleman level was 10%, the traditional market or wet market level was 20.63% and the consumer level of 11.36% (Figure 1). It can be concluded that more than half of tomato production became waste and is not used for human consumption. In this study, losses and waste were caused by pests and diseases and poor post-harvest handling. Estimation of tomato losses in each country had varying percentages, this difference can be due to the differences in handling along the supply chain, function value, economic value of tomatoes in each country and different weather conditions.

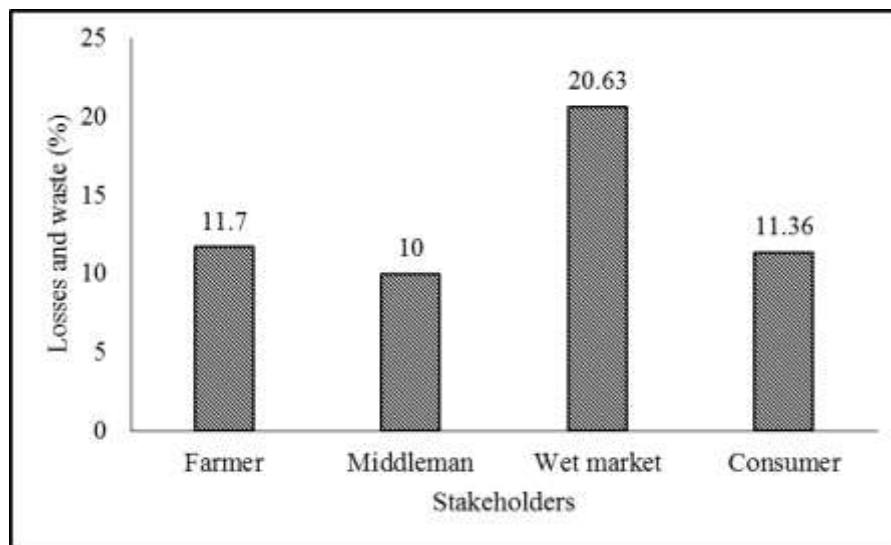


Figure 1. Losses and waste total of tomato along the supply chain.

3.3. Estimated losses and waste red chilli

3.3.1. Farmer level

This study found that losses on postharvest red chilli ranged from 2-3% at the farmer level with an average 2.33% which came during sorting by farmers, thus red chilli with a low-quality would be immediately discarded by farmers. Grading of red chilli did not by the farmers at the time of collection, therefore red chilli will not be wasted again. If there is rotten or low-quality red chilli, the red chilli is still bought by the middleman and mixed with other healthy red chilli.

3.3.2. Middleman level

At this level, found that estimated red chilli losses of 5% due to mechanically damaged and diseased, thus the middleman is required to perform grading after buying from the farmer and while storing in the store. As long as there are low-quality red chillies, the same quality red chillies were collected and still sold to consumers, but with a lower price than healthy and good quality of red chilli.

Red chillies in the farmer and middleman level is packaged using a plastic sack or plastic bag with a mass of about 30 kg even it had a maximum capacity of 25 kg. This packaging can make the red chilli damage even higher compared to crates and carton packing. The damage was mechanical damage, physiological damage, and post-harvest diseases.

3.3.3. Traditional market or wet market level

This study found that in the market level estimated waste of 4% to 20% with an average estimation of 10.80% due to red chilli quality may changes every day and grading was conducted daily. Low-quality red chillies will still be sold by sellers with relatively lower prices than healthy red chillies.

In the wet market, red chillies were easy to get physiological disorders such as blossom end-root which is indicated by decaying the lower end of the fruit, the symptoms can also make the surface skin dry and wrinkle this physiological disorders can also attack tomatoes [15]. Although in retail packaging still not famous in the Indonesian market, modified atmosphere packaging (MAP) is an option to minimize damage to red chilli on the market. In other hands, a simple option that can decrease loss is by using clear polyethylene packaging material.

3.3.4. Consumer level

Whereas respondents who claimed that they throw away unsuitable for consumption red chilli were 55 respondents. While in percentage, respondents estimated waste of red chilli ranging from 5% to 50%.

Meanwhile, the average waste was 11.18%. Overall, respondents thrown red chilli by throwing them into a dump and for the respondents that the habit of disposing was a common thing. In general, respondents thrown it because the red chillies were rotten and they were unsuitable for consumption and they claimed bought too much and made a recommendation to buy as needed and storage in a good place to minimized wasting.

The buying parameters of red chilli by consumers in Indonesia by skin color (bright red skin color), type, price/kg, skin surface, fruits shape, and hotness. From these parameters, if the visual of red chilli not bright red, these products would not be purchased by consumers. Nor when the color turns dark along bad storage due to postharvest disease or chilling injury.

3.3.5. Total of loss and waste

This study found that the entire estimation of red chilli losses and waste expressed by the respondents were summed and estimated in totaled losses and waste of 29.32% along the supply chain (Figure 2), with details at the farmer level was 2.33%, middleman level was 5%, traditional market level was 10.80 % and consumer level was 11.18%. It could be said that the estimation of losses and waste of red chilli is minimal compared to the total losses and waste in tomatoes due to the high economic value of red chilli compared to tomatoes.

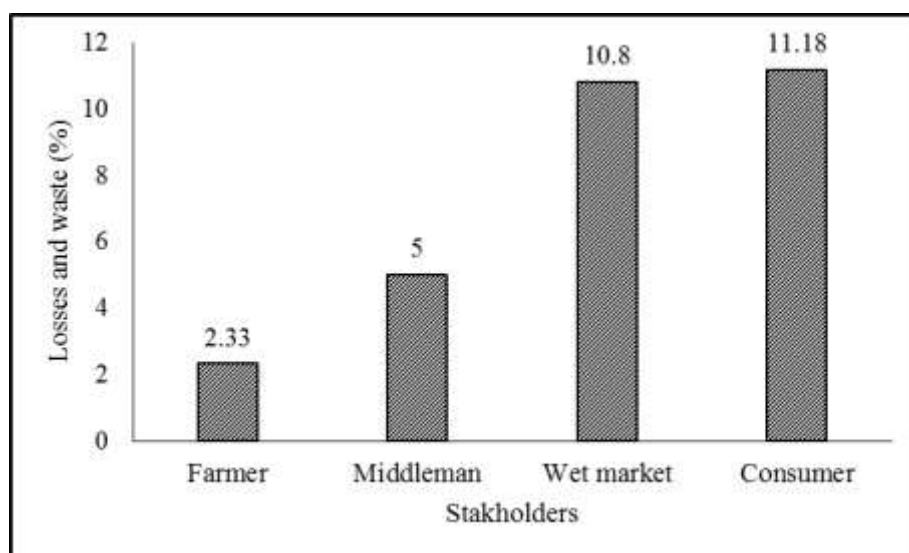


Figure 2. Losses and waste total of red chilli along the supply chain.

4. Conclusion

Tomatoes and red chillies were losses during post-harvest were caused by poor post-harvest handling. At the farmer level, less of treatment for sorting and grading, poor packaging, cannot protect the product leads to the product is susceptible to mechanical damage. In the middlemen level, the condition of vehicles has a mass limit is not examined properly, thus the volume and load of the vehicle exceed the maximum limit and the product easily being squeezed. Hot environmental conditions cause the product to be exposed to direct sunlight and poorly maintained hygiene, thus the quality of the product decreases, as well as sellers too many provide stock. If tomatoes are not sold, sellers can dispose of them easily because it has low sale value. At the consumer level, main causes of consumers dispose of their products, among others, are consumers generally bought the products in the large quantity and bad storing treatment.

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