

Full Length Research Paper

# Determinants of postharvest losses in tomato production in the Offinso North district of Ghana

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The aim of this study was to examine the determinants of postharvest losses in tomato production in the Offinso North district of Ghana. A standardized structured questionnaire was used to collect data from 150 farmers who were selected through a combination of purposive and simple random sampling techniques. We used descriptive statistics to summarize the characteristics of the respondents. Multiple regression analysis was conducted to examine the determinants of postharvest losses in tomatoes. A typical tomato farmer in the district was found to be a male of 44 years, married, with a household size of five and had attained basic level of education. On average, farmers cultivated tomatoes on a farm size of about 5 acres and had about 20 years of farming experience. The study showed that farmers obtained 1,159.21 kg of tomatoes in the major season and 962.78 kg in the minor season on an acre of land, out of which 40 and 14% were lost, respectively. From the perspective of the farmers, the primary sources of losses were rot and bruises caused by poor handling, diseases and pest attack. From the regression analysis, gender of the farmer, household size, farm size, days of storage, membership of Farmer Based Organization (FBO) and type of tomato variety cultivated were found to significantly influence the level of postharvest losses incurred. Female gender, farm size and days of storage were found to be positively associated with losses in tomato production. However, household size, membership of FBO and cultivation of improved varieties were found to reduce postharvest losses, *ceteris paribus*. Lack of storage facilities, high cost of production and limited access to credit were found to be the critical constraints faced by tomato farmers. The study recommended the formation and joining of FBOs, periodic training and education of farmers on the cultivation of improved varieties of tomatoes as well as training on proper handling of tomato fruits to reduce postharvest losses.

**Key words:** Tomato, postharvest losses, regression analysis, Ghana.

## INTRODUCTION

Tomato is an important cash crop in the forest, transitional and savannah zones of Ghana (Norman, 1992). It forms a very important component of food consumed at the household level as evident in the fact

that many Ghanaian dishes have tomatoes as a component ingredient (Tambo and Gbemu, 2010). Tomato production is a source of livelihood and income for a greater number of people in the Offinso North

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district in Ghana as well as agents involved in its distribution and marketing throughout the country.

Vegetables like tomato are usually harvested when they are fresh and high in moisture and are thus distinguished from field crops, which are harvested at the mature stage for grains, pulses, oil seeds or fibre. This high moisture content of such vegetables makes their handling, transportation and marketing a special problem particularly in the tropics (Sablani et al., 2006).

The quality and nutritional value of fresh produce like tomato are affected by postharvest handling and storage condition (Sablani et al., 2006). Tomato losses can be caused by a wide variety of factors, ranging from growing conditions to handling at retail level. Many postharvest losses are direct result of factors such as high field temperatures on crops before harvesting, pests and diseases attack, among others.

In Ghana, there has been serious attempt at improving the production capacities of farmers to increase tomato production (Yeboah, 2011). However, the sector is plagued with huge levels of post-harvest losses. Robinson and Kolavalli (2010) indicated in their research report that postharvest losses are highest for tomatoes and lettuce which record up to 20% after 5 days of harvesting. Out of the 510,000 metric tons of fresh tomato fruits produced annually in Ghana, the country losses about 153,000 metric tons (30%). In 2011, the Offinso-North district produced about 19,550 metric tons of tomatoes but lost about 31% due to postharvest losses (MoFA, 2011).

The tomato production sector in Ghana has failed to reach its maximum potential in terms of yields as compared to other countries as well as improving the livelihoods of those households involved in the production of the crop. Average yields remain low, typically under 10 tons/ha, due partly to postharvest losses (Robinson and Kolavalli, 2010). Not only are these losses clearly a waste of food, but they also represent a waste of human effort, farm inputs, and scarce resources such as water (World Resource Institute, 1998).

Many factors have been hypothesized in the professional literature to be very important determinants of postharvest losses in tomato. Inappropriate storage facilities and rough handling during harvesting result in bruising and increased possibilities of contact of the produce with the soil which leads to contamination with organisms. Long distances from farms to markets as well as insufficient storage conditions can lead to losses to the tomato produce (Chandy, 1989). Adarkwa (2011) reported that improper harvest and postharvest practices result in losses due to spoilage of the product before reaching the market, and loss of quality attributes such as appearance, firmness, taste and nutritional value. A study by Babalola et al. (2010) showed that the longer the distance from farm to the market, the greater the losses experienced due to congestion of the tomato fruits and the resultant build-up of heat. Mujib et al. (2007) also

noted that type and quantity of labour used in harvesting played a vital role in postharvest losses. Skilled labourers pick and handle the produce with care and hence do little damage to the fruit. They, therefore, recommended the use of trained labourers if postharvest losses are to be minimized. Tomato fruits should be harvested at mature green state for long distance marketing and full ripen stage for fresh consumption in order to reduce postharvest losses (Moneruzzaman et al., 2009). The variety of tomato cultivated affects the level of postharvest losses experienced by farmers as different varieties have different characteristics such as firmness, disease resistance, among others, which impact on postharvest losses. Orzolek et al. (2006) recommended that tomato producers should harvest mature fruits in the morning when the temperature is cool to reduce losses.

In Ghana, attempts at explaining the underlying causes of postharvest losses in tomato production have largely remained in the realm of speculation and conjecture. However, empirical information on the main causes of these losses are required if solutions are to be found for this critical problem in tomato production. Therefore, this study was designed to examine empirically, the factors that influence the level of postharvest losses of fresh tomatoes at the farm level. Specifically, the study sought to determine the level of postharvest losses experienced by tomato producers and the key factors that account for these losses.

## METHODOLOGY

### Study area

The study was conducted in the Offinso North district of the Ashanti Region of Ghana. Offinso North is located in the extreme North-Western part of the region and lies within longitude 1°45'N and 1°65'W. The district has a population of about 56,881 (GSS, 2010), with a total land area of 1,008.3 km<sup>2</sup>. The current farming population is around 30,000 comprising 15,030 males and 14,970 females. The district lies within the wet semi-equatorial zone of Ghana with a bi-modal rainfall regime and a mean monthly temperature of 27°C. Offinso North district is the leading tomato producing district in the Ashanti region. Tomato is grown all over the district with heavy concentration at Akomadan, Afrancho, Nkenkaasu, Asuoso, Nsenua and Mantukwa communities. The average annual production is over 19,000 metric tons of tomato fruits. Each year over 30% of tomato fruits goes waste with some farmers refusing to harvest due to very low market price for the commodity. Total land area under tomatoes cultivation is estimated at about 20,049 ha. Tomato is produced throughout the year in the district in valley bottoms and with small scale local irrigation schemes (MoFA, 2011).

### Method of data collection and analytical procedure

Primary data was obtained from tomato farmers through personal interviews with the use of a standardized structured questionnaire. In consultation with Agricultural Extension Agents (AEAs) at the district, a list of communities noted for tomato production was prepared and a simple random sampling technique was used to

**Table 1.** Summary statistics of the socioeconomic characteristics of respondents.

Variable	Minimum	Maximum	Mean	Std. deviation
Age (years)	19.00	62.0	44.00	9.44
Household size	1.00	13.00	5.00	1.82
Years of education	0.00	19.00	5.00	4.16
Annual income (GHC)	478.00	8000.00	3303.40	1880.45
Farm size (Ha)	0.20	8.00	2.12	1.84
Land owned by household (ha)	0.00	18.00	7.75	4.68

Source: Survey Data (2013).

select six communities including: Akomadan, Afrancho, Nkenkaasu, Asuoso, Nsenua and Mantukwa. A list of tomato producers at the community level was obtained and a systematic random sampling technique was used to select 25 farmers from each community. The questionnaire used for the interview sought information on general characteristics of respondents, production information, postharvest losses and constraints faced by tomato producers. Interviews were done in the local language in order not to create any language barrier. Key informant interviews (with Agricultural Extension officers and Researchers at Crops Research Institute) were also conducted to gather technical information on tomato production in order to verify and validate the accuracy of some information supplied by farmers.

Descriptive statistics such as arithmetic mean, standard deviation as well as frequency distribution tables and charts were employed to summarize the characteristics of the respondents. Economic value of fresh tomato fruits lost was obtained by multiplying the physical quantity of fruits lost by the average prevailing market price. Multiple regression analysis was employed to determine the main factors that influence postharvest losses. The model used was specified in the double logarithmic form as:

$$\ln PHL = b_0 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + b_8 \ln X_8 + \mu$$

Where  $\ln$  denotes natural logarithm; PHL = postharvest losses (kg);  $X_1$  = time of harvest after maturity (days);  $X_2$  = type of labour used for harvesting (1 = family labour; 0 if otherwise);  $X_3$  = time between harvesting and selling of produce (days);  $X_4$  = variety of tomato grown (1 = if Improved variety; 0 if otherwise);  $X_5$  = farm size (acres);  $X_6$  = distance from farm to market (km);  $X_7$  = member of Farmer Based Organization (FBO) (1 = Yes; 0 = No);  $X_8$  = Quantity of fruits harvested (kg);  $\mu$  = error term.

The double logarithmic functional form is usually preferred in empirical analysis since coefficients are easy to interpret; it also has the added advantage of reducing the incidence of multicollinearity. The model was estimated using the ordinary least squares method. A five-point likert scale was used to assess the constraints faced by tomato producers in the district.

## RESULTS AND DISCUSSION

### Characteristics of farmers

Tomato production in the Offinso district was found to be dominated by males; only 23% of the respondents were females. However, most of these males work together with their spouses on their tomato farms. A typical tomato farmer was found to be about 44 years, with basic level of

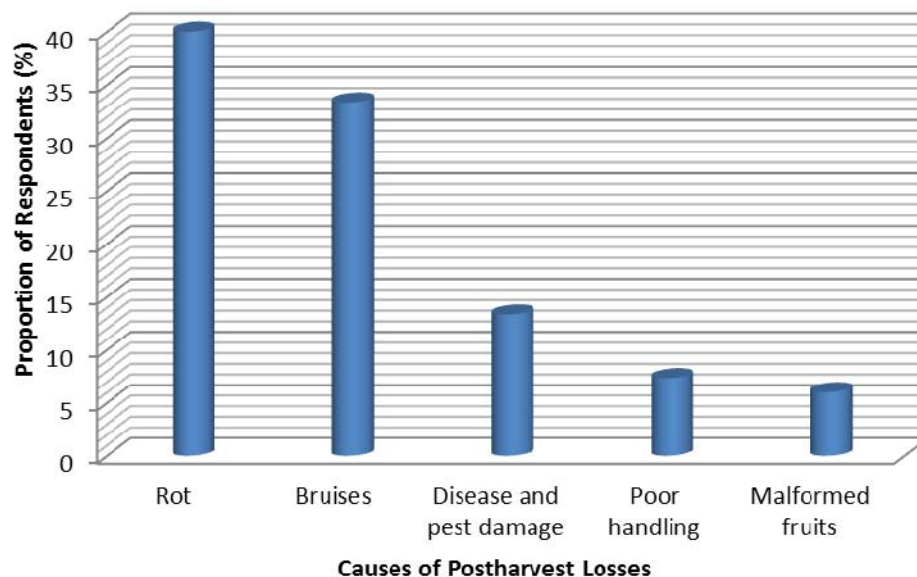
education and a household size of five people (Table 1). Out of about 7.6 ha of farm land owned by a typical farmer, about 2.1 ha were put under tomato cultivation, implying that farmers are largely small to medium scale producers. Annual income at the household level was estimated to be GHC3303.40 (US\$1573.05) which translates to about GHC660.68 (US\$314.61) per capita per annum. It can be inferred from the figure that on average tomato farmers are quite poor since they live under US\$2.00 per day per capita.

### Causes of postharvest losses

Farmers were provided with several options to select the main cause of postharvest losses in tomato production. From their ranking, postharvest losses resulted largely from rot and bruises (mechanical damage) which were mainly caused by on-farm activities (Figure 1). Farmers reported that rot resulted from over-use of spraying chemicals (herbicides and insecticides), excess watering and contact of fruits with the soil. Bruises, however, resulted from poor staking and poor handling during harvesting and sorting. From the perspective of the farmers, the three most critical secondary factors that impacted heavily on postharvest losses in tomato production were lack of ready market for produce, unreliable means to transport produce to market and longer distances from producing centres to market centres (Table 2). It can be inferred from the table that farmers consider marketing issues as the main cause of postharvest losses in tomato production. Things within their control such as time of harvest, type of variety grown and harvesting technique adopted were rather considered to have low or minimal impact on postharvest losses.

### Analysis of tomato output, revenue and postharvest losses

Table 3 summarizes information on production, losses and revenues obtained from tomato production during the 2012 cropping season (Detailed results are in the Appendix). The results indicate that the average land



**Figure 1.** Primary causes of postharvest losses in tomato production. **Source:** Generated from field data (2013).

**Table 2.** Contribution of secondary factors to postharvest losses.

Factor	Very high (5)	High (4)	Moderate (3)	Low (2)	Very low (1)	Mean score	Rank
Lack of market avenue	91	44	14	1	-	4.50	1 <sup>st</sup>
Unreliable means of transport	21	65	48	14	2	3.59	2 <sup>nd</sup>
Longer distance to market	6	67	48	22	7	3.30	3 <sup>rd</sup>
Untimely harvest	3	45	75	24	3	3.14	4 <sup>th</sup>
Type of variety used	14	18	92	26	-	3.13	5 <sup>th</sup>
Poor harvesting technique	15	33	66	27	9	3.12	6 <sup>th</sup>

Source: Generated from field data (2013).

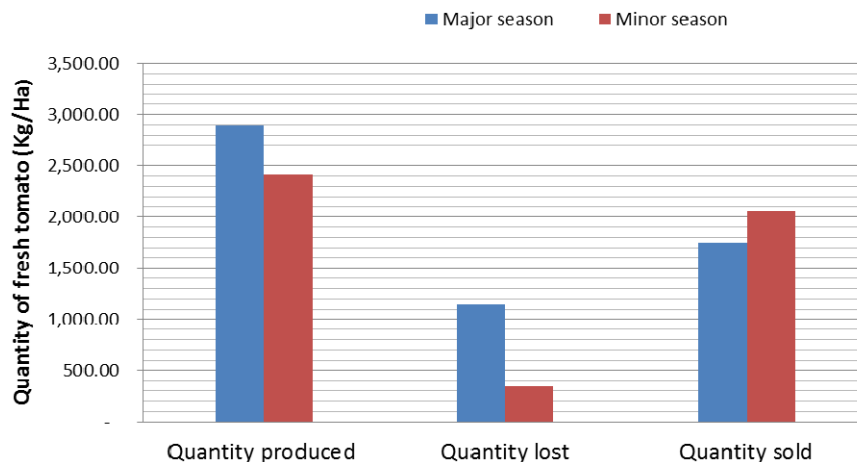
**Table 3.** Analysis of tomato output and postharvest losses for the 2012 cropping season.

Variable	Major season	Minor season
Land area (ha)	2.12	2.02
Output (kg)	6,143.80	4,871.68
Quantity of output lost (kg)	2,437.46 (39.7%)	690.83 (14.2%)
Quantity sold(kg)	3,706.34	4,180.77
Unit price (GH¢ /100 kg)	56.51	97.33
Revenue obtained (GH¢ )	2,094.45	4,069.22
Value of losses (GH¢ )	1,377.41	672.39
Potential revenue (GH¢ )	3,471.86	4,741.61

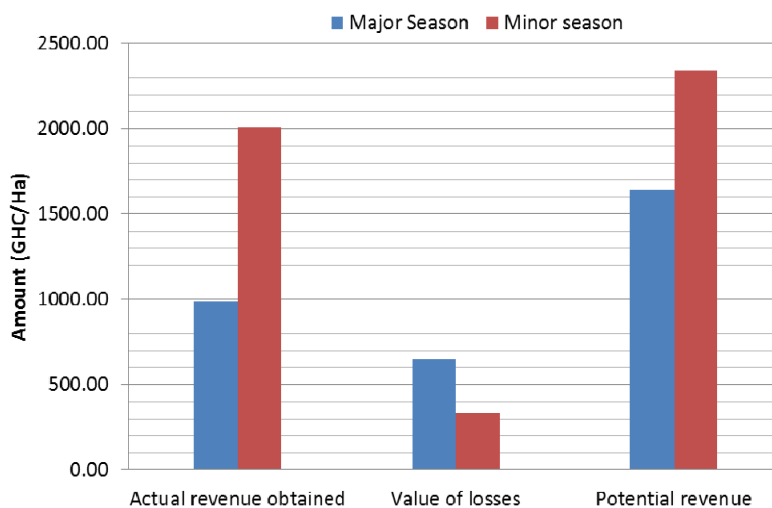
Source: Generated from field data (2013).

area put under tomato cultivation was about 2 ha during both major and minor seasons. On average, the total output of fresh tomato obtained in the major season was 6,143.80 kg compared to 4,871.68 kg in the minor

season. Average yield was estimated at 2,898 kg/ha for major season and 2,412 kg/ha for the minor season. Quantity of output lost during the major season was 2,437.4 kg and its value in monetary terms was GH¢



**Figure 2.** Analysis of tomato yield and postharvest losses per hectare. **Source:** Generated from field data (2013).



**Figure 3.** Analysis of actual and potential revenue from a hectare of tomatoes. **Source:** Generated from field data (2013).

1,377.41. This represents a loss of 40% of the harvested produce. Quantity of output lost during the minor season was 690.83 kg, which was valued at GH¢ 672.39, representing about 14% of the harvested produce. On average, quantity sold during the major season was found to be 3,706.34 kg valued at GH¢ 2,094 and that for the minor season was 4,180.77kg at a value of GH¢ 4,069.22.

Potential revenue that could have been generated in the absence of postharvest losses was estimated at GH¢ 3,471.86 for the major season and GH¢ 4,741.61 for the minor season. This means that farmers lost about 40% of the potential revenue from tomato production during the major season and 14% during the minor season.

Figures 2 and 3 indicate that on per hectare basis, quantity of tomato fruits lost during the major season was

about 1,150 kg, valued at about GHC649.72. In the minor season, only about 341 kg of tomato fruits (valued at GHC332.21) was lost per hectare cultivated. This implies that due to postharvest losses, tomato farmers received only 60% of the potential revenue during the major season and 86% during the minor season per hectare (Figure 3).

#### Determinants of postharvest losses

Table 4 gives a summary of the results obtained from the multiple regression analysis. The adjusted coefficient of determination ( $R^2$ ) was 0.42 indicating that 42% of the variation in the quantity of tomato fruits lost during and after harvesting was explained by the specified variables

**Table 4.** Regression estimates of the determinants of tomato losses.

Variable	Coefficient	Std. error	t	p>t
Constant	6.0879***	0.2463	24.72	0.000
Gender (1 = male; 0 = female)	-0.2675***	0.0951	-2.81	0.006
Ln Household Size	-0.0638**	0.0242	-2.63	0.010
Ln Education (years.)	0.0158	0.0117	1.35	0.181
Ln Farm size	0.0312**	0.0147	2.12	0.036
Ln Days to storage	0.0551**	0.0243	2.27	0.025
Ln Extension contact (per month)	-0.0145	0.0132	-1.10	0.276
Membership of FBO (1 = yes 0 = no)	-0.6081***	0.0988	-6.15	0.000
Ready market (1 = yes; 0 = no)	-0.0978	0.1097	-0.89	0.374
Ln Distance to market	0.0049	0.0151	0.32	0.744
Improved variety (1 = Yes; 0 = No)	-0.1505*	0.0884	-1.70	0.091

$R^2 = 0.424$ ;  $F = 9.78$ ; (Significant at 1%);  $SER = 0.127$  (\*, \*\* and \*\*\* denote 10, 5 and 1% significant levels, respectively)  
 Dependent variable:  $Ln_{}$  quantity of tomato fruits lost.

in the model. The F-statistic was found to be significant at 1%, which implies that all the explanatory variables had a significant joint impact on the level of tomatoes lost after harvest.

Gender and household size were the demographic variables that had a significant effect on postharvest losses in tomato production. Female farmers were found to be more prone to high levels of losses than their male counterparts. This contradicts the findings of Babalola et al. (2010) who concluded that there was little or no gender inequality in tomato farming and hence no effect of gender on postharvest losses. Tomato harvesting is very labour intensive. Generally, male-headed households tend to have many man-hours available and more time for tomato harvesting and other farm activities compared to their female counterparts who are naturally not too strong but also have household/family responsibilities to attend to. All things being equal, women tend to use longer period for fruit harvesting which then causes high levels of postharvest losses.

Household size was found to have a significant negative relationship with the level of postharvest losses incurred. Farmers who had larger household sizes tended to have lower levels of postharvest losses because they have relatively high amount of family labour that help with tomato harvesting for the process to be faster and efficient, *ceteris paribus*. Farm size had a significant positive effect on the level of postharvest losses recorded by farmers. Larger farms usually have higher output levels which require high amount of labour for harvesting and carting. When the household has labour constraint and there is a little delay from traders, huge volumes of tomato fruits are usually lost by farmers. This finding is consistent with findings of Babalola et al. (2010) who reported that the larger the area put under cultivation the higher the quantity harvested and chances of losses due to poor handling and lack of proper storage. Increase in the quantity of fruits to be harvested as

a result of larger farm size results in increase in postharvest losses because of poor storage facilities and the high labour requirement to carry out the harvesting on time.

The number of days harvested tomato fruits are stored till time of sale was also found to have a significant positive effect on losses experienced. This is consistent with a *priori* expectation because tomato is highly perishable due to its shorter shelf life. Membership of FBO had a negative correlation with the level of postharvest losses incurred. This means that farmers who join or are members of FBO's have lower probability of experiencing postharvest losses as they link up with trader associations who buy their produce after harvesting. Babalola et al. (2010) also noted that farmers who join agricultural cooperatives would obtain some form of assistance in selling their produce and invariably have lower postharvest losses.

Cultivation of improved varieties (that is, improved *zuarungu* and *pectomech*) was associated with lower levels of losses as these varieties have certain advantageous qualities that the local varieties do not have. Such qualities as firmness, disease resistance, longer shelf life and thick skin help the fruits to withstand pressure during harvesting and maintain quality during storage. This finding is in consonance with the finding by Moneruzzaman et al. (2009) who noted that the variety of tomato cultivated goes a long way to indicate the level of postharvest losses experienced by a farmer.

### Constraints faced by tomato producers

Table 5 shows that tomato producers in the study area face a number of challenges. On a five-point Likert scale, lack of storage facility was ranked as the most important and critical constraint facing tomato producers in the Offinso North district. Overall cost of tomato production

**Table 5.** Constraints in tomato production.

Constraint	Very high (5)	High (4)	Moderate (3)	Low (2)	Very low (1)	Mean	Rank
Lack of storage facilities	115	30	4	5	-	4.8	1 <sup>st</sup>
High cost of production	78	51	15	5	1	4.3	2 <sup>nd</sup>
Limited access to finance	47	77	21	5	-	4.1	3 <sup>rd</sup>
Lack of market	25	79	38	8	-	3.8	4 <sup>th</sup>
Unreliable transport	18	66	47	18	1	3.5	5 <sup>th</sup>
Lack of technology	12	30	80	28	-	3.2	6 <sup>th</sup>

Source: Field survey (2013).

was considered to be very high and therefore, ranked as the second most important constraint faced by farmers. Farmers considered limited access to finance/credit as the next important production constraint. A survey by MoFA (2011) also indicated that lack of storage facilities, high cost of production, limited access to finance, unreliable transport and lack of technology were serious constraints that tomato farmers in Ghana are faced with.

## Conclusion

The study has shown that postharvest losses are very significant in tomato production in the Offinso North district. The male gender, household size, membership of FBOs and cultivation of improved varieties (*pectomech* and improved *zuarungu*) were associated with lower levels of postharvest losses. However, farm size and number of days the produce is stored before sale were found to be associated with higher levels of postharvest losses in tomato production. Largely, a number of the underlying causes of the huge losses are within the control of the tomato farmer. When these factors are managed well, there will be reduction in postharvest losses, and food availability would be increased without necessarily cultivating an additional hectare of land. Through formation of FBOs, farmers can establish small processing centres that would process tomato into purees and other alternative products when there is no ready market for the fresh fruits. The extension unit of the Ministry of Food and Agriculture should sensitise and create awareness about the improved tomato varieties available (that is, *pectomech* and improved *zuarungu*) to increase their adoption rate in order to minimise postharvest losses. Farmers should be encouraged to stagger production/plan production in stages to allow for harvesting in stages which comes with reduced labour requirements and reduced postharvest losses. Periodic training in harvesting and proper handling of harvested tomato fruits should be organized for farmers. Private entrepreneurs should also be encouraged to invest in the tomato industry by building appropriate cold storage facilities at the district level to help farmers store their harvested produce before they are taken to the market. This will help reduce losses that occur at the farm level.

## Conflict of Interests

The author(s) have not declared any conflict of interests.

## REFERENCES

- Adarkwa I (2011). Assessment of the postharvest handling of six major vegetables in two selected Districts in Ashanti Region of Ghana; An MSc Dissertation submitted to the School of Graduate Studies, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.
- Babalola DA, Makinde YO, Omonona BT, Oyekanmi MO (2010). Determinants of postharvest losses in tomato production: A case study of Imeko – Afon local government area of Ogun state. *J. Life. Phy. Sci.* 3(2):14-18.
- Chandy KT (1989). Post-Harvest loss of fruits and vegetables. *J. Agric. Environ. Educ.* 4(3):1-14.
- GSS (2010). Report on the 2010 Ghana Population and Housing census, Ghana Statistical Service (GSS), Accra, Ghana.
- MoFA (2011). Annual Report for Offinso North District, Ministry of Food Agriculture, Ghana.
- Moneruzzaman KM, Hossain ABMS, Sani W, Saifuddin M, Alenazi M (2009). Effect of harvesting and storage conditions on the postharvest quality of tomato (*Lycopersicon esculentum* Mill) cv. Roma VF. *Austr. J. Crop Sci.* 3(2):113-121.
- Mujib ur R, Naushad K, Inayatullah J (2007). Postharvest Losses in Tomato Crop (A Case of Peshawar Valley). *Sarhad. J. Agric.* 23:4.
- Norman JC (1992). *Tropical vegetable crops*. Elms Court: Arthur H. Stockwell Ltd.
- Orzolek MD, Bogash MS, Harsh MR, Lynn F, Kime LF, Jayson K, Harper JK (2006). Tomato Production. *Agricultural Alternatives Pub. Code # UA291*. pp. 2-3.
- Robinson JZE, Kolavalli LS (2010). The case of tomato in Ghana: Productivity. Working Paper # 19. Development and Strategy Governance Division, IFPRI, Accra, Ghana: Ghana Strategy Support Program (GSSP) GSSP. pp. 1-9.
- Sablani SS, Opara LU, Al-Balushi K (2006). Influence of bruising and storage Temperature on vitamin C content of tomato. *J. Food Agric. Environ.* 4(1):54-56.
- Tambo JA, Gbemu T (2010). Resource-use efficiency in tomato production in the Dangme West District, Ghana. Conference on International Research on Food Security. Tomato from related wild nightshades.
- World Resources Institute (1998). *Disappearing Food: How Big is Postharvest Losses?* Published by Stanford University Press. P. 167.
- Yeboah AK (2011). A Survey on postharvest handling, preservation and processing methods of tomato (*Solanum lycopersicum*). [<http://www.dspace.knust.edu.gh:8080/jspui/bitstream.html>]. Accessed: 10th January, 2013].