

## **Assessment of Post-Harvest Handling Practices of Tomatoes Farmers and Retailers in Some Selected Districts in the Upper West Region of Ghana**

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### **Abstract**

In most developing countries like Ghana, post-harvest loss of tomato has become a critical issue which bothers on the degree of produce perishability and inevitable cost to tomato handlers within the tomato value chain. The Post-Harvest Loss Value Chain Model was explored to critically analyse the post-harvest handling practices, examine the causes, challenges and treatment methods used by tomato farmers and retailers in four selected districts in the Upper West Region of Ghana namely Wa Municipal, Wa West District, Wa East District and Jirapa District. The mixed method research design was used for the study as the study employed both qualitative and quantitative source of data. The study population was all tomato farmers and retailers in the four selected districts in the Upper West Region. The sample size consists of forty-one (41) tomato farmers and fifty-seven (57) tomato retailers. The sampling techniques used were convenience and purposive. Survey questionnaires and structured interview were the instruments used to gather data for the study. Data from the study revealed that about 97% of tomato handlers harvested the produce in the morning in its matured ripped red state. About 42% of tomato handlers do not sort, grade and pre-cool their produce after harvest.

**Keywords:** Postharvest handling practices, tomatoes, farmers, retailers, sorting, grading

### **1. Introduction**

Vegetable production needs to be given prime concern to improve food security, increase farmers' income, and stop hunger, especially in developing countries (Food and Agriculture Organization, 2010). Food insecurity often occurs as a result of crop losses and this has a resultant unfavourable effect on the environment, economic development, and food quality. Globally, about 1.3 billion tonnes of food is lost every year. Water, land, managerial expertise, labour, and other inputs that could have been directed toward productive areas are all wasted because of crop losses (FAO, 2011). About 40% to 50% of vegetable crop produce is wasted

annually and this is caused by mechanical bruises to the fresh produce, pest and disease infestations, and rot (Kitinoja, 2004). Post-harvest losses have therefore been considered to be one of the factors that influence food shortages in developing countries. Post-harvest loss of tomatoes has become a critical issue that bothers the rate of produce perishability and unavoidable cost to tomato handlers within the tomato value chain in developing countries such as Ghana (Babalola, Makinde, Omonona, & Oyekanmi, 2010). Post-harvest loss is a major challenge hampering tomato production in Ghana. Tomato being a perishable crop as a result of high moisture content has a short shelf life of about 48 hours under tropical conditions (Arah, Ahorbo, Anku, Kumah & Amaglo, 2016). Special post-harvest handling practices and treatment methods are needed to extend the shelf life of tomatoes after harvest.

Today, one of the major global challenges in the agriculture sector is food security as well as ensuring long-term sustainable development. According to the Food and Agriculture Organization report (FAO, 2008), the production of food will need to rise by 70% to feed the ever-increasing global population which will reach nine (9) billion by 2050 according to Kiaya (2014). Crop losses should be given prime concern to improve food security, increase farmers' income and stop hunger, especially in developing countries (FAO, 2010). While a total food insecure population continues to be unacceptably high as a result of post-harvest losses on the food journey chain from harvest to consumption due to several factors, it is very imperative to assess and if possible reduce the rate to ensure food sustainability.

Tomato (*Solanum Lycopersicum*), belongs to the family *Solanaceae* which is an extensively grown and consumed staple vegetable fruit in the world, and it is a good source of nutrients such as minerals and vitamins in food consumed by humans (Babalola et al, 2010). According to Van der Hoeven, Ronning, Giovannoni, Martin, and Tanksley (2002), *Solanaceae* is the third main economically grown crop after cereals and legumes and it is the worthiest in terms of vegetable crops and agricultural utility. Tomato forms part of the food consumed in Ghana and it is an important ingredient in Ghanaian dishes during meal preparation and service (Tambo & Gbemu, 2010; Osei et al., 2014). Tomato cultivation has been viewed as one of the primary drivers of employment development and poverty alleviation in Ghana's rural and urban areas during the last few decades (Asare-Bediako et al., 2007; Sugri et al., 2013). Following Sugri et al. (2013), tomato production in the Upper West Region is noted as an antidote to the widespread unemployment and poverty for the majority of households.

Maturation, ripening, and senescence are three clear-cut phases in the life span of vegetables and fruits that have been differentiated by a postharvest physiologist. Maturation denotes fruit being ready for harvest (Arah, Amaglo, Kumah, & Ofori, 2015). Matured tomatoes are usually harvested when the plant is fresh and has high moisture content. Tomato farmers and traders in the tropics are confronted with special problems in handling, transportation, and marketing due to the perishability nature of the product precisely. The storage life of fresh vegetables such as

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tomatoes depends on good harvesting practices such as harvesting quality ones (Hurst, 2010; Kitinoja&Gorny, 2010). Fresh tomatoes are easily damaged and have short storage life if harvested in a fully ripened state. The study, therefore, seeks to assess the post-harvest handling practices of tomatoes farmers and retailers in some selected Districts in the Upper West region of Ghana.

### **2. Literature review**

#### **2.1 Post-Harvest Handling Practices of Tomatoes**

Post-harvest handling practices of tomatoes to a very larger extent can have a terrible consequence on the post-harvest quality and shelf life of the produce. Irregular handling in the course of harvesting and after harvesting tomatoes can cause mechanical injuries with severe adverse effects on the post-harvest quality and shelf life of the harvested produce (Arah et al. 2015). In times past, rural farmers and retailers depended on native or local ideas for improving farming and marketing systems. Such ideas being native or local denote the dexterity and experience acquired by verbalized traditions and practices for several generations as observed by Nnenna (2011). Attainment of such aboriginal skillfulness by indigenous farmers and retailers has barely helped in improving agrarian yield (Nnenna, 2011). This practice of adopting primitive skills for improved farming and marketing of tomatoes is generally evident in developing countries such as Ghana because storage, packaging, transport, and handling systems are realistically non-existent for perishable crops, so this results in substantial losses of produce. Besides, undignified post-harvest sanitation, improper packaging systems, and mechanical damage in course of harvesting, handling, and transportation resulting from vibration by undulation and irregularities on the road according to Idah et al. (2007), further enhance wastage. It is worrying to indicate that so much is being invested in planting tomatoes; therefore, a lot of resources expended on irrigating, fertilizing, and crop safety management are only to be fruitless a few days after harvest. Post-harvest loss of tomatoes occurs due to immaturity, over-ripening, mechanical damage, and decay (Esguerra&Rolle, 2018). They added that these losses can be attributed to poor harvesting methods, irregular handling, inappropriate packaging, and unsuitable transport conditions.

Babalola&Agbola (2008) concluded that post-harvest losses of tomatoes have been regarded as an element of food problems in most developing economies like Ghana. Ajagbe, Oyediran, Omoare, & Sofowora, (2014) observed that information concerning post-harvest handling of tomatoes is well circulated among tomato farmers and retailers themselves. The reason is that most of these tomato handlers obtain their information on new variability, its physiognomies and benefits, period of planting and harvesting, selling, use, and post-harvest practices from their fellow farmers and retailers since farmers and retail unions play significant roles in obtaining information on tomato post-harvest handling practices among their members. Ajagbe et al. (2014) also established that some tomato handlers obtain their post-harvest handling practices information from their friends and neighbours. These results are reflected in the observations of

Adekunle, Omoare&Oyediran (2014) that farmers depend on data from farmers', retailers' unions, and fellow farmers, with only a handful relying on radio/television, and Agric extension officers, which is pretty unfavorable to post-harvest practices of tomato.

Ajagbe et al. (2014) believed that tomato handlers rather should obtain agricultural information for improved farming and marketing systems from credible sources such as extension officers, public libraries, radio, television, film shows, agricultural pamphlets, state and local government agricultural agencies. This is due to the fact that proper tomato post-harvest management is essential for maintaining quality and ensuring customer safety while ensuring timely delivery. This also helps meet buyers' specifications and trade requirements.

With ever-changing consumer tastes and lifestyles, more attention is placed on post-harvest handling of tomatoes to fulfill their request for enhanced quality and safe produce. Arah et al. (2016), postulate that physical handling can pose a severe effect on the post-harvest quality and shelf life of so many fruits and vegetables. They elaborated that jagged handling during and after harvesting can affect the product by causing mechanical injuries that can disturb the post-harvest quality and shelf life of harvested crops like tomatoes. Esguerra et al. (2018) opined that the characteristics of the tomato fruit and its handling practices affect its post-harvest life. Improper handling may cause wounds that pave way for decay-causing agents. Wounds are also pathways to loss of water in a production loss and can further accelerate the maturing course, they added. Inappropriate handling such as staking the produce in bamboo baskets and sitting on stalked tomatoes during transport causes damage to the fruit.

According to Ajagbe et al. (2014), there are different methods of packaging tomatoes. Tomato farmers and retailers use woven baskets of 25-75kg and perforated plastics to package their produce. It is pertinent to note that in most rural communities where tomatoes are mostly grown, woven baskets of different dimensions are regarded as ideal containers for packing tomatoes since they are cheap, have adequate holes for aeration, are less difficult to carry, offer better care from mechanical injury, and suitable for retailing (Ajagbe et al. 2014). It is important for tomato handlers to familiarize themselves with suitable post-harvest handling practices required to preserve the quality and prolong the shelf life of harvested tomatoes for producers in developing economies. Some of the handling practices comprise Reaping, Pre-cooling, Cleaning and disinfecting, Sorting and grading, packaging, transportation, and storage as outlined by Arah et al. (2016).

## **2.2 Harvesting as a Post-harvest Handling Practice of Tomatoes**

The physiological maturity of tomatoes at harvest has an important effect on post-the harvest quality of the produce (Beckles, 2012) because the harvesting time of tomatoes is a crucial stage for attaining its greatest quality. According to post-harvest physiologists, the lifespan of fruits and vegetables can be classified into three stages Maturation, ripening and senescence (Esguerra et al. 2018). The FAO (2008) explain maturation as an indicative period for the harvesting of the

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produce, and also, the stage during which the edible part of it is fully developed in size, although it might not be ready for immediate consumption. Concerning tomatoes, Arah et al. (2015) asserted that the product can be harvested in either matured green, partially ripe, or ripe state. Harvesting them at the mature stage will give enough time for ripening and senescence to take place, especially for producers targeting distant markets, and will prevent or reduce mechanical injuries in the course of harvesting. This claim is supported by Orzolek, Bogash, Harsh, Lynn, Kime, Jayson & Harper (2006) who state that the harvesting of tomatoes is a labour-intensive venture requiring its harvesting in matured green stage to prevent overripe in the course of transportation to long distanced market centres. Ripening precedes maturation rendering the crop eatable as indicated by taste. Senescence is the final stage, considered a natural deprivation of the fruit or vegetable as in loss of texture, flavour, colour etc.

The time of picking is a vital factor in post-harvest practices in tomato production. Ajagbe et al. (2014) posit that 62% of tomato farmers picked their tomatoes in the evening to be transported all night. They do so because they want to reduce perishability due to the daytime high temperature under which the product will be transported, the long distance between farms and markets in urban centres coupled with the poor nature of roads. Farmers and retailers as a result of this pick their produce to make them arranged for transportation and accessible for sale in the markets the next day. Nonetheless, few tomato farmers and retailers harvest their tomato products in the morning because they transport their tomato products to the local and nearby markets all by themselves. These observations regarding the time for tomato harvesting by these handlers are consistent with the discoveries of Muhammad et al. (2012) who found that the reaping of fruits and vegetables should be carried out during the cool part of the day. Regrettably, most growers in developing economies (specifically those in rural communities) reap tomatoes whenever they are somewhat or completely ripened. Completely ripened tomatoes are vulnerable to mechanical damages in the course of harvesting occasioning their shorter shelf life (Arah et al. 2016). The usage of harvesting and packaging containers that have sharp edges must not be given prominence to avert bruising and puncturing of the crops. Fruits and vegetables should also be harvested early in the morning or late in the evening to avoid excessive field heat generation.

### **2.3 Pre-cooling after harvest as a post-harvest handling practice**

Ilyas (2010) and Bachman & Earles (2000) identified pre-cooling as the initial stage that is appropriate for post-harvest management of tomatoes, since the field warmth of a newly reaped crop, as in the case of tomato (heat that is contained in the product emitted by the sun and warm temperature is commonly high) ought to be quickly eliminated before they are shipped, processed or stored. Extreme field warmth accelerates the undesirable increases in metabolic actions, and so early cooling after harvest is therefore important. The appropriate temperature range of about 13–20°C for the handling of tomatoes can be achieved either at dawn or the latter part of the evening (Kader; 1984, Risse, Miller & McDonald; 1985, Arah et al., 2016).

Pre-cooling lessens the effect of microbial action, metabolic activity, respiration level, and ethylene production and at the same time reduces the ripening rate, water loss, and decay leading to the preservation of quality and extension of shelf life of harvested tomatoes (Shahi, Lohani, Chand & Singh, 2012). Contingent on the sort of fruits and vegetables, various pre-cooling techniques exist. Ilyas (2010) outlined cooling of the room, compulsory cooling, water cooling, top or liquid icing, and vacuum cooling as the various pre-cooling types. In Africa and for that matter Ghana, tomato producers gather their harvested produce under a tree shade in a bid to minimize field heat, even though it is an effective and reliable means of attaining reduced heat of harvested tomato as being suggested by Arah et al. (2015), the acceptance of a simple on-farm set up like a small hut built of thatch can be very beneficial in pre-cooling of harvested tomatoes.

#### **2.4 Cleaning or disinfecting as a Post–Harvest handling practice**

Good hygiene is of great concern to all handlers of tomatoes not only because of post-harvest infections but also to prevent the occurrence of foodborne sicknesses that can be conveyed to consumers. Washing and disinfecting are required to clean product that has acquired latex stains from injuries resulting from bad harvesting and handling. This can be further elaborated that clean water should be used and that the tomato produce should not be washed in re-circulated water because it can easily become heavily contaminated with decay organisms leading to rotten of the washed product. It is beneficial to add hypochlorite or chlorine to the washing water of fresh fruits and vegetables to treat them to reduce microbial load before consumption. This however is mostly is recommended for only large-scale operations (Wahome, 2019). On the contrary, cleaning or disinfecting tomatoes after harvest is an uncommon technique for many handlers of tomatoes in developing economies like those in Africa (Arah et al. 2016). This technique may be ascribed to either non-existence of portable water at the production spots or the absolute witlessness of the technique. Elaborating further, Arah et al. (2016) indicated that disinfectants can be used for either washing or precooling in places where water is not a constraint, to reduce both post-harvest losses and foodborne diseases in fruits and vegetables. Tomatoes can be dipped in thiabendazole solution to reduce microbial load on the fruit (Batu& Thompson, 1995). Outbreaks of salmonella and E coil are often a result of contamination from animal waste used as a source of fertilizer. It is therefore important that all organic fruits and vegetables are thoroughly washed before sending to the market.

#### **2.5 Sorting and Grading**

Vegetables that are produced and sold in modern markets should be sorted and graded based on their size, colour, and texture. Sorting is the elimination of rotten, spoilt, or unhealthy fruits and vegetables from healthy and hygienic ones (Arjenaki et al. 2013). The damaged or diseased fruit can produce ethylene in considerable amounts which can contaminate the healthy ones close by. Grading is the procedure for grouping fruits and vegetables based on size, colour, and phase of maturity or extent of ripening. Sorting limits the spread of infectious microorganisms from bad fruits to other healthy fruits during post-harvest handling of tomatoes whereas grading assists

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handlers to group fruits and vegetables within shared parameters and this provides stress-free handling (Arah et al., 2016). Arah et al. (2016) further added that there are four basic steps involved in primary selection during sorting and grading. They involve the removal of over matured, too small, severely damaged, and deformed or rotten ones. Good class and harmless tomato fruits are matured, cleaned, well-shaped, free from pests and disease destruction, free from a mechanical injuries like cuts, abrasion, and punctures, free from microbial, chemical, and physical contamination (Esguerra et al., 2018). Classifiers must exercise good individual cleanliness like washing hands with soap and clean water before handling produce. The workers should also be in a comfortable position during sorting since an uncomfortable position can lead to fatigue and hence inappropriate sorting procedures.

### **2.6 Transportation**

The main objective in transport is to ensure that produce attain top quality condition to the final market or consumer. Tomatoes usually undertake three transport phases, farm to a collection centre or packing shed, packing shed to wholesale market and from the wholesale market to retail market (Esguerra et al. 2018). In most developing countries, transporting harvested tomatoes from the point of production to distribution centres is hampered by a poor road network. Transporting reaped tomatoes to the market on a bad road and the non-existence of proper transportation systems like chilled vans remain the greatest challenge to producers and retailers (Abimbola, 2014). This challenge according to Kader (1986) and Arah et al. (2016), causes needless interruptions in conveying the produce to the market. Any delay between the reaping and eating of tomatoes can lead to potential losses. Producers invariably use any obtainable mode of transport to convey their produce to marketing centres without bearing in mind its suitability to avoid delays which increases the perishability rate. Some of these modes of transport are tricycles, human labour, animals, public transport, hired trucks, buses, lorries, articulated trucks and pick-up vans (Esguerra et al. 2018; Getinet et al. 2011). Similar findings by Ajagbe et al. (2014) revealed that tomato farmers constantly conveyed their produce to marketing centres by using pick-up vans, motorcycles and trucks, with a handful of them using their cars to convey the produce to markets. Bicycles and heads are not commonly used to convey tomatoes to the market. This observation by Ajagbe et al. (2014) is supported by the assertion of Muhammad et al. (2012) that transportation of tomatoes ought to be carried out in a well-ventilated vehicle with a cover at the top to avoid direct sunlight, safety from rainfall and other hazards. Therefore, the use of these inappropriate transport systems facilitates post-harvest loss in fruits and vegetables.

In the course of transportation, the produce should be properly packaged and stacked to avoid excessive movement and vibration (Hurst, 2010; Idah et al. 2007). Using unsuitable packaging can cause an undesirable loss in fruits and vegetables during transport. That is severe bruising and other types of mechanical injury. The produce is susceptible to physical or chemical damages as well as microbial contamination during transport. It is therefore important

comprehensive food safety and food quality program is given adequate attention to the management of the transportation environment to avoid undue losses. Loading and unloading should be as careful as possible, transit time should also be short, the product should be well protected about its sustainability to physical injuries, avoid overheating during transport, adequate ventilation and air supply should be provided and if possible, transport vehicle should not stop under the sun and the produce protected with a cover.

### **3. Materials and methods**

#### **3.1 Research Design**

The research design used in this study was the Triangulation Design model with the main aim of obtaining different but complementary data on the same topic (Morse, 1991, p. 122). As observed by Creswell and Plano Clark (2007) and the Office of Behavioural and Social Sciences Research (2001), this type of research design is described as a philosophically underpinned method of inquiry, where the qualitative method was used to triangulate the quantitative research design in this study. Hence, the study employed the descriptive survey method.

#### **3.2 Study Population**

The population of this study was the tomato farmers and retailers in the Upper West Region of Ghana. In this study, the target population involved tomato farmers and retailers from four selected districts in the Upper West Region namely Wa Municipal, Wa East District, Wa West, and Jirapa District. The total number of the target population was 220 from the four selected districts. The accessible population was 138 farmers and retailers from six (6) tomato growing communities in the selected Districts within the Upper West region of Ghana.

#### **3.3 Sample Size**

The study employed the use of randomized purposive sample technique to obtain data. As a result of this, the researchers selected 138 respondents (about 57 tomato farmers and 81 retailers) as the accessible population and sampled 71% (98) of them as the sample size for the study. To enhance the credibility of the study, a sample size of 41 tomato farmers and 57 tomato retailers was used for this study. It is important to observe that

#### **3.4 Sampling Technique**

The sampling techniques employed for the study were convenience, purposive and random sampling. Convenience sampling was used to select the Region and further used to select the Districts and Municipal Assemblies for the study. The purposive sampling method was also used to select the communities from the various Districts and Municipal Assemblies within the Upper West Region for the study. According to Agyedu, Donkor, and Obeng (1991), this sampling method permits researchers to intentionally sample only participants whose knowledge of the subject is essential in understanding the subject under investigation. In this study after the participants have been purposefully sampled, the random sampling technique was further



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employed to accidentally select a fraction or a reasonable proportion of the participants (sample size - 98), which represented 71% of the accessible population (138) for the study.

### **3.5 Data Collection Instrumentation**

Hsu and Sandford (2010) describe instruments for data collection as the tools used by researchers to measure variables of importance in the data gathering process. There is several research tools for data gathering, nevertheless, considering the data required and the nature of the study, questionnaire instruments about the descriptive survey method were found to be most appropriate for obtaining the right data in this study. The questionnaires were administered to the farmers and retailers and were ably assisted by the researcher to gain a full understanding of the questions asked. The activities of the farmers and retailers were closely observed by the researcher for two months.

### **3.6 Questionnaire**

Malhotra and Birks (2007) describe a questionnaire as a set of questions for collecting data from large group(s) of individuals at the same time and respondents are free to express their views without being intimidated by the researchers. Two sets of questionnaires were designed to obtain data from tomato farmers and retailers. In this study, a standardised structured questionnaire was used to gather data from respondents for the study. Close-ended questions were used to seek the views of respondents on the handling practices of tomatoes by tomato producers and retailers.

### **3.7 Validation and Reliability of Instruments**

Validation of instrument gives an elucidation on how effective the systems of measurement in a study are captured by the data obtained through the research questions. Validation confirms the precision and validity of the study design. Validation also determines the degree to which the results of the study can replicate similar results in a different place, and can be generalized to other populations or circumstances. Validation ensures that the study conducted and reported is an illustration of the validity and reliability of the research. More importantly, the face and content validity of the instruments were carried out by the Catering and Hospitality Department of the University. To ensure the reliability of the instruments used in this study, pilot testing was conducted in four other districts in the region namely: Lawra, Nadowli/Kaleo, Issah, Busie, Daffiama, and Lambussie/Karni districts. These districts were chosen because they were the second leading producers of tomatoes in the Upper West Region. Drafted copies of the questionnaire were administered to farmers and retailers. The retailers and farmers were randomly selected and briefed. Respondents were met at an appropriate place to discuss any ambiguity and doubt that they might face with any aspect of the draft questionnaire.

### **3.8 Ethical Consideration**

Ethical consideration is simply the standards of behaviour that separate conventional and unconventional behaviour. They simply refer to performing actions that are ethically and right

when carrying out a study. The subsequent ethical issues were considered. The researchers sought consent to conduct the study from the University using an introductory letter. Participants of the study were briefed on the nature and purpose of the study before eliciting information from them. Respondents were also assured of a high standard of confidentiality. Additionally, the participants of the study were informed that the data obtained from them is exclusively for academic purposes.

#### **4. Results and discussion**

##### **4.1 Demography of the Tomato Handlers (Farmers and Retailers)**

The demographic information of the study participants in this study presents details of the population structure, which aids to fashion out fair representation of the various participants that represented the entire population. The study analysed demographic characteristics of the respondents by establishing their gender, age, marital status and nationality. The study therefore sought to determine how the sampled participants (tomato farmers and retailers) were spread by gender, age, nationality, marital status, and to allow for tabulation of response. Data in Table 1 shows how the participants (tomato farmers and retailers) of the study were distributed by gender, age, nationality and marital status.

The data obtained in this study revealed that the gender of the sampled farmer respondents were 53.7% (majority) for males and 46.3% females. This was an indication that more males were engaged in tomato farming compared to a few females in tomato production in the study area. It can also be inferred from the outcome of the study that gender was not fairly distributed in the sampled tomato farmers' population, a situation clearly described by Yeboah (2012) as a male-dominating profession. Anaba (2018) makes similar observation that a greater number of farmers in the Upper East Region were males, a strong indication that tomato farming is dominated by males, which could be attributed to the fact that women mostly performed almost domestic chores and may not necessarily have equal amount of time for tomato farming like their male counterparts. This fallout also supports similar findings by current research by Awunyo-Victor, Wongnaa and Aidoo (2016) that farming in Ghana is a male-dominated profession. The data obtained in this study also revealed that the gender of the sampled retailer respondents were 61.4% (majority) for females and 38.6% males. It can therefore be inferred that tomato retailers in the study area were predominantly women. Data in Table 1 also indicate that 29.3% of tomato farmers in the study area were aged between eighteen (18) to twenty-four (24) years, while those between twenty-five (25) and forty (40) years were 36.6%, those between forty-one (41) and fifty-five (55) years were 17.1%, and those above fifty-five (55) were 14.6%. No farmer was below eighteen (18) years.

In Table 1, the data obtained from the respondents indicated that 15.8% of tomato retailers in the study area were aged between eighteen (18) to twenty-four (24) years, while those between twenty-five (25) and forty (40) years were 38.6%, those between forty-one (41) and fifty-five

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(55) years were 35.1%, and those above fifty-five (55) were 10.5%. No retailer was below eighteen (18) years. Table 1 shows that majority (97.6%) of the tomato farmers were Ghanaians, while only 2.4% (1) was a non-Ghanaian. Data in Table 1 also shows that majority (91.2%) of the tomato retailers were Ghanaians, while only 8.8% (5) were non-Ghanaians. Data shown in Table 1 revealed that majority (58.5%) of the sampled farmer respondents were married, while 9.8%, 9.8%, 7.3% and 14.6% were single, divorced, widowed and separated respectively. Data presented in table 1 indicated that majority (70.1%) of the sampled retailer respondents were married, while 5.3%, 8.8%, 10.5% and 5.3% were single, divorced, widowed and separated respectively.

**Table 1: Demography of Respondents**

Variables	Frequency ( <i>f</i> )	Percentage (%)
<b>Farmer Respondents</b>		
<b>Gender</b>		
Male	22	53.7%
Female	19	46.3%
<b>Total</b>	<b>41</b>	<b>100.0</b>
<b>Age</b>		
Below 18	0	0
18 – 24 years	12	29.3%
25 – 40 years	15	36.6%
41 – 55 years	7	17.1%
Above 55 years	6	15.6%
<b>Total</b>	<b>41</b>	<b>100.0</b>
<b>Nationality</b>		
Ghanaian	40	98%
Non-Ghanaian	1	2%
<b>Total</b>	<b>41</b>	<b>100.0</b>
<b>Marital Status</b>		
Married	16	58.5.7%
Single	4	9.8%
Divorced	4	9.8%
Widowed	3	7.3%
Separated	6	14.6%
<b>Total</b>	<b>41</b>	<b>100.0</b>
<b>Retailer respondents</b>		
<b>Gender</b>		
Male	16	39%
Female	25	61%

<b>Total</b>	<b>41</b>	<b>100.0</b>
<b>Age</b>		
Below 18	0	0
18 – 24 years	9	15.8%
25 – 40 years	22	38.6%
41 – 55 years	20	35.1%
Above 55 years	6	10.5%
<b>Total</b>	<b>41</b>	<b>100.0</b>
<b>Nationality</b>		
Ghanaian	52	91.2%
Non-Ghanaian	5	8.8%
<b>Total</b>	<b>57</b>	<b>100</b>
<b>Marital Status</b>		
Married	40	70.1%
Single	3	5.3%
Divorced	5	8.8%
Widowed	6	10.5%
Separated	3	5.3%
<b>Total</b>	<b>57</b>	<b>100.0</b>

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Data was collected on the post-harvest handling practices of tomatoes by tomato farmers and retailers and the results are presented in Table 2.

Tomato farmers responded in Table 2 that majority (56.1%) of them agree with the statement that their tomatoes are usually matured (ripped) and that they are usually harvested in their red state, with (41.5%) of them strongly agreeing to this statement. Very few (2.4%) of them strongly disagreed with this assertion.

Majority (78%) of the respondents answered in agreement that their tomatoes are more often harvested in the morning, with (17.1%) of them strongly in agreement, while 2.4% of the disagreed and (2.4%) of them remained undecided. About (34.1%) of the farmers disagreed that their tomatoes are often harvested and heaped on the ground before sorting and grading, while (31.7%), (2.4%) and (4.9%) of them agreed, strongly agreed and strongly disagreed respectively. Exactly (24.4%) of the respondents remained undecided as to whether or not they often harvested and heaped their produce on the ground before sorting and grading. It was disagreed by (34.1%) of farmers that they do clean and disinfect their tomatoes after harvesting, while

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(29.3%) strongly disagreed and (31.7%) of them remained undecided whereas (4.9%) of the farmers agreed to this assertion. Exactly (41.5%) of the farmer respondents strongly disagreed that they sort and grade their produce after harvesting, whereas (39%) disagreed, (2.4%) strongly disagreed (7.3%) agreed and (9.8%) remained undecided.

When asked as to whether farmers precool their produce before transporting, majority of the respondents (51%) disagreed to the statement, (7.3%) strongly disagreed, (12.2%) agreed and (29.3%) of them remained undecided to the statement. When enquired whether there were poor transportation networks leading to tomato farms, (75.6%) representing majority agreed that there were indeed poor transportation networks leading to their tomato farms, whereas (4.9%) also strongly agreed, (9.8%) disagreed and (4.9%) of them remained undecided. Regarding the provision of training in post-harvest management of tomatoes, (46.3%) of the farmer respondents strongly disagreed with the statement that farmers in their respective communities often receive training in post-harvest management of tomatoes with (26.8%) in disagreement, while (14.6%) agreed, (4.9%) strongly agreed and (7.3%) remained undecided. Majority (68.3%) of farmers agreed with the statement that they do not have refrigerated vans to transport their produce to marketing centres, whereas (7.3%) strongly disagreed to the statement, (9.8%) disagreed and (7.3%) remained undecided. Also, majority (75.6%) of the participants agreed that farmers do place their tomato produce in wooden crates for sales as against (7.3%) strongly in disagreement, (9.8%) in agreement and (7.3%) remaining undecided. Majority (80.5%) of the respondents agreed that tomatoes are usually placed in woven baskets for sale to middlemen, while (2.4%), (9.8%), and (4.9%) strongly disagreed, disagreed and remained undecided respectively. When asked whether tomatoes are often placed in buckets for sale to traders, (73.2%) of farmer respondents indicated they were in agreement with the assertion that their produce are often placed in buckets for sale to traders, while (9.8%) disagreed and (14.6%) remained undecided.

On whether farmers often transport their tomatoes using motor bicycles/tri-cycles, most (80.5%) of the respondents reported that they agree with the statement, whereas (9.8%) disagreed and (4.9%) remained undecided. On whether most farmers used trucks/pick-up to convey their produce to market centres, most (65.9%) of the respondents agreed to the statement, while (2.4%) strongly disagreed, (17.1%) disagreed and (9.8%) remained undecided. On the issue of tomato farmers transporting their produce by heads to the market centres, (43.9%) disagreed, contrary to (29.3%) agreeing, (4.9%) strongly disagreeing with (22%) remaining undecided. Regarding the distance between the farm and market centres, majority (70.7%) of the farmer respondents agreed with the statement that their tomato farm is far away from the market centres, whereas (22%) strongly agreed, (4.9%) disagreed and (2.4%) remained undecided. With respect to tomatoes usually taking long duration before they are bought by buyers/ traders, majority (73.2%) of the respondents agreed to the statement, (17.1%) strongly agreed, while (4.9%) disagreed and (9.8%) remained undecided. Most (73.2%) of the sampled respondents

agreed and (12.2%) strongly agreed with the statement that the hand-picking method mainly used by farmers delays the harvesting process contrary to (4.9%) disagreeing and (9.8%) remaining undecided.

The findings of this study indicated that almost all tomato farmers (97%) wait for their tomato produce to be matured red before harvesting them. This findings is in contradiction with the situation generally described by Yeboah (2011) and Orzoleket *al.* (2006) contending that tomatoes for the retail market are best harvested at the mature green stage to avert the fruit from becoming overly ripped during long transportation and handling. The scholars recommend that tomatoes should be left on the stalk to ripe if they can be conveyed to market quickly and in good condition. In fact, this handling practice was not being adhered to in the study area since majority of the respondents harvested their tomatoes in a matured ripped reddish stage. It however takes a longer duration for it to be conveyed to the marketing centres and this could render the produce perished before reaching its final destination. Ashby (2000) further recommends that the appropriate condition to harvest and transport tomatoes is when they in the freshly green matured state. The study identified morning harvest of tomatoes as one of the best handling practices of tomato because most (98%) of the respondents affirmed that this was the usual practice by tomato handlers (farmers) in the study area. This finding support similar findings of Yeboah (2011) and earlier findings by Gould (1992) that the success of any good post-harvest handling method depends largely on the initial ambient conditions the freshly harvested tomato is subjected to and therefore, recommended harvesting under cold condition preferably early morning or late evenings as a method to cool harvested tomato fruit.

The study also established that about 80% of tomato farmers do not sort and grade their tomatoes after harvesting. This revelation is contrarily to the ideal practice which prevails that harvested tomatoes should be sorted and graded in order to get rid of damaged produce so as to prevent the possibility of contamination (Kintinojaet *al.*, 2005). They also do not precool their produce before transportation to the market. This is in affirmation to similar finding by Yeboah (2011) that connotes that tomato farmers do not exercise pre-cooling of harvested tomatoes before packing them into bins, they generally do not know of the principle of pre-cooling. This might be as a result of the fact most of them harvested their produce early in the morning where there is no field heat or lack of skills and logistics of practising pre-cooling.

It became evident in the study that transportation is one of the handling practices of tomatoes. In this study, post-harvest loss of tomatoes was attributed to poor transportation system. This was because the produce sustains bruises and mechanical damage as a result of the bad nature of roads they travel on and the transport systems that are being used. This finding reaffirms similar studies by Anaba (2018) and Barbosa-Canovas (2003) that bad transportation system worsens the produce vulnerability to deterioration and microbial development. In this study, it was established that close to 69% of tomato farmers do not have refrigerated vans to transport their produce. A situation largely attributed to lack of support from non-governmental organizations and other stake-holders. Packaging of farm produce has high chance of minimizing waste.

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Packing tomatoes in woven baskets, wooden boxes, buckets, tricycles, trucks were identified as common handling practices that have been adopted by tomato handlers in this study. A study by Issahku (2012) buttressed this assertion. In most cases, some of these handling practices become driving factors of post-harvest losses as observed by Anaba (2018) and Issahku (2012). To them, freshly harvested tomatoes that are packed in wooden boxes and other such containers experience high losses.

**Table 2: Post-Harvest Handling Practices of Tomatoes among Farmers**

No.	Questionnaire Items	Strongly Disagree 1	Disagree 2	Undecided 3	Agree 3	Strongly Agree 5
1	Tomatoes are usually	1	0	0	23	17
	matured (ripened) and	(2.4%)	(0%)	(0%)	(56.1%)	(41.5%)
2	Tomatoes are more often	0	1	1	32	7
	harvested in the morning	(0%)	(2.4%)	(2.4%)	(78%)	(17.1%)
3	Tomatoes are often	2	14	10	13	2
	harvested and heaped on	(4.9%)	(34.1%)	(24.4%)	(31.7%)	(2.4%)
4	Farmers do clean and	2	14	13	12	0
	disinfect their tomato	(29.3%)	(34.1%)	(31.7%)	(4.9%)	(0%)
5	Tomato produce are	1	16	4	17	3
	often sorted and graded	(2.4%)	(39%)	(9.8%)	(41.5%)	(7.3%)
6	Tomato farmers do	3	21	12	5	0
	process their tomato	(7.3%)	(51.2%)	(29.3%)	(11.2%)	(0%)
7	There are poor	0	4	2	31	2
	transportation networks	(0%)	(9.8%)	(4.9%)	(75.6%)	(4.9%)
8	Farmers in my	19	11	3	6	2
	community often get	(46.3%)	(26.8%)	(7.3%)	(14.6%)	(4.9%)
9	Farmers do not have	3	4	3	28	3
	refrigerated vans to	(7.3%)	(9.8%)	(7.3%)	(68.3%)	(7.3%)
10	Farmers do place their	3	4	3	31	0
	tomato produce in	(7.3%)	(9.8%)	(7.3%)	(75.6%)	(0%)
11	Tomatoes are usually	1	4	2	33	1
	placed in woven baskets	(2.4%)	(9.8%)	(4.9%)	(80.5%)	(2.4%)
12	Tomatoes are often	0	4	6	39	1
	placed in buckets for sale	(0%)	(9.8%)	(14.6%)	(73.2%)	(2.4%)
13	Farmers often transport	0	4	2	33	2
	their tomatoes using	(0%)	(9.8%)	(4.9%)	(80.5%)	(4.9%)
14	Most farmers used	1	7	4	27	2
	trucks/pick-up to convey	(2.4%)	(17.1%)	(9.8%)	(65.9%)	(4.9%)
15	Tomatoes farmers	0	18	9	12	2
	transport their produce	(0%)	(43.9%)	(22%)	(29.3%)	(4.9%)
15	Your tomato farm is far	0	2	1	29	9
	away from the market	(0%)	(4.9%)	(2.4%)	(70.7%)	(22%)
16	Tomatoes usually take	0	2	4	30	7
	long duration before they	(0%)	(4.9%)	(9.8%)	(73.2%)	(17.1%)

17	The hand-picking method mainly used by farmers delays the	0 (0%)	2 (4.9%)	4 (9.8%)	30 (73.2)	5 (12.2%)
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SA = Strongly Agree, A = Agree, U = Undecided, D = Disagree, SD = Strongly Disagree

#### 4.2 Post-Harvest Handling Practices of Tomatoes among Retailers in Some Selected Districts in the Upper West Region of Ghana

Tomato retailers in table 4.2.2 revealed that tomatoes are usually sold to them in their matured (ripped) reddish state by farmers. Majority (86.1%) of the respondents agreed to this assertion, with (8.8%) of them strongly agreeing to this statement. Very few (1.8%) of them strongly disagreed with this assertion whereas (3.5%) of them remained undecided. Majority (73.7%) of the respondents answered in agreement that tomatoes are more often harvested in the morning by farmers before being sold to retailers with (7%) of them strongly in agreement, while (7%) of the respondents disagreed and (12.3%) of them remained undecided. About (54.4%) of the retailers agreed that tomatoes are often harvested and heaped on the ground before being sold to them, while (17.5%) of them disagreed. Exactly (24.6%) of the respondents remained undecided as to whether or not farmers harvested and heaped their produce on the ground before selling to retailers. Exactly 66.7% of the retailer respondents agreed to the statement that they sort and grade tomatoes after buying from farmers before selling, whereas (7%) strongly agreed, (5.3%) disagreed and (21.1 %) remained undecided.

When enquired whether there were poor transportation networks leading to tomato farms, (82.5%) making a majority of the retailers agreed that there were indeed poor transportation networks leading to tomato farms, whereas (5.3%) also strongly agreed and (12.3%) of them were undecided. Majority (86%) of retailer respondents agreed with the statement that they do not have refrigerated vans to transport tomatoes, whereas (53%), (3.5%) and (5.3%) strongly agreed, disagreed and remained undecided respectively. Also, majority (75.4%) of the participants agreed that retailers do place their tomato produce in wooden crates for sales as against (8.8%) who disagreed, with (8.8%) remaining undecided.

Majority (70.2%) of the respondents agreed that tomatoes are usually placed in woven baskets for sale to customers, while (8.8%), (1.8%), (17.5%) and (4.9%) strongly agreed, strongly disagreed, disagreed and remained undecided respectively. When asked whether tomatoes are often placed in buckets for sale to customers, (71.9%) of retailer respondents indicated they were in agreement with the assertion that their produce are often placed in buckets for sale, (10.5%) strongly agreed, while (12.3%) disagreed and (5.3%) remained undecided. On whether farmers often transport their tomatoes using motor bicycles/tri-cycles, most (80.7%) of the respondents reported that they agree with the statement and 8.8% strongly agreed, whereas 1.8% disagreed, 1.8% strongly disagreed and 7% remained neutral. On whether most retailers used trucks/pick-



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up to convey their produce to market centres, most (77.2%) of the respondents agreed and (10.5%) strongly agreed, while (1.8%) disagreed and (10.5%) remained undecided. On the issue of tomato retailers transporting their produce by heads to the market centres, 64.9% (majority) agreed and (5.3%) strongly agreed in contrast to (12.3%) disagreeing with (17.5%) remaining neutral. Regarding the distance between the farm and market centres, majority (71.9%) of the retailer respondents agreed with the statement that tomato farms are far away from the market centres, whereas (10.5%) strongly agreed, (1.8%) disagreed and (15.8%) remained undecided. With respect to tomatoes usually taking long duration before they are bought by customers, majority (71.9%) of the respondents agreed, (7%) strongly agreed, while just (5.3%) disagreed and (15.8%) remained neutral.

Findings from the study revealed that most retailers buy their tomatoes from farmers when they are reddish red (fully ripped). This means they are harvested ripped and ready for immediate sale and should not be subjected to long distance of travel. Freshly harvested fruits continue to respire after harvest and can easily deteriorate if not sold or consumed after a short period. This finding is contrarily to the assertion of Yeboah (2011) which reiterated that tomatoes for the retail market should be harvested when matured green to give room for longer distances and hours of travel to the marketing centres before it becomes overly ripped and finally deterioration. Again, majority of the retailers agreed that they sort and grade their tomatoes in order to separate wholesome and damaged ones before selling. This practiced is highly commendable as partially ripped, overly ripped, damaged and wholesome tomatoes are separated/detached to ensure longer keeping value of quality ones and also to avoid transfer of microorganisms. This practice is highly recommended by Arjenakiet *al.* (2013) which affirmed that sorting limits the spread of microorganisms from unhealthy to healthy fruits.

It is established from the study that one of the handling practices that easily subject the produce to perishability is transportation. This is as a result of the fact that poor road network coupled with inappropriate transport systems used to convey tomatoes to marketing centres subject the produce to mechanical damages causing punctures and bruises on the fruit. This finding is in affirmation with similar findings from Barbosa-Canovas (2003) which revealed that bad transport systems worsened the produce vulnerability and further aggravate microbial contamination. The study also identified inappropriate packaging as one of the handling practices of tomatoes by retailers which increases damage caused on tomatoes. Close to 85% of the tomato retailers affirmed that packaging tomatoes in basins, buckets and similar containers which do not allow free air circulating on the produce and exposure to severe sunshine generates excessive heat around the produce and eventually influence spoilage. This revelation is in agreement with similar argument raised by Idah et al. (2007) which indicated that undignified post-harvest sanitation, improper packaging systems, mechanical damaged, poor transport, undulating and irregular nature of the roads are some of the rough handling practices that leads to potential losses. Esguerra et al. (2018) in support of the findings explained that the

characteristics of tomatoes does not support improper handling which can easily leave punches, holes, wounds and pathways to loss of water and other vital nutrients.

**Table 3: Post-Harvest Handling Practices of Tomatoes among Retailers**

No.	Questionnaire Items	Strongly Disagree 1	Disagree 2	Undecided 3	Agree 3	Strongly Agree 5
1	Tomatoes are usually sold in a matured reddish (ripped) form to retailers	1 (1.8%)	0 (0%)	2 (3.5%)	49 (86%)	5 (8.8%)
2	Tomatoes are more often harvested in the morning before they are bought by retailers	0 (0%)	4 (7%)	7 (12.3%)	42 (73.7%)	4 (7%)
3	Tomatoes are often harvested and heaped on the ground before selling to retailers	0 (0%)	10 (17.5%)	14 (24.6%)	31 (54.4%)	2 (3.5%)
4	Retailers often sort and grade tomatoes after buying from farmers	0 (0%)	3 (5.3%)	12 (21.1%)	38 (66.7%)	4 (7%)
5	There are poor transportation networks leading to tomato farms	0 (0%)	0 (0%)	7 (12.3%)	47 (82.5%)	3 (5.3%)
6	Retailers do not have refrigerated vans to transport their produce	0 (0%)	2 (3.5%)	3 (5.3%)	49 (86%)	3 (5.3%)
7	Retailers do place their tomato produce in wooden crates for sales	0 (0%)	5 (8.8%)	5 (8.8%)	43 (75.4%)	4 (7%)
8	Tomatoes are usually placed in woven baskets before they are being sold to customers	1 (1.8%)	10 (17.5%)	1 (1.8%)	40 (70.2%)	5 (8.8%)
9	Tomatoes are often placed in buckets before they are being sold to customers	0 (0%)	7 (12.3%)	3 (5.3%)	41 (71.9%)	6 (10.5%)
10	Traders often transport their tomatoes to the market centres using motor bicycles/tri-cycles	1 (1.8%)	1 (1.8%)	4 (7%)	46 (80.7%)	5 (8.8%)
11	Most retailers used trucks/pick-up to convey their produce to market centres	0 (0%)	1 (1.8%)	6 (10.5%)	44 (77.2%)	6 (10.5%)
12	Tomatoes retailers transport their produce by heads to the market centres for sale to customers	0 (0%)	7 (12.3%)	10 (17.5%)	37 (64.9%)	3 (5.3%)

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13	Tomato farm is far away from the market centres	0 (0%)	1 (1.8%)	9 (15.8%)	41 (71.9%)	6 (10.5%)
14	Tomatoes usually take long duration before they are bought by customers in the market centres	0 (0%)	3 (5.3%)	9 (15.8%)	41 (71.9%)	4 (7%)

SA = Strongly Agree, A = Agree, U = Undecided, D = Disagree, SD = Strongly Disagree

## 5. Conclusion

The study revealed that tomatoes are harvested early in the morning in matured reddish state for transported. Longer distance of travelling to marketing centres renders the produce to perish faster. Tomatoes are not sorted, graded and pre-cooled to remove overly ripped, under ripped, small and big one. No pre-cooling is also done to remove heat and warmth from tomatoes which can render it perishes. Tomatoes are inappropriately packaged and transported in inappropriate vehicles which increase mechanical damages on the produce. The longer hours of travelling from tomatoes farms to marketing centres with already ripped tomatoes in undulating roads increases spoilage rate before tomatoes finally get to the consumer. The study discovered that mechanical damage, limited available market, Inappropriate transport and bad nature of the roads, diseases and pests infestations, low quality of locally produced tomatoes, long distances of farming communities to marketing centres and so many farmers producing tomatoes at the same time or period for the same market leading to excessive glut of the produce as the cause of post-harvest loss of tomatoes in the selected districts in the Upper West Region

## 6. Recommendations

Tomato farmers and retailers in the various district should be linked to boarding and day schools in their respective districts as suppliers of tomatoes for the school feeding program by the various district assembles

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