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DETERMINANTS FOR POST-HARVEST LOSSES IN MAIZE PRODUCTION FOR SMALL HOLDER FARMERS IN TANZANIA

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ABSTRACT

Maize is a major staple crop produced and consumed by the majority population in Sub-Saharan Africa (SSA). Tanzania being part of SSA, it has been ranked 19 top maize producing countries in the world and the first in East Africa. However, for the past 10 years, maize production in Tanzania has been increasing year to year ranging from 3.3 Metric tons in 2005/06 to 5.4 MT in 2013/14. Despite the steady production of maize over the past ten years, post-harvest losses of maize remained the highest, up to 20-40 % in some of rural areas. In this respect, the main objective of the current study was to assess the factors affecting the amount of Post-harvest Losses (PHL) of maize in Mbozi and Kongwa districts of Tanzania. The structured and semi-structure questionnaires were used in collecting the primary data from 240 randomly selected smallholder farmers. The Tobit model was used in assessing factors affecting PHL and the results indicate that, education level, family size, quantity of maize production, market experiences, type of storage facilities, bad weather condition, distance to the market and number of livestock were found to have a significant effect on the quantity of maize post-harvest losses. Therefore, it is recommended that, provision of up-to-date storage facilities and post-harvest handling tools such as hermetic storage and combined harvesters be encouraged. This could reduce the amount of post-harvest losses in maize production and thus contribute to food security and poverty reduction.
Key words: Maize; Post-harvest losses, Smallholder Farmers, Tanzania

1.0 INTRODUCTION

In the last few decades, staple food crops have emerged as crucial crops to guarantee food security in most countries in the world. Maize together with wheat and rice are the three most cultivated cereal crops worldwide (Suleiman and Kurt, 2015). Currently the maize production at the world level stood at 10.14 billion metric tons (Friedrich and Kassam, 2016). Moreover, about 30% of the world maize production comes from the United States followed by China (21%), Brazil (7.9%) and Africa (7%) (FAOSTAT, 2014). Two-thirds of all Africa maize comes

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from eastern and southern Africa in which Tanzania being a part (Verheye, 2010; FAOSTAT, 2014).

In Sub-Saharan Africa (SSA), maize is the most widely-grown staple food crop occupying more than 33 million ha each year (FAOSTAT, 2015) and staple food for about 1.2 billion people (Moctar, d'Hotel Edlodie and Tristan, 2015).Tanzania being a part of SSA, it has been reported to be among of the major maize producer in SSA. Moreover, in the last five decades, Tanzania has been ranked among the top 25 maize producing countries in the world and first (1) in East Africa (Barreiro-Hurle, 2012; Suleiman and Kurt, 2015). Currently, Tanzania is ranked the first (1) in East Africa and 19 top maize producing countries in the world (FAOSTAT, 2014). Moreover, it is estimated that, over 80 % of the population of Tanzania depends on maize for food (Shekania, and Mwangi, 1996) and contributes up to 60 % of the total energy in the diets of the consumers. The study by Maziku (2016) and NBS (2014) reported that, for the past 10 years maize production in Tanzania, has been considerably increasing year to year, ranging from 3.3 Metric tons (MT) in 2005/06 to 5.4 MT in 2013/14 season. On the other hand, the national yield for maize in Tanzania only is oscillating between 1.0 and 1.5 t/ha being low as compared to the estimated potential yields of 4-5 t/h (Barreiro-Hurle, 2012; NBS, 2014). Furthermore, maize in Tanzania account for more than 75% of the cereal consumption and it is estimated that the annual per capita consumption of maize is around 128 kg (Suleiman and Kurt, 2015).

Despite the steady production of maize over the past three decades and its important in ensuring availability of food and security, yet its potential is not being fully realized in Tanzania. This is because post-harvest losses of maize remained a significant phenomenon and it account for about 30-40 % of the produced maize in rural areas originating from inadequate post-harvest handling (Suleiman and Kurt, 2015). Furthermore, a study by Ngowi and Selejio (2014) reported maize as a grain with the highest PHL (40%) in Tanzania. Though, findings from previous studies conducted in Tanzania pointed out some reasons for PHL in maize production, but most of them were based on biotic and environmental factors such as high crop perishability, mechanical spoilage, excessive exposure to high temperatures, relative humidity and rain, contamination by spoilage fungi and bacteria (Mycotoxin contamination), pests attack such as rodents and insects. However, information related to socio-economic factors and households characterize which may have noticeable effects on PHL among farmers is inadequately covered in most of these studies. Therefore, it is under this basis current study was made with main objective of assessing socio-economic factors that determine amount of post-harvest losses in maize production among small scale farmers in the districts of Kongwa and Mbozi districts in Dodoma and Songwe regions. Specifically the study was intending to determine factors which can affect the PHL in maize production.

2.0 REVIEW OF POST-HARVEST

2.1 Definition of Post-harvest losses of maize

Post-harvest loss (PHL) is defined as grain loss which occurs after separation from the site of growth or production to the point where the grain is prepared for consumption (Nyambo, 1993). Other authors, describe PHL as a measurable phenomenon both in quantitative, qualitative and economics of grain loss across the supply chain (Aulakh and Regmi, 2013; Tefera, 2012). Rembold, Hodges, Bernard, Knipschild and Leo (2011) on the other hand, defined post-harvest loss (PHL) to include losses that occur at time of harvest, though various postharvest operations on farm to the first level of market. Moreover, Amentae, Tura, Gebresenbet and Ljungberg, (2016) defined PHL as losses in grain both during harvesting process and during the post-harvest activities throughout the supply chains in the process of getting the cereal down to consumers. However, post-harvest loss in this study was referred to losses of maize that occur at all stages of the harvesting, post-harvest handling, processing and transportation to the final markets (Urban markets).

2.2 Types of Losses

According to Suleiman and Kurt (2015) post-harvest losses can be classified into three main categories; quantitative loss, qualitative loss, and economic or commercial loss. However, other scholars such as Zorya, Morgan, Diaz Rios, Hodges, Bennett, Stathers, ... & Lamb (2011) classified PHL as direct and indirect losses. The quantitative loss indicates the reduction in physical weight and can be readily quantified and valued to get a total, example a portion of grain damage by pests or lost during transportation can be estimated at the point before and after transporting down to consumers. Conversely, qualitative loss is resulted from the contamination of grain by molds and it includes loss in nutritional quality, edibility, consumer acceptability of the products and the caloric value (Zorya *et al.*, 2011; Kader, 2004). Economic loss on the other hand is the reduction in monetary value of the product due to a reduction in quality and or/ quantity of product as a results of post-harvest activities (Tefera, 2012; FAO, 2014). However, this study was concerning with the quantitative losses which were resulted from harvest, storage and transportation activities carried out by farmers from harvest down to the market in the study areas.

2.3 Review of Empirical Studies on the Post-harvest Losses of Maize

The study by FAO (2013) revealed that, PHL of cereal (including maize) in SSA ranged between 5-40 % which worth for around $4 billion (Gustavsson, Cederberg, Sonesson, Van otterdijk and Meybeck, 2011; Zorya *et al*, 2011). Moreover, in the Eastern and Southern African countries PHL of cereal account for over 40 % of the total PHL in SSA countries (Suleiman and Kurt, 2015). These percentages of losses are equivalent to about $1.6 billion in value as economic losses each year (Zorya *et al*, 2011). Furthermore, it has been reported by Meronuck (1987) and FAO (2013) that, post-harvest losses of maize in various storage facilities in Least Developed countries (LDCs) ranged between 15-25 % because of poor storage facilities. However, the highest losses of maize occur at the field/harvest and storage stages which make only 60-74 % of the harvested maize reach the final consumer (Abass, Ndunguru, Mamiro, Alenkhe, Mlingi and Bekunda, 2014). Furthermore, maize in the study by Ngowi and Selejio (2014) was reported as a grain with the highest PHL (40%) in Tanzania. The same authors also found that, about one tone (1ton) of the harvested maize by the farm household lost due to pests and infestations in every year. The higher percentage of PHL in maize as the main staple food for majority of Tanzanians prompted this study to look on the major factors contributing to this trend of increase in PHL among small maize farmers. This is because the enhancement of strategies focuses on reducing PHL has positive consequences for poverty alleviation, food security, nutrition status, and

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increases household income for the smallholder farmers in Tanzania and other developing countries.

2.4 Measuring of Post-Harvest losses

The process of measuring food losses can be done in quantitative or qualitatively depending on the nature of the available data. According to Tefera (2012) and APHLIS (2014) food loss can be quantitatively estimated in two ways; first, using scattering of grain due to poor post-harvesting handling practices which include harvesting, threshing, drying, poor packaging and transport. Second, using bio deterioration brought by pest organisms such as insects, molds, fungi, rodents and birds in which weight of undamaged grains and weight of damaged grains is estimates to represent the loss (Hodges, 2013). However, because of the dearth of reliable information on actual food loses in LDCs which could induce challenges and difficulties on measuring food losses directly (quantitatively), Basavaraja *et al.* (2007) and Amentae *et al.* (2016) suggested the use of indirect method which measures food losses in terms of factors causing food losses. The method use questionnaire (Likert scale) to indicate subjective estimated losses by people experiencing the losses in food supply chain as a latent variable. The method is associated with two benefits, first, we estimate or measure food losses not only to know the loss amount but also to reduce losses and reducing losses are possible through knowledge and interventions on factors causing losses. Second, it allows the use of econometrics models, which enables to know both the level of losses and factors causing the loss in order of severity. Therefore, such method could clearly indicate factors causing losses with their level of significance and invite prioritized interventions to reduce food losses. Similarly, this study adopted the approach as used by Amentae *et al.* (2016) in measuring the PHL of maize production in the two districts of Kongwa and Mbozi in Dodoma and Songwe region of Tanzania.

3.0 RESEARCH METHODOLOGY

3.1 Study Area

This study was conducted in the two maize producing districts of Mbozi and Kongwa in Songwe and Dodoma regions respectively. The two districts were selected because of their potentials in maize production and marketing. About 50% of the maize produced in Songwe region comes from Mbozi district while Kongwa contributes for about 40% of the total maize produced in Dodoma region (Gabagambi, 2013; NBS, 2014; Maziku *et al.*, 2016).

3.2 Research design and Sampling Procedures

The study used a cross-sectional research design in conducting a research survey for the collection of primary data on maize losses and households' characteristics. The cross-sectional design was selected because the researcher wanted to collect data related to PHL of maize at one point in time from the maize small farmers in Mbozi and Kongwa districts. The multiple stages sampling procedures were employed in the selection of the sample size whereby in the first stage, regions, districts and wards were purposely selected in which Dodoma and Songwe regions were involved due to their potential in maize production and high level of PHL compared to other regions. Then, two districts (Mbozi and Kongwa) were also purposely selected and from each district, two wards were selected making a total of four wards for the two

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districts. The selection of districts and wards was based on their production potential of maize, quantity of maize produced and proportional of PHL. At the second stage, two villages from each ward were randomly selected making a total of 4 villages namely, Igamba and Ihanda for Mbozi district and Hembahemba and Dosidosi for Kongwa district. In the third stage, 60 household heads from each village were randomly selected using the systematic sampling technique making a total of 240 small householder farmers (120 and 120 farmers for Mbozi and Kongwa districts respectively).

3.3 Data Collection and Analysis

Structured and semi- structured questionnaires were administered in gathering primary data on PHL from the maize producers in Mbozi and Kongwa districts. In addition, personal observation was used for gathering information which was not easy to quantify. Focus Group Discussion was also conducted at the village and district level with key informants. The key informers included village officers, transporters, district officers, traders and extension officers to supplement information collected from questionnaire. With the help of SPSS computer software, the collected data were analyzed both descriptively and empirically using simple descriptive measure such as means, frequency, variance and findings were presented in graphs and tables. On the other hand, empirical analysis on factors affecting PHL for smallholder maize farmers were done using Tobit model because of being a binary response model. The choice of the Tobit model against Probit or Logit model was based on the fact that with it, the intensity of loss as it relates to each loss causing factors (independent variables) can be easily determined. Thus, maximum likelihood Tobit estimation (Tobin, 1958) was used in the analysis of factors affecting the amount of post-harvest losses of maize among farmers.

3.3 Model specification - Tobit Model

The Tobit model which expresses the observed response (Y), in terms of underlying latent variable (Y^*) was employed. In this case, the post-harvest losses of maize were measured as latent variables relating to socio-economic factors determining the PHL as independent variables to measure the latent variable. The latent variable Y^* was established which measures the level of loss that the i^{th} farmer experience from post–harvest handling activities. The variable Y^* takes the value of 0 if $Y \geq 0$ and $Y^* = 0$ when $Y = 0$.Tobit model is one of the limited dependent variable models where there is a limit or boundary on the dependent variable and some of the observations hits this limit. The limits could be upper or lower. But in this study, the values of maize post-harvest loss for a rational farmer relating to particular believed cause of maize loss never go beyond zero. Therefore, the Tobit model with lower limit censoring at zero was expressed as:

$$Y = \beta_0 + X\beta + \mu, \mu / X \approx Normal\left(0, \delta^2\right) \quad \text{(1)}$$

$$Y = Max\left(0, Y^*\right) \quad \text{(2)}$$

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However, before running the Tobit model, multicollinearity and autocorrelation problems were tested and results proved that, data were free from such problems of multicollinearity and autocorrelation. In checking for multicollinearity problem, a simple regression matrix diagnostics was done. The results indicates that, average Variance Inflation Factor (VIF) was 2.4 which is less than 10, implying that variables in the model had no serious multicollinearity (Damodar, 2004). In addition, Durbin Watson test (DW) was employed to test for serial autocorrelation which could occur due to omission of explanatory variables and misspecification of the mathematical model. The average value of DW was 0.61 which also indicate no autocorrelation problem among independents variables in the model.

4.0 RESULTS AND DISCUSSION

4.1 Descriptive Results

Table 1 presents socio-economic characteristics of respondents from Mbozi and Kongwa districts. Results on sex of household heads indicated that, majority (83%) of maize famers from the two districts were male while only 16% of them were female. This implies that, most of households were headed by males who were the main decision makers at the household on issues regarding to production and marketing decisions. However, despite the large number of male respondents (84% and 83% for Mbozi and Kongwa district respectively), yet agricultural activities were managed by both male and female in two districts.

Table 1: Socio- Economic factors of respondents

Characteristics of HH		Districts		
		Mbozi (%) (n =120)	Kongwa (%) (n=120)	Total (n= 240)
Gender of HH head	Male	84.2	83.3	83.8
	Female	15.8	16.7	16.2
Level of post-harvest losses	High	81.7	76	75.5
	Low	18.3	24	24.5
Availability of PH Technology	Available	30	18	65
	Not available	70	82	35
Education level of HH head	None	3.4	5.8	0.8
	Primary	67	67	85.6
	Form four	26.7	24.2	12
	High school	3.3	3.3	0.8
Market accessibility	Not accessible	64.2	67.5	82
	Accessible	35.8	32.5	18

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In addition, about 76% of the farmers in the two districts reported to experience high level of post-harvest losses caused by various factors including bad weather and poor storage facilities. Moreover, findings on education level for household heads indicated that, a lager percent (86%) of farmers have primary education while only few who attained the secondary education in the two districts (12% and 0.8% respectively). This implies that, most of household heads had only attained the lowest level of education (primary in this regard), the situation which could contribute to the difficulty in adoption of new post harvesting technologies and influence in other factors related to farm management skills and access to market information. These findings concur with those of Lubungu, Chapoto, & Tembo (2012) who found that, households with higher level of education may have better abilities to adopt new technologies and therefore have more information than those with relative less education.

On the other hand, Table 2 presents mean of age, family size, experience and distance to urban markets for farm households in the study area. The average age among maize farmers in the two districts was 47 years and the minimum age was 21 years. This indicated that, maize production in the two districts was occupied by young and adults and older households were retired.

Table 2: Socio-economic information of maize farmers in the study area

Characteristics	**N**	**Mean**	**Minimum**	**Maximum**	**Std. Deviation**
Age	240	45.6	21.00	90.00	13.55905
Family size	240	8.0	4.00	9.00	1.63764
Farm size (acres)	240	3.4	.25	12.00	2.68832
Distance farm to district market	240	15.3	24.00	60.00	12.47947
Total loss	240	1.8	200.00	3500.00	978.24880

In addition, the family size of 8 persons which was higher as compared to what were reported in the National Population Census of 2012 which was estimated 5 persons per household (NBS, 2014). The large number of persons at the family will imply that, more maize is need for consumption and on the other hand could indicate higher ability of household to produce more maize by using family labour. In addition, the average number of household members among smallholder farmers was 7 persons per household. However, the mean for distance to district markets was 15 km which implying that, majority of farmers were located relatively far from the district markets. This has an implication on the post-harvest handling activities such a transport and access to market by farmers because their effect increases with distance (being spatial in nature). Also the mean losses of maize in the two districts were found to be 1.8 kg per household which is relative high compare to that of the national (Table 2).

4.2 Determinants of maize post-harvest losses

To assess the factors that determine the post- harvest of maize among smallholder farmers in the two districts, the Tobit model was used and the results were presented in Table 3. Out of the ten variables fitted in the model, about eight variables were significantly explaining the occurrence

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of losses in maize production among smallholder farmers in the study area. The results as presented in Table 3 indicated that, education level of household head affects the amount of post-harvest loss at farm level negatively at less than 5% probability level. The marginal effect of education on the amount of post-harvest loss was -0.0812. This implies that, the additional of one year in schooling by the household head could reduce post-harvest losses on maize production for about 8% among producers. This is because the high level of education empowers farmers in adoption of modern storage technologies and mode of transportation. Also, education increase the access to market information which makes a farmer to be more informed about market requirements in terms of price, quality, and right quantity of maize needed by buyers (Mugisha, Bwalya and Hyuha, (2013). This finding concurs to Amentae *et al.* (2016) who claimed that, education has capacity to influence the adoption of new post-harvest technologies and other factors like management skills, household income, household size and access to capital, which would all have a positive effect on post-harvest reduction.

Table 3: Factors affecting maize post-harvest losses in the study area

Variables	**Parameter Estimates**		**Marginal Effects**	
	Coefficients	**Std. Error.**	**dy/dx**	**Std-Error**
Age of HH head (Years)	0.025	0.013	0.0095	0.0051
Education level of HH head (No year)	- 0.081**	0.029	-0.0752	0.077
Family size (No. of person)	- 0.056*	0.057	0.0144	0.0221
Storage facilities (No=1 Yes=2)	0.464**	0.164	0.1590	0.1851
Experience in maize market (Years)	- 0.034*	0.015	-0.0132	0.0058
Distance to nearest market (Km)	0.059**	0.018	-0.041	0.0069
Quantity of maize produced (Kg)	0.061***	0.021	0.051	0.0023
Weather condition (Bad =1, Good=2)	0.134**	0.195	-0.0532	0.07538
No. of livestock owned by hh (numbers)	-0.089**	0.051	0.0344	0.01965
Ownership mobile(Yes =1, No = 0)	-0.095	0.162	0.0366	0.06258
Sex of household head (Male=1 Female=2)	-1.116	0.351	-0.4304	0.13571
Constant	4.235***	6.386		
Prob> chi2 = 000,	Pseudo R2=	0.461, Log	-105.586	

Moreover, household size was found to have a significant negative relationship with the level of post-harvest losses as occurred at farm level at less than 10% probability level. This implies that when household size increases by one person the amount of post-harvest losses decreases by 0.056 kg per kilogram. This means that, an addition of one person to the family reduces maize post-harvest losses by 5.6 percent due to fact that, maize production is the labour intensive crops in Tanzania. Therefore, an increase in number of active labors at the family is expected to reduce

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Post-harvest losses. These findings are consistent to that of Amentae *et al.* (2016) who found that, the amount of post-harvest losses for Teff decreased by 3.75% with the increase in family size by one person in Ethiopia. On the other hand, lack of modern storage facilities among famers showed a positive relationship with the post-harvest losses in maize production and was significant at 5% probability level. This implies that, lack of modern storage facilities by household could increase the amount of post-harvest loss for maize production by 15%. This is due to fact that, majority of farmers in the two districts were found to use more tradition storage facilities such as Vihenge and Jute bags. This finding concurs to those of Rugimamu (2004) and Suleiman and Kurt (2015) who found that post-harvest losses of maize were higher (40%) for those famers who were using traditional storage facilities. The similar results also were found in the study by Ngowi and Selejio (2014) that, maize was reported as the grain crop with the highest post- harvest losses in Tanzania.

Furthermore, the amount of maize output produced by farmers indicated to be associated with high level of Post-harvest losses. The unit increase in the quantity produced by a farmer could increase the amount of PHL by 5.1% (Table 3). This could be due to the fact that as the amount of maize produced increases, it became difficult for farmers to harvest on time the whole production due to lack of manpower and poor harvest methods. These findings are consistent with those Amentae *et al.* (2016) who found that, the level of output produced by Teff farmers shown a positive relationship with the post-harvest losses in Ethiopia. Also, these findings were similar to those of (Basavaraja *et al.*, 2007) who demonstrated a positive relationship between the amount of post-harvest losses and amount of wheat and rice produced in India. The weather condition also indicated to have positive effects on the amount of post-harvest losses of maize. Results from Table 3 show that, change in weather condition could increase the amount of post-harvest losses by 5% especially during the bad weather condition. This is because during the rainy season, post-harvest activities were reported to cause more losses of maize.

In contrast, market experiences and number of livestock owned by households indicated to have a negative impact on the amount of post-harvest losses and were significant at 10% and 5% probability level. This situation has also implied by their marginal values of 0.013 and 0.0344 which indicating that, an increase in number of years on market experiences and number of animals by households could reduce the amount of post-harvest losses by 1.3% and 3.4% respectively. This is because cattle such as oxen were found to be used in moving ox-carts of maize from farm to the markets as major means of transport for majority farmers in Mbozi and Kongwa districts. Therefore, ownership of these assets to some extent could contribute in reducing the amount maize losses due to transpiration.

5 CONCLUSION AND RECOMMENDATIONS

The result of the Tobit model on determining factors of maize post-harvest losses at the farmers' level revealed that, education level, family size, quantity of maize production, market experience, type of storage facilities, bad weather condition, distance to the market and number of livestock were found to have a significant effect on the size of maize post-harvest losses in the study area. However, poor storage facilities and means of transport were found to be the more contributing factors to post harvest losses among famers in Mbozi and Kongwa districts with the loss of 15%. The study recommends that, provision of more education and marketing information to farmers could empower them on adoption of new technologies. Moreover provision of up-to-date storage facilities and post-harvest handling tools such as hermetic storage and combined harvesters which take only few days in harvesting could reduce the amount of post-harvest losses in maize production. This could be done through credit and subsidies provision from government and development agencies.

REFERENCES

Abass, A. B., Ndunguru, G., Mamiro, P., Alenkhe, B., Mlingi, N., and Bekunda, M. (2014). Postharvest food losses in a maize-based farming system of semi-arid savannah area of Tanzania. *Journal of Stored Products Research*, *57*: 49-57.

Amentae, T.K., E. G.Tura, G. Gebresenbet and D. Ljungberg (2016). Exploring value chain and post-harvest losses of Teff in Bacho and Dawo districts of central Ethiopia, *Journal of Stored Products and Postharvest Research* 7(1): 11-28.

APHLIS. (2014). Africa Postharvest Losses Information System. Losses tables; Estimated Postharvest losses (%) 2003-2014. Online available at http://www.aphlis.net/?form=home. (Accessed on January 31, 2018).

Aulakh, J., and Regmi, A. (2013). Post-harvest food losses estimation-Development of consistent methodology. Online available at:http://www.fao.org/fileadmin/templates/ess/documents/meetings/Improving_methods_for_estimating_post_harvest_losses/Final_PHLs_Estimation_6-13-13.pdf. (Accessed on January 19, 2018).

Barreiro-Hurle, J. (2012). Analysis of incentives and disincentives for maize in the United Republic of Tanzania. Technical notes series, MAFAP- FAO, Rome, Italy. (Accessed on December 15, 2017).

Basavaraja, H., Mahajanashetti, S. B., & Udagatti, N. C. (2007). Economic analysis of post-harvest losses in food grains in India: a case study of Karnataka. *Agricultural Economics Research Review*, *20*(347-2016-16622), 117.

Damodar, N. (2004). *Basic econometrics*. The Mc-Graw Hill.

FAO (2013). *Review of Food and Agricultural Policies in the United Republic of Tanzania*. Food and Agriculture Organization, Rome, Italy. 137pp

FAOSTAT. (2014). Africa maize production- 2012/13. http://faostat3.fao.org/browse/Q/QC/E. Accessed on November 10, 2018.

FAOSTAT. (2015). Country profile. United Republic of Tanzania. Online available at: Farmers Perceptions, of Rodents as Crop Pests: Knowledge, Attitudes and Practices.

Friedrich T, and Kassam A. (2016). Food security as a function of Sustainable Intensification of Crop Production. *AIMS Agriculture and Food*, 1(2):227-238 (DOI:10.3934/agrfood.2016.2.227).

Gabagambi, D. (2013). Barriers to Trade for Smallholder farmers in Tanzania: *A Review and Analysis of Agricultural Related Market Policies in Tanzania*. Eastern and Southern African small scale Farmers Forum, Dar es Salaam, Tanzania. 40.

Gustavsson, J., Cederberg, C., Sonesson, U., Van Otterdijk, R., & Meybeck, A. (2011). *Global food losses and food waste* (pp. 1-38). Rome: FAO.

Hodges, R. J. (2013). Rural 21. Focus. Tackling post-harvest cereal losses in sub-Saharan Africa. Online available at: http://www.rural21.com/uploads/media/rural2013_01-S16-18/ pdf. Accessed on January 18, 2018.

Kader, A. A. (2004). Increasing food availability by reducing postharvest losses of fresh produce. In *V International Postharvest Symposium 682* (2169-2176).

Lubungu, M., Chapoto, A., & Tembo, G. (2012). *Smallholder Farmers Participation in Livestock Markets: The Case of Zambian Farmers* (No. 1093-2016-87989).

Maziku, P. (2016): *Effects of Non-Tariff Barriers on Maize Trade In Mbozi and Momba Districts of Tanzania*. *International Journal of Economics, Business and Management Studies, 3(1), 1-11.*

Meronuck, R. A. (1987). "The significance of fungi in cereal grains." *Journal of Plant disease* 71(3): 287- 288.

Moctar, N., d'HôtelElodie, M. and Tristan, L. (2015). *Maize Price Volatility: Does Market Remoteness Matter? World Bank Group*. Policy Research Working Paper No. 7202. Washington DC. USA. 33.

Mugisha, J., Bwalya, R., & Hyuha, T. (2013). Transaction costs and smallholder household access to maize markets in Zambia.

National Bureau of Statistics of Tanzania-NBS (2014). *Tanzania National Panel Survey Report* National Bureau of Statistics, Dar es Salaam, Tanzania. 109.

Ngowi, E.R. and Selejio, O. (2014). Factors Influencing Adoption of Improved Post-Harvest Storage Technologies by Small holder Farmers in Tanzania.

Nyambo, B. T. (1993). Post-harvest maize and sorghum grain losses in traditional and improved stores in South Nyanza District, Kenya. *International Journal of Pest Management* 39(2): 181 187.

Rembold, F., Hodges, R., Bernard, M., Knipschild, H., & Léo, O. (2011). The African postharvest losses information system (APHLIS). *European Union, Luxembourg*.

Rugimamu, C. P. (2004). Insect infestation of maize, Zea Mays (L.) in indigenous storage structures in Morogoro region, Tanzania. *Tanzania Journal of Science* 29(2): 1-10.

Suleiman, R. A., & Kurt, R. A. (2015). Current maize production, postharvest losses and the risk of mycotoxins contamination in Tanzania. In *2015 ASABE Annual International Meeting* (1). American Society of Agricultural and Biological Engineers.

Tefera, T. (2012). Post-harvest Losses in African Maize in the Face of increasing Food Shortage. *Journal of Food Science –Springer Science*, 4: 267-277.

Tobin, J. (1958). Estimation of relationships for limited dependent variables. *Econometrica: journal of the Econometric Society*, 24-36.

Verheye, W. (2010). Growth and production of maize: traditional low-input cultivation. In *Land use, land cover and soil sciences*. UNESCO-EOLSS Publishers.

Zorya, S., Morgan, N., Diaz Rios, L., Hodges, R., Bennett, B., Stathers, T., ... & Lamb, J. (2011). Missing food: the case of postharvest grain losses in sub-Saharan Africa. The World Bank. Report No. 60371-AFR. The World Bank, Washington, DC, USA.