Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.6, No.12 2016

Determinants of Post Harvest Losses among Tomato Farmers in The Navrongo Municipality in The Upper East Region

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Abstract
Food supply can be induced either by increase in production or reduction in loss. Many postharvest losses are direct result of factors such as higher temperatures on crops before harvesting, pests and diseases attack etc, hence increase in postharvest losses. The study analysed the determinants of postharvest losses among tomato farmers in the Navrongo Municipal in the Upper East region. The specific objectives were to: investigate the factors that influence the losses of tomato in the study area, determine the effects of the losses on the revenue of the tomato farmer in the study area and examine the preservative methods adopted by tomato farmers in the study area. Multiple stage sampling technique was used. Purposive sampling was employed in selecting five (5) tomato farming communities in the study area. Simple random sampling was used to select twenty (20) respondents from each of the five communities, making a total of hundred (100) respondents. Data was collected using semi-structured questionnaires. Results on socio-demographic characteristics revealed that, majority of the tomato farmers were males and 50% of the respondent fell between the age ranges of 20-39 years. Majority of the farmers had household size ranging between 1 – 5 persons and that gave a percentage of 50. The multiple linear regression model result showed that 76% in the variation in the quantity of fruit loss from harvesting to marketing stages were explained by the specified variables. The double log analysis showed that 64.8% of the variation in farmers' revenue from sales of tomato was explained by its association with the independent variables. Only eight (8) out of hundred (100) respondents adopted drying as a preservative method as at the time of study. The regression showed that losses had a significant effect on the revenue of farmers. In order for postharvest losses to be reduced, Pwalugu tomato factory needs to be re-established, Extension services should be rendered to educate tomato farmers on various ways to preserve the produce after harvest and roads linking farms to markets should be improved to reduce transit losses.
Keywords: Post-harvest losses, tomato, preservative method, adoption, farmer revenue

1. Introduction

Fresh fruits and vegetables are essential sources of vitamins and minerals for humans (smith, 1994). The quality and nutritional worth of fresh produce is affected by postharvest handling and storage conditions (sablani et al, 2006). Vegetables are typically harvested when the plant is fresh and high in moisture and therefore they are distinguished from field crops, which are harvested at the mature stage for grains, pulses, oil seeds or fibre. The high moisture content of vegetables makes their handling, transportation and marketing a big problem especially in the tropics.

The fresh market tomato is the leading produce in the United States, with an average annual production of over two billion pounds valued at 517 million dollars (Mongelli, 1984). Considering both the quantity of fresh market tomatoes handled annually and the perishable nature of tomatoes, it is not surprising to find that a significant amount of tomatoes are injured and lost from postharvest handling system yearly. According to USDA (1965), losses in tomatoes were estimated at approximately 13.68 million dollars higher than any other fresh fruit or vegetable studied at the time.

According to Charles, (2009), Nigeria is one of the leading producers of tomatoes, pepper, onions, okra and other vegetables that are grown in its various agro-ecological zones that range from humid, in the south to sub-humid in the middle belt and semi-arid/arid in the north yet, farm produce are lost at a disturbing rate of 30 - 50% yearly by poor pre and postharvest practices.

Tomato, (*Lycopersicum esculentum*), the crop of interest, is a stable fruit vegetable and has become an important cash and industrial crop in some parts of the world, (IAR & T, 1991).

In Ghana tomato is perhaps the most important vegetable grown and a wide range of areas are suitable for its production (FAO, 1995). According to TWN (2007), tomato cultivation has been an important economic activity in Ghana, particularly in the north, upper east and around southern Volta region of Ghana. The total land area for tomato production increased from 28,400ha to 37000ha in 2000. In 1999, for example, vegetables accounted for 9.6% of the total food expenditure and 4.9% of the total expenditure in Ghana and tomato alone made up to 38% of the vegetables expenditure (Wolff, 1999).

Currently, domestic production is being intensified across Ghana but local production has not been

able to meet domestic demand as a result, tomatoes are being imported from nearby countries largely from Burkina Faso (Horna et al, 2006). The failure to meet domestic demand in Ghana is as a result of many factors, among which is postharvest handling of the produce.

Efforts are made by farmers to increase production of tomatoes to meet the demand of the local market. In spite of this, Ghana continues to import several tonnes of tomato and tomato products into the country. According to ghanaweb (2006), the European Union reportedly exported 27000 tonnes of canned tomato to Ghana in 2009. Although figures of subsequent years were not revealed, the trend suggests that Ghana's import volume of tomato paste or puree increases by an average of 23% yearly.

The perishable nature of vegetables results in the inability of the producer to manage supply in the assembling markets. Further, the large distances that separates the production area and the sub-optimal post-harvest technology management (including the method of harvesting, grading, packaging, storing and transporting), results in a large proportion of vegetables being lost at the various stages of post-harvest chain. Verma and Singh (2004) observed that the overall losses in vegetables can be up to 25 per cent of total production. Poor transportation facilities, lack of know-how, poor management and improper market facilities or careless handling of the produce by farmers, market intermediaries and consumers are responsible for the postharvest losses of vegetables, (Gauraha and Thakur, 2008; Singh et al., 2008). According to Karim and Wee (1996), well managed post-harvest activities for vegetables led to higher yields and profits to producers. It is therefore, important that the post-harvest practices are given as much attention as production practices.

Taking into account that Ghana experiences excess production during the major season when a high percentage of the harvested produce is lost, it is necessary to identify the causes of such losses during postharvest handling. Thus, as more fresh fruits are needed to supply the growing population and as more produce are stored to obtain all year round supply, post-harvest loss prevention measures become more important. The aim of the study therefore is to investigate the determinants of postharvest losses among tomato farmers in the Navrongo Municipality while the specific objectives were to nvestigate the factors that influence the loss of tomato, determine the effects of the losses on the revenue of the tomato farmers and examine the preservative methods adopted by the tomato farmers in the study area.

2. MATERIALS AND METHODS

2.1 Study Area and Sampling

The research was conducted in Navrongo in the Upper East Region of Ghana. It is predominantly a farming community involving wet and dry season farming due to the availability of an irrigation project in the study area. . A multi-stage sampling technique was used. Purposive sampling was used to select all the five communities.These communities are Bonia, Yogebania, Wuru, Gia-Nao and Saboro. The target group were purposely tomato farmers.Simple random sampling was used to select 20 respondents from each of the five (5) communities giving a total of 100 for the study.

2.2 Data collection

Nominal scales were used to collect some dichotomous demographic characteristics such as gender, age, educational background, religion, marital status and family size while numerical scales were collected on other demographic variables as well as input, output, and income variables. Personal interviews using semi-structured questionnaires were employed in obtaining information on the factors of postharvest losses among tomato farmers, the adopted preservative methods that was used by the tomato farmers, costs of the produce among others. Secondary data from project documents were sourced to know more about the project.

2.3 Data analysis

Data was analyzed using descriptive statistics and regression analysis. Specifically, descriptive statistics were used to analyze the demographic characteristics. A multiple linear regression model was used to test the significance of the factors affecting postharvest losses of tomato while a double log regression model was used to test the effects of losses on the revenue of tomato farmers.

2.4 Empirical Model of Multiple Linear Regression Model for factors that influences the losses of tomato in the study area.

The dependent variable is quantity of fruit loss. The likely independent variables are: Age of respondent, Farm size, Quantity harvested, Age of fruit at harvest, Household size, Experience and Educational background.
The regression model is defined as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \varepsilon_i$$

Given;
Y = Quantity of fruit loss :X_1 = Farm size (FS): X_2 = Quantity harvested (QH): X_3 = Age of fruit at harvest

(AFH): X_4 = Age of respondent (Age)
X_5 = Educational background (Edu): X_6 = Household size (HHS): X_7 = Experience (Experi)
Where $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6,$ and β_7, are the coefficients of the factors that cause postharvest losses of tomatoes.
β_0 = intercept.

ε_i = Error term

The expectations are $\beta_1 > 0$, $\beta_2 > 0$, $\beta_3 > 0$, $\beta_4 > 0$, $\beta_5 < 0$, $\beta_6 < 0$, and $\beta_7 < 0$.

Double Log Multiple Regression Model to determine the effects of the losses on the revenue of the tomato farmers in the study area.

$$\ln Z = \beta_0 + \beta_1 \ln(X_1) + \beta_2 \ln(X_2) + \beta_3 \ln(X_3) + \beta_4 \ln(X_4) + \beta_5 \ln(X_5) + \beta_6 \ln(X_6) + \varepsilon_i$$

Where:Z = Revenue from sales of produce and ε_i = error terms

2.5 Theoretical framework of Multiple Regression Model for factors that influences the losses of tomato in the study area.

$$Y = \beta_0 + \beta_1 FS + \beta_2 QH + \beta_3 AFH + \beta_4 Age + \beta_5 Edu + \beta_6 HHS + \beta_7 Experi + U_i$$

Double Log Multiple Regression Model to determine the effects of the losses on the revenue of the tomato farmers in the study area.

$$\ln Z = \beta_0 + \beta_1 \ln(Fs) + \beta_2 \ln(Lab) + \beta_3 \ln(Fert) + \beta_4 \ln(Agrochem) + \beta_5 \ln(transp) + \beta_6 \ln(PHL) + \varepsilon_i$$

Where:

Z = revenue from sales of produce. And ε_i = Error term.

The double log functional form is usually preferred in empirical analysis since coefficients are easy to interpret and also has the incidence of multicolinearity.
Table 1 presented below illustrates the explanatory variables and how they are measured.

Table 1. A priori expectations for both models

Independent Variables	Unit of Measurement	A priori expectation
Age of respondent	Years	+
Farm size	Acres	+
Quantity harvested	Crates	+
Age of fruit at harvest	Days	+
Household size	Numbers	-
Experience	Years	-
Educational background	Levels	-
Farm size	Acres	+
Cost of labour	Cedis	+
Cost of fertilizer	Cedis	+
Cost of agrochemical	Cedis	+
Cost of transportation	Cedis	+
Postharvest loss	Cedis	-

It also includes the apriori expectation of the various independent variables used in the models.

3. RESULTS AND DISCUSSION

3.1 Socioeconomic characteristics of respondents

From the research conducted, majority of the respondents were males, representing 80% whiles females were 20%. This shows that males contribute a larger proportion to tomato production and this could be attributed to certain cultural beliefs such as the inability of a female to inherit or hold land. In terms of age, 50% of the respondents ranged between the ages of 20 – 39, followed by the 40-59 age bracket (35%). While only 14% were above 60years, the remaining 1% was below 19 years. This is an indication of a strong labour force in the agricultural sector in the study area. Also, as high as 49% of the respondents had no formal education, 40% of the respondents however received basic education, 9% of the respondents had vocational/ secondary education and 2% had tertiary education. It was observed that farmers with 11 – 15 years of experience in tomato farming had the least frequency with a total of 11 (11%) of the sample size. Those with more than 15 years of experience in tomato farming had the highest frequency 50 (50%). Farmers with 1 – 5 years of experience had 17% and those with 6 – 10 years had 22%.

3.2 Factors that influence the losses of tomato in in the study area.

From the results in table 2 below it was observed that Number of years in farming (Experience), Age of fruit at harvest, Quantity harvested (crates), Household size, Educational background are significant, thus some maintaining their expected signs.

Table 2. Parameter estimates of the regression model

Variables	Unstandardized Coefficients	Standardized Coefficients	T	P-value
	Std. Error	Beta		
(Constant)	7.492		1.306	.195
Farm size (acres)	2.371	.043	.494	.622
Quantity harvest (crates)	.023	.761	8.232***	.000
Age of fruit at harvest	1.145	-.153	-2.524**	.013
Age of respondent	3.108	.054	.784	.435
Educational background	2.441	.086	1.627	.107
Household size of respondent	3.059	-.132	-2.105!**	.038
Number of years in farming	1.851	.119	1.826*	.071

Source; Computed from survey data

Dependent variable: Quantity of fruit loss (crates)

Number of observation = 100 Prob. > .000 R – squared = .761 Adj. R- squared = .742

*= significant at 1%, ** = significant at 5% and *** = significant at 10%.

Farm size is a factor that is often argued as essential in quantity of fruit loss. It is often argued that farmers with larger farms are more likely to record more losses than those with smaller farms. From the study it is realized that farm size has no significant influence on quantity of fruit loss (p = 0.622). This is however contrary to our expectation and the findings of Babalola *et al* (2010) who reported that farm size has a significant influence on quantity of fruit loss.

Results from the multiple linear regression from table 2 above indicates that there is no significant relationship between age of respondent and quantity of fruit loss (p = 0.435). Even though age of respondent is positive, the extent to which it increases quantity of fruit loss is statistically insignificant.

Educational background was hypothesized to have a negative influence on quantity of fruit loss. This means that the higher the educational level of respondents the lesser the quantity of fruit loss. From the study, it was realized that educational background was statistically significant (P = 0.107). That is a unit change in educational background will increase quantity of fruit loss by 0.086 units. This is significant at 10% level of significance. This is contrary to our expectation.

A larger household size means that the respondent in question has enough laborer's at his/her disposal and therefore may lead to a reduction in quantity of fruit loss. The hypothesis was therefore to have a negative influence on the quantity of fruit loss. The study revealed that household size was significant (p = 0.038) at 5 %. This suggests that a unit change in household size will result in 0.132 reductions in quantity of fruit loss. This is consistent with the findings of Aidoo et al. (2014).

Farmers with higher experience in tomato production appear to often have full information on postharvest losses. Hence it was hypothesized to have a negative influence on quantity of fruit loss. With respect to the farming experience of respondents, the most experienced farmers were the highest (50%) meaning 50 out of a total of 100 respondents had more experience. Those with the least experience were 11 (11%). From the result on the table above, (p = 0.071) shows that experience has a positive influence on quantity of fruit loss, suggesting that a unit change in experience will lead to 0.119 unit increase in quantity of fruit loss. This is significant at 10%. The result is however not consistent with apriori expectation.

The expectation for quantity of fruit harvested in this study is positive. That is the more the quantity of fruit harvested, the more the loss. Result from the multiple regression (p = 0.00) shows that, quantity harvested was positively related to quantity loss. This indicates that a unit change in quantity harvested will result in 0.761 units in quantity of fruit loss. This is at 1% significant level. It is however consistent with our a priori expectation and the findings of Babalola *et al* (2010) that says that an increase in quantity harvested results in an increase in losses when there are no effective storage facilities.

Quantity of fruit loss can be influenced by the longer days the fruits spend on the farm after maturity. That is the higher the age of fruit at harvest the more the quantity loss. The priori expectation for this variable is positive. The result from the analysis (p = 0.013) shows that age of fruit at harvest was statistically significant; indicating that a unit change in age of fruit at harvest will result in 0.153 reduction in quantity of fruit loss. It is contrary to the a priori expectation.

The Prob. > F = 0.000 means that the entire model is fit and the R^2 = 0.761 means 76% of the variation in the dependent variable is explained by the independent variable.

3.3 Effects of losses on the revenue of the tomato farmers.

From the results from table 3 below, it was observed that cost of transportation (ln_Transp), cost of fertilizer (ln_Fert) were significant at 1% and postharvest loss was significant at 10%.

Table 3. Parameter estimates of the regression model.

	Unstandardized Coefficients	**Standardized Coefficients**	**T**	**P-value**
	Std. Error	Beta		
(Constant)	.904		.072	.943
ln_FS	.144	-.107	-1.078	.284
ln_Lab	.095	.123	1.531	.129
ln_Fert	.153	.272	2.891***	.005
ln_Agrochem	.130	.031	.309	.758
ln_Transp	.111	.468	5.252***	.000
ln_PHL	.114	.157	1.758*	.082

Source; Computed from survey data

Dependent variable: revenue from sales of produce (ln_Revenue) in Ghana cedis.
Independent variables: ln_FS (farm size), ln_Lab (cost of labour), ln_Fert (cost of fertilizer), ln_Agrochem (cost of agrochemical) and ln_Transp (cost of transportation).
Number of observation = 100, Prob. > F = .000 R – squared = .659 Adj R – squared = .638
*= significant at 10%, **= significant at 5% and ***= significant at 1%.

The partial slope coefficient of 0.272 measures the elasticity of revenue from sales of produce with respect to cost of fertilizer. More specifically, 0.272 states that holding cost of labour (ln_Lab), farm size (ln_FS), cost of Agrochemical (ln_Agrochem), cost of transportation (ln_Transp) constant and Postharvest loss(ln_PHL) fixed, if the cost of fertilizer (ln_Fert) is increased by 1 unit, on average, revenue from sales of produce decreases by 0.272 Percent.

Revenue from sales of produce will rise on average by approximately 0.468 Percent for each additional 1 cedi increment in the cost of transport (ln_Transp), holding farm size (ln_FS), cost of labour (ln_Lab), cost of Agrochemical (ln_Agrochem) and cost of fertilizer(ln_Fert) and Postharvest loss(ln_PHL) fixed.

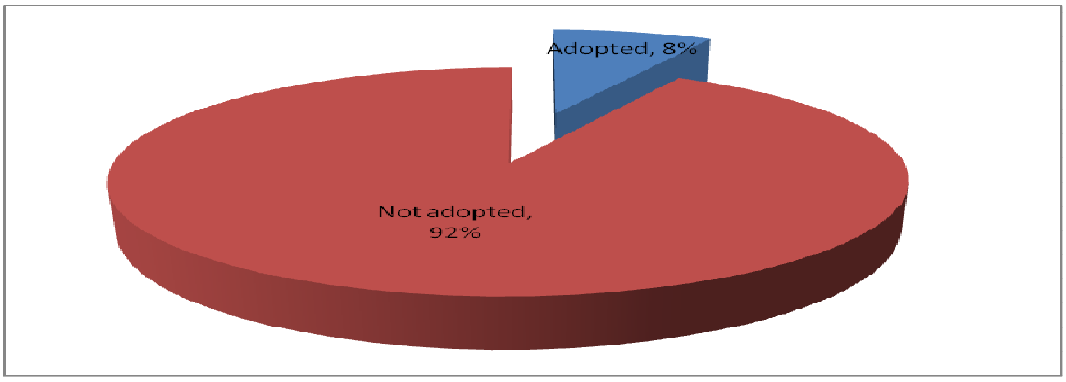
0.157 measures the elasticity of revenue from sales of the produce with respect to Postharvest loss (ln_PHL). Specifically, 0.157 states that holding farm size (ln_FS), cost of labour (ln_Lab), cost of fertilizer (ln_Fert), cost of Agrochemical (ln_Agrochem) and cost of transportation (ln_Transp) constant, if Postharvest loss(ln_PHL) is increased by 1 cedi, on average, revenue from sales of produce will increase by 0.157 Percent.

From the table, the sum of the elasticity gives the economically important parameter called the Return to scale parameter. This parameter gives the response to revenue from sales of produce for a proportional change in all the dependent variables. The economic return to scale from the table is 0.944. This suggest that for every 1% increment in farm size (ln_FS), cost of labour (ln_Lab), cost of fertilizer (ln_Fert), cost of Agrochemical (ln_Agrochem), Postharvest loss(ln_PHL) and cost of transportation (ln_Transp), the tomato farmer has a decrease return to scale of 0.944. This suggests that the farmer gets less than what he/she puts in the tomato production meaning he/ she runs at a loss.

The Prob. > F = 0.000 means that the entire model is fit and the R^2 = 0.658 means 66% of the variation in the dependent variable is explained by the independent variable.

3.4 The preservative methods adopted by tomato farmers in the study area.

As indicated in the figure 1 below the use of post-harvest technology is minimal in the study area because only a few of the farmers (8 out of 100) use technology of storing such as drying and storing of the produce before taking it to the market to sell. The reason for their lack of preservative knowledge is as a result of lack of awareness created by extension workers on the various ways by which they can go about preserving their produce.



Source; Computed from survey data

Figure 1 Percentage Distribution of Tomato Farmers and Adoption of Preservative Methods

Another reason that accounts for the lack of preservative methods adopted by the farmers is the absence of storage facility in the study area. The only way by which the eight (8) respondents store their produce is either by cutting the fruits into pieces and drying them or by covering the produce with grasses. However, covering the produce with grasses, only lasts for a day before they are taken to the market for sale; a period too short to address issues involved in market delays.

4. CONCLUSIONS AND RECOMMENDATION

This study has analyzed the causes of post - harvest losses in tomato production in Navrongo in the Upper East Region of Ghana. The results indicates that Number of years in farming (Experience), Age of fruit at harvest, Quantity harvested (crates), Household size, Educational background were significant, with some maintaining their expected signs. However, educational background which was expected to negatively affect quantity of fruit loss had a positive effect.

Farm size, cost of labour, cost of fertilizer, cost of agrochemical and cost of transportation were some of the factors that affect the revenue of tomato farmers in the study area. Cost of transportation and cost of fertilizer were significant. The study revealed that, the economic return to scale is 0.913 and this suggests that for every 1% increment in farm size, cost of labour, cost fertilizer, cost of agrochemicals and cost of transportation there was a decrease return to scale of 0.913. This implies that the farmer incurs loss.

It was realised that a few of the respondents adopted preservative method. That is cutting them into pieces and drying them for household consumption or by covering them with grasses before taking them to the market for sale. This could only last for a day; a period too short to address issues of market delays.

It can be concluded that, the factors that affects post-harvest losses among tomato farmers such as poor road network, mode of transportation, pest attack and lack of already market has contributed negatively to tomato production and consequently affected their total revenue in the study area.

Based on the findings of the study, the recommendations are suggested includes provision of a good storage facility in the study area to help store the produce. This will help reduce post-harvest losses and also addresses issues of market delays, re-establishing the Pwalugu tomato factory to help add value to tomato, thus processing the fruit into ketchup and puree. This will help addresses issues of post-harvest losses and also lack of ready market,extension services should be rendered to educate farmers on the various ways that can be used in processing their produce to prevent loss and roads linking farms to markets should be improved to reduce transit loss.

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