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Full Length Research Paper

Maize farmers' knowledge and perception of improved postharvest storage technologies in Kilolo District, Tanzania

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This study assessed small-scale maize farmers' knowledge and perception on the use of improved postharvest storage technologies in Kilolo District, Tanzania. The participants of the study include 260 farmers who were randomly selected from four villages. Data were collected by using interview schedule, questionnaire, Focus Group Discussions (FGD) and personal observation. Descriptive statistics such as means, frequencies, and percentages were computed. The study found that majority of respondents had low knowledge on the use of improved postharvest storage technologies. However, majority of the respondents had positive attitudes towards the use of improved postharvest technologies. It is recommended that Kilolo District Council and other development partners should promote the use of improved post-harvest technologies to reduce maize post-harvest losses; develop training programs on capacity building of extension officers and farmers on postharvest handling of maize and ensure that maize postharvest storage technologies are made available to farmers at a subsidized price.

Key words: Maize farmers, knowledge, perception, postharvest storage technologies, Kilolo.

INTRODUCTION

More than half of the cultivated land in Tanzania is allocated to cereal crop production (FAOSTAT, 2014). Of all food and cash crops cultivated in Tanzania, maize is the staple crop (USAID, 2010), that takes about 60% of cultivated food crops (URT, 2016). It accounts for 31% of the total food production, constitutes more than 75% of cereal consumption and contributes about 34-36% of total average daily calorie intake in Tanzania (Zorya et al., 2011). Maize production in Tanzania is dominated by small-scale farmers who constitute about 85% of total production (FAOSTAT, 2014). Although maize is grown almost in all regions of Tanzania, the southern zone regions (Iringa, Rukwa, Ruvuma, Njombe, and Mbeya) are the largest maize producers in the country, accounting for over 45% of the total annual maize production (USAID, 2010).

Studies by the Alliance for Green Revolution Africa (AGRA) (2013) and FAOSTAT (2014) show that the overall maize production in Tanzania has grown at an annual rate of 4.6% over the last 25 years. Furthermore, the total area under maize production has increased from 1,630 ha in the 1990s to over 4,000 ha in the 2010s (Barreiro, 2012). However, these developments have not resulted in ensuring food security and increasing income

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to small-scale farmers in the country. One of the reasons is that Post Harvest Losses (PHL) has remained high. Studies inform that PHL has an impact on livelihood, income, production incentive and investment (Kimenju and De Groote, 2010; World Bank, 2011; Mbwambo et al., 2016). PHL losses, which occur between harvest and the moment of human consumption, include on-farm losses, such as when the grain is threshed, winnowed and dried as well as losses that occur during transportation, storage and processing (World Bank, 2011).

In Tanzania, the PHL is between 30-40% of the total annual crop production (URT, 2017), while in Kilolo District PHL in 2012 was between 25-30%, and in 2015 it was between 22-28% (RUDI, 2016). Poor post-harvest handling practices, poor infrastructure, weather variability, biotic factors such as insects, bacteria, pathogens, viruses, and fungi often aggravate such losses that result in reducing the quality and quantity of the products (Shiferaw et al., 2013). This impedes efforts to reduce poverty and improve food security.

For years various initiatives have been taken by the government and partner institutions to improve crop storage to reduce PHL in Kilolo District. For example, in 2014 One Acre Fund programme implemented a two years project, which targeted 200 farmers (Kilolo District Council, [KDC] 2018). The objective of the project was to supply inputs recommended for an acre for the target maize farmers and promoted the use of improved storage technologies. Similarly, Rural and Urban Development Initiative (RUDI), in the same year implemented a three years project, which targeted 24 farmer groups. The main objective of the project was to introduce a warehouse receipts system and establish a demonstration plot for each group on the General Agricultural Practices (GAPs) for maize production. Furthermore, the Clinton Foundation in 2016 trained 30 groups of farmers on GAP, improved postharvest storage technologies and demonstrated the use of Purdue Improved Crop Storage (PICS), Metal Silo technologies for each group (ibid).

These initiatives made by the local government and partners were founded on the understanding that efforts to improve maize production and bring about the desired impacts should go hand in hand with building farmers' capacities on the use of technologies and improving infrastructure to reduce PHL. Despite the efforts taken by different stakeholders to promote the use of improved postharvest storage technologies in Kilolo District, experience shows that the extent to which farmers are using improved storage technologies is still low and postharvest losses are still witnessed (22-28%) (Kilolo District Council, 2018). This study, therefore, was conducted to determine farmers' knowledge of use and perception of improved postharvest storage technologies in Kilolo District. Although postharvest losses occur during different processes from farm to fork African Post Harvest Losses Information System (Shee et al., 2019), this study focused on postharvest losses of maize grains during storage after harvest, specifically the use of improved storage technologies.

MATERIALS AND METHODS

Study area

This study was conducted in Kilolo District (Figure 1), one of the four districts in Iringa Region, Tanzania. The district is located 7° and 8.3° South of equator and 34° and 37°East of Greenwich. The district lies on an altitude of 1200 to 2700 meters above sea level (KDC, 2018). The district was selected first, due to its high potential for producing maize, as statistics show that the current maize production level is on an average at 2.5 tonsha^{-1} but postharvest loses stand at 22-28% (RUDI, 2016), and secondly because of the existence of initiatives promoting the use of improved postharvest technologies.

Population, sampling procedure and sample size

The population of the study constituted all maize farmers who are using postharvest storage technologies to store their farm produces. The study adopted a multi-stage sampling technique as suggested by Verstraete and Meirvenne (2008). First, the district was purposively selected based on the reasons stated above. Secondly, Simple Random Sampling (rotary technique) was employed to select study villages. Thirdly, two hundred and sixty (260) respondents were randomly selected from the list of small-scale maize farmers. Twelve key informants: One District Agriculture, Irrigation and Cooperatives Officer (DAICO), three Subject Matter Specialists (SMS), four Extension Officers and four ward executive officers (WEO) were selected for in-depth interviews.

Instrumentation and data collection procedures

Data were collected in face-to-face interviews with respondents by using a semi-structured questionnaire and interview guides, which were all pre-tested before actual data collection for improvement. In order to get detailed information on farmers' knowledge and perception of postharvest storage technologies, Focus Group Discussions (FGD) were also conducted. Data were collected in two phases from January to February 2018. Phase one involved reconnaissance visit to the study area while the second phase involved the actual collection of primary data. Reconnaissance visit was mainly for the researchers' familiarization with the study area, consultations with different people, identification of study villages and drawing the sample.

To determine the level of knowledge on the use of improved storage technologies, 10 items meant for measuring the respondents' understanding of the technical recommendations or practices for the use of improved storage technologies were used. These statements were generated from the literature review and researchers' understanding of the subject. Respondents were requested to respond to a given statement (all statements were positively stated) by indicating 'yes' for the statement they perceived to be correct or 'no' for the statement they perceived to be incorrect. Each correct response was assigned one mark while an incorrect response was assigned zero. Respondents who scored less than five marks were categorized as less knowledgeable; those scoring between five and eight marks were categorized as knowledgeable and above eight marks were categorized as highly knowledgeable (Table 2). On the other hand, Likert Scale type

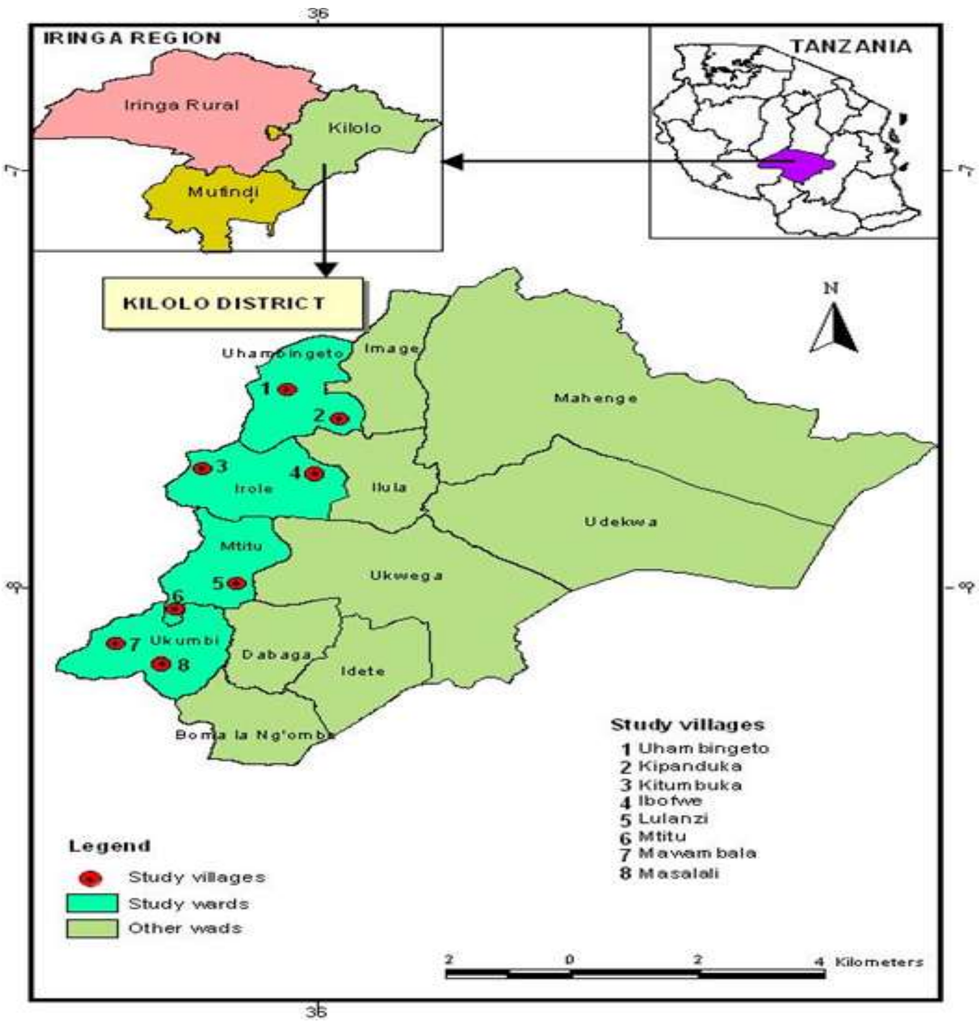

Figure 1. Map showing study area.

statements were used to determine farmers' perception on the use of improved postharvest storage technologies. There were nine attitudinal statements developed after reading literature on postharvest storage technologies. Respondents were requested to indicate whether they strongly agree, agree, are undecided, disagree or strongly disagree for each statement. For data analysis Agree and Strongly Agree responses were combined and treated as Agree, on the other hand, Strongly Disagree and Disagree responses were combined and treated as Disagree. The undecided or neutral responses indicated that the respondents knew nothing or were not sure thus leading to three points Likert scale, as indicated in Table 3a and 3b.

Data analysis

The collected quantitative data were coded, edited and analyzed using the Statistical Package for Social Sciences (SPSS) version 16 Computer software. Descriptive statistics such as mean, standard deviation, frequency and percentages were computed. Qualitative data were analyzed by the Content Analysis approach (Mayring, 2014). In this technique, all elements of data set were examined to clarify concepts and constructs as well as the deconstruction of the textual data into manageable categories, patterns, themes and relationships for meaningful interpretation.

RESULTS AND DISCUSSION

Demographic characteristics of respondents

Findings (Table 1) indicate that most of the respondents (82.7%) were married, 76.9% were from male-headed households. About 87.6% were aged between 26-55 years, which is a productive age. Most of the respondents (66.5%) had primary school education, 13.1% had secondary education while only a small proportion (1.5%) had post-secondary education. Further, the findings show that the majority (73.5%) cultivated one to four acres of land, which is an indication that small-scale farmers generally dominate the agricultural sector in the study area. This supports the findings by Mrutu et al. (2014) that small-scale farmers who cultivate less than five acres

Table 1. Demographic characteristics of respondents (N=260).

Variable	F	%
Sex of household head		
Male	200	76.9
Female	60	23.1
Age of respondents		
26-35	57	21.9
36-45	114	43.8
46-55	57	21.9
>55	32	12.4
Education level		
Non-formal	49	18.8
Completed primary school	173	66.5
Completed secondary school	34	13.1
Post-secondary education	4	1.5
Marital status		
Single	23	8.8
Married	215	82.7
Separated	8	3.1
Divorced	8	3.1
Widow	6	2.3
Household size		
1-3	39	15.0
4-6	70	26.9
>6	151	58.1
The total area under cultivation in acres		
1-4	191	73.5
5-8	62	23.8
Above 8	7	2.7
Purposes of growing maize		
Consumption	33	12.7
Sale	4	1.5
Consumption and sale	223	85.8

F = Frequency.

dominate the agriculture sector in Tanzania.

About 60% of all the sampled households had more than six individuals, which is slightly higher than the average household size in Tanzania. According to the National Bureau of Statistics, the average household size for Tanzania is five individuals (URT, 2012). Over three quarters (85.8%) grow maize for both consumption and sale. This means that maize is required to be stored to maintain its quality and quantity for consumption and sale. It is well established that efficient storage of agricultural produce is critical to maintaining product quality while stored and when taken to the market (Tefera et al., 2011).

Respondents' knowledge level on improved postharvest storage technologies

The findings (Table 2) indicate that, as compared to other categories, the larger proportion (61.5%) of respondents was less knowledgeable on the use of improved storage technologies. This could be attributed to insufficient training on improved storage technologies, poor extension services and farmers' lack of knowledge on improved

Table 2. Respondents' knowledge of the use of improved storage technologies (N=260).

Practices (Multiple responses)	Yes response	
	F	%
Harvesting matured/dried maize grain	180	69.2
Maize should be stored at the moisture content of (12-14%)	45	17.3
Cleaning maize before storage	145	55.7
Should be tightened well (PICS)	55	21.2
Should be put on a pallet (PICS)	18	6.9
The metal silo should be cleaned before storage	10	3.8
Caps are well tightened (metal silo).	12	4.6
Use recommended rates of storage chemicals	25	9.6
Rat guards should be used (improved granaries)	14	5.4
The inlet and outlet pots well closed (improved granaries).	22	8.5
Overall score		
Highly knowledgeable	32	12.3
Knowledgeable	68	26.2
Less knowledgeable	160	61.5
Total	260	100

F = Frequency.

storage technologies in the study area (Kamanula et al., 2011; AGRA, 2013; Maonga et al., 2013).

This implication is further supported by Ndunguru et al. (2016) who reported that most (86%) small-scale farmers in Tanzania have limited knowledge on the use of appropriate methods for proper management of storage technologies. AGRA (2013) and Maonga et al. (2013) also add that farmers' low knowledge level on the use of postharvest storage technologies is directly associated with education level, wealth level, farmers' organization, access to credit and geographical location of the farmers. Findings reveal that majority of respondents have a general understanding on the aspects of storage, such as harvesting mature maize (69.2%), cleaning harvest maize before storage (55.7%), and well tightening of storage containers (21.2%). During FGD with the District Agricultural, Irrigation and Cooperative Officer (DAICO), Crop Officers, District Agricultural and Extension Officer and Agricultural Field Officers (AFO), one participant had this to say,

''You know most of our farmers do not know how to effectively use improved storage technologies. There are many reasons but the most important one for me is budget constraint that makes our department unable to play our educational role'' (Kilolo District Agricultural and Extension Officer, 17/2/2018).

Generally from the discussions, it was revealed that majority of the farmers in the study area had low knowledge on the use of improved storage technologies as a result of the failure of the Department to implement capacity building activities for improving postharvest storage technologies due to budget constraints. Generally, data show that more than half of the respondents had low knowledge on the use of postharvest storage technologies.

Farmers' perception about improved postharvest storage technologies

Findings (Table 3a and b) indicate that half of the respondents agreed with the statement that Metal Silo, improved Granaries, PICS and Storage Chemical technologies maintain the quality of stored products. Comparing the four, Metal Silo and PICS had higher rates of 64 and 61%, respectively. Of all the four technologies, Metal Silo was highly perceived by respondents as durable (89%), environmentally friendly (65%) and safe for human consumption (84%). On the other hand, Metal Silos were perceived to have a high initial cost (85%) closely followed by improved granaries. However, almost 90% of the respondents agreed that improved granaries were associated with high maintenance cost.

During FGDs participants revealed that improved granaries are not much durable as other technologies like PICS and Metal Silos, thus requires regular maintenance compared to other improved postharvest storage technologies, which are found in the study area. Also, surprisingly, 58% of the respondents agreed with the statement that crop products that are stored with storage chemicals are safe for human consumption. Probably this is due to lack of knowledge on the side effects of storage chemicals, especially when applied without considering

Table 3a. Score on the items of the Likert scale for assessing respondents' about the use of improved postharvest storage technologies (N=260).

Attitudinal statement	Technology											
	PICS						Metal silo					
	Disagree		Undecided		Agree		Disagree		Undecided		Agree	
	n	%	n	%	n	%	n	%	n	%	n	%
Maintaining the quality and quantity of stored products	43	16.5	59	22.7	158	60.8	65	25	28	10.8	167	64.2
Technology is durable	48	23.5	82	31.5	140	53.8	39	15	54	20.8	232	89.2
Technology is environment friendly	66	25.4	43	16.5	151	58.1	29	11.2	61	23.4	170	65.4
Stored products are safe for human consumption	58	23.5	12	4.6	190	73.1	12	4.6	219	11.2	219	84.2
Require high initial cost	190	73.1	12	4.6	58	23.5	13	5	25	9.6	222	85.4
Have high maintenance cost	211	81.2	12	4.6	37	14.2	240	92.3	8	3.1	12	4.6
Prone to rodents attack	211	81.2	12	4.6	37	14.2	240	92.3	8	3.1	12	4.6
Less effective against insects storage pests	24	9.2	191	73.1	45	17.3	240	92.3	12	4.6	8	3.1
Stored products exposed to thieves	190	73.1	37	14.2	33	12.7	232	89.2	25	9.6	3	1.2

Table 3b. Score on the items of Likert scale for assessing respondents' perception about the use of improved postharvest storage technologies (N=260).

Attitudinal statement	Technology											
	Storage chemicals						Improved granaries					
	Disagree		Undecided		Agree		Disagree		Undecided		Agree	
	F	%	F	%	F	%	F	%	F	%	F	%
Maintaining the quality and quantity of stored products	84	32.2	26	10	150	57.7	38	14.6	82	31.5	140	53.8
Technology is durable	173	66.5	75	28.8	12	4.6	16	6.2	12	4.6	167	64.2
Technology is environmental friendly	178	68.5	53	20.3	29	11.2	82	31.5	64	24.6	114	43.9
Stored products are safe for human consumption	96	36.9	12	4.6	152	58.5	30	11.5	150	57.7	80	30.8
Require high initial cost	169	65	12	4.6	79	30.4	78	30	106	40.8	173	66.5
Have high maintenance cost	96	36.9	12	4.6	152	58.5	4	1.5	24	9.2	232	89.2
Prone to rodents attack	228	87.7	20	7.7	12	4.6	98	37.7	150	57.7	12	4.6

F = Frequency.

their recommended rates.

By using a three-point rating responses (2 indicates to agree; 1 indicates to disagree; and 0 indicates to be undecided), means and standard deviation values associated with each item for each technology were determined (Table 4). For data to be interpreted, the mean of each item ranging from 1.5 and above was characterized as positive attitudes and the values which were below the mean were considered as negative attitudes.

The findings (Table 4) show that all five positively phrased statements, respondents perceived that products stored in improved storage technologies such as PICS and Metal

Table 4. Score of the respondents' perception about improved postharvest storage technologies using mean and standard deviation (N=260).

Attitudinal statements	Technologies									
	Improved granaries		PICS		Metal Silo		Storage chemical		Overall	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Maintain the quality and quantity of stored products	1.85	0.47	1.75	0.54	1.88	0.45	1.54	0.52	1.75	0.5
Technology is durable	1.65	0.56	1.67	0.34	1.88	0.45	1.12	0.38	1. 69	0.58
Safe for human consumption	1.67	0.63	1.55	0.68	1.81	0.52	0.98	0.32	1.55	0.64
The technology is environmental friendly	1.51	0.64	1.68	1.59	1.84	0.42	1.25	0.64	1.52	0.56
Require high initial cost	1.77	0.55	1.77	0.55	1.81	0.52	0.94	0.38	1.57	0.6
Have high maintenance cost	1.34	0.64	1.25	0.58	1.32	0.64	0.98	0.72	1.22	0.58
Prone to rodents attack	1.34	0.68	1.25	0.58	1.18	0.28	1.26	0.66	1.24	0.55
Less effective against storage pests	0.94	0.36	1.25	0.58	1.23	0.61	1.56	0.56	1.25	0.48
Stored products exposed to thieves	1.89	0.44	1.44	0.67	1.42	0.62	0.58	0.22	1.32	0.43

Silos are safe for human consumption (mean= 1.55) but when considering the mean of each technology, Metal Silo had a mean of 1.81 compared with storage chemicals, which had a mean of 0.98. This implies that, according to farmers, maize stored in a Metal Silos is best for human consumptions compared to those stored in PICS and improved granaries. One good thing about Metal Silos is that they create an unfavourable environment for the growth of microorganisms like fungus (*Aspergillus flavus*), which is the causative agent of aflatoxin in grains. This is especially when they are kept clean and dry and products are stored at recommended moisture contents (12-14%).

Improved postharvest technologies are durable because when used they last longer as revealed in the study area (mean=1.69). Improved storage technologies such as PICS, improved Granaries and Metal Silo can be used to store products for more than three years and hence reducing costs of purchasing technologies each year. Also, they are environment friendly (Mean=1.52) compared to traditional storage technologies as they help to preserve trees, bamboos and grass by not requiring intensive use of such forestry products. Thus, improved maize storage structures have potential in contributing to environmental conservation efforts because they reduce the use of forest products and hence maintaining natural vegetation. The findings are in consistence with Stathers et al. (2013) who found that improving postharvest management techniques can also help build resilience against current and future climate-related shocks and reduce the need for expanding farmland and damage to environmental services, including carbon sequestration (mitigating the effects of global warming).

Further analysis indicated that respondents rated high (mean=1.75) the statement, that when products are stored in improved storage technologies their lifespan increases and their quantity and quality are maintained for a desired period; for improved granaries (mean = 1.85), Metal Silos (mean = 1.88) and PICS (mean = 1.75). In the study area, the respondents perceived Metal Silo and PICS as effective. This means that they are perceived more positively on maintaining the quality and quantity of stored products (over 60% agreed) compared to products stored by using storage chemical technologies. These findings contradict those of Kimani (2018) who found that small proportion (33%) of respondents perceived that Metal Silo technology maintained the quantity and quality of stored grains. Likewise, Gladstone and Hruska (2002) found that about 60% of the respondents were found to have maize grain in their silos at the beginning of the next harvest in comparison with only 29% of the non-users. For instance, product stored either in PICS or Metal Silo was free from infestation and this could be because of their characteristics of not allowing insects to invade the products and free from contamination. These findings are in agreement with Tefera et al. (2011) and De Groote et al. (2013) who found that Metal Silos were effective in controlling maize weevils and larger grain borers (LGBs).

Also, the study findings show that generally respondents perceived high initial cost for purchasing the improved postharvest storage technologies (mean1.57). The mean score for improved Granaries was 1.77 and for Metal Silos it was 1.81. For example, Metal Silos are made up of galvanized iron sheets, which are expensive. Okoedo-Okoije and Onemolease (2009) also reported that the high initial cost of improved storage technologies accounts for farmers not using storage technologies. Similarly, Kassie et al. (2013) reported that the poor adoption of improved storage technologies in India was caused by the high initial cost of the improved storage technologies. Concerning the study area, 69.2% of the respondents complained about the high initial cost for purchasing Metal Silos and 61.5% of respondents complained about high cost for the improved granaries as discussed earlier in the Likert scale above. Generally, respondents positively perceived Metal Silo, improved Granaries and PICS to be more effective while Storage Chemicals was negatively perceived on the ground of perceived health concern or implication.

CONCLUSION AND RECOMMENDATIONS

The study assessed maize farmers' knowledge of use and perception of improved postharvest technologies. Based on the study findings, the following conclusions were made: generally, respondents had low knowledge on the use of improved postharvest storage technologies; as a result only a few respondents were able to use the recommended technologies; majority of the respondents had positive attitudes towards the use of PICS, Improved granaries and Metal Silos. The main argument made by respondents was that the technologies are durable and maintain the quality and quantity of stored products; therefore products stored in these technologies were perceived to be safe for human consumption and these technologies are environmentally friendly. Nevertheless, these technologies require high initial cost while some of them have high maintenance costs. Kilolo District Council in collaboration with the private sector and other development partners should: promote the use of improved post-harvest technologies to ensure reduced PHL and ensure food security and increased income; develop training programs on capacity building of extension officers and other key actors to enable them to train small scale farmers on maize postharvest handling; equip extension officers with skills to mobilize and encourage farmers to form groups or utilize existing farmer organizations for collective/community crop storage such as cereal banks and warehouse receipt systems. Similarly, the government should look into the possibilities of subsidizing improved postharvest storage technologies such as a Metal Silo, improved granaries and PICS, which seems to have high initial costs but were perceived as most effective by the farmers.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Alliance for Green Revolution in Africa (AGRA) (2013). Establishing the Status of Post-Harvest Losses and Storage for Major Staple Crops in Eleven African Countries. Alliance for Green Revolution in Africa, Nairobi, Kenya 12 p.

Barreiro HJ (2012). Analysis of Incentives and Disincentives for Maize. Technical Notes Series No 4. Food and Agriculture Organization, Rome, Italy 12 p.

FAOSTAT (2014). Assessing. Purdue improved crop storage bags to mitigate fungal growth and aflatoxin contamination. Journal of Stored Products Research 59(1):12-15.

Gladstone S, Hruska A (2002). Guidelines for Promoting Safer and More Effective Pest Management with Small Holder Farmers: a Contribution to USAID-FFP Environmental Compliance. Prepared for CARE's FRCT, Atlanta, Georgia.

Kamanula J, Sileshi G, Belmain R, Sola P, Mvumi M, Nyirenda G, Nyirenda P, Stevenson C (2011). Farmer's insect pest management practices and pesticidal plant use in the protection of stored maize and beans in Southern Africa. International Journal of Pest Management 57(1):41-49.

Kassie M, Jaleta M, Shiferaw B, Mmbando F, Mekuria M (2013). Adoption of interrelated sustainable agricultural practices in smallholder systems: Evidence from rural Tanzania. Technological Forecasting and Social Change 80(3):525-540.

Kilolo District Council (KDC) (2018). Quarterly Report on the Activities Implemented in the Department of Agricultural, Irrigation and Cooperative. Kilolo District Council, Iringa, Tanzania 42 p.

Kimani A, Tadele T, Olubayo F, Kilalo D (2018). Effect of Sealing Method and Lighting Candle in Metal Silos on Survival of the Larger Grain Borer, *Prostephanus Truncatus*, in Stored Maize. Journal of Agricultural Science 10(8):90-99.

Kimenju SC, De Groote H (2010). Economic analysis of alternative maize storage technologies in Kenya Contributed Paper presented at the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa, September 19-23, 2010.

Maonga B, Assa M, Haranan E (2013). Adoption of small metallic grain silos in propensity score matching. Storage technologies in Kenya and Cape Town, South Africa. [www.containerexchanger.com/steele-totes] site visited on 10/06/2018.

Mayring P (2014). Qualitative Content Analysis. Theoretical Foundation, Basic Procedures and Software Solution Klagenfurt, Austria 143 p.

Mbwambo H, Kotu B, Mpenda Z (2016). An economic evaluation of improved grain storage technology in Tanzania. Poster prepared for Africa RISING Humidtropics Systems Research Marketplace, Ibadan, Nigeria, 15-17 November 2016. Ibadan, Nigeria: IITA.

Mrutu BA, Tileye F, Ndunguru J (2014). Assessment of genetic diversity of maize inbred lines and hybrids in the Southern Highlands of Tanzania by using random amplified polymorphism markers. American Journal of Research Communication 2(4):84-98.

Ndunguru A, Letaa E, Katungi EC, Kabungo C (2016). Impact of Improved Common Bean Varieties on Household Food Security on Adopters in Tanzania. African Crop Science Journal 23(3):261-277.

Okoedo-Okoije DU, Onemolease EA (2009). Factors Affecting the Adoption of Yam Storage Technologies in the Northern Ecological Zone of Edo State, Nigeria. Journal of Human Ecology 27(2):155-160.

Rural and Urban Development Initiative (RUDI) (2016). Annual Report on Warehouse Storage System in Kilolo District. Alliance for Green Revolution in Africa Tanzania. [https://operations.ifad.org/documents/654016/b0b9c8b5-e418-4992-9683-58f72125e3f2] site visited on 10/06/2018.

Shee A, Mayanja S, Simba E, Stathers T, Bechoff A, Bennett B (2019). Determinants of postharvest losses along smallholder producers maize and Sweetpotato value chains: an ordered Probit analysis. Food Security 11:1101–1120. DOI.org/10.1007/s12571-019-00949-4.

Shiferaw B, Smale M, Brain H, Duveiller E, Reynolds M (2013). Crops that feed the World. Past success and future challenges to the role played by wheat in global food security. Journal of Food Security 3(5):291-317.

Stathers T, Lamboll R, Mvumi BM (2013). Postharvest agriculture in changing climates: Its importance to African smallholder farmers. Food Security 5(3):361-392.

Tefera T, Kanampiu F, De Groote H, Hellin J, Mugo S, Kimenju S, Beyene Y, Boddupalli PM, Shuferaw B, Banziger M (2011). The metal silo: An effective grain storage technology for reducing post-harvest insect and pathogen losses in maize while improving smallholder farmers' food security in developing countries. Journal of Crop Protection 30(3):240 -245.

Unite Republic of Tanzania (URT) (2012). National Strategic for Growth and Reduction of Poverty II. Ministry of Finance and Economic Affairs, Dar es Salaam, Tanzania 217 p.

Unite Republic of Tanzania (URT) (2016). Agricultural Sector Development Programme II. Framework and Process Document. National Printing Company, Dar es Salaam, Tanzania 121pp.

Unite Republic of Tanzania (URT) (2017). Ministry of Agriculture Livestock and Fisheries (MALF) 2017/2018 budget speech. Dar es Salaam, Tanzania.

United States Agency of International Development (USAID) (2010). Postharvest Losses in Maize Based on Farming Systems of Semi-Arid Area of Tanzania. United States Agency of International Development, Dodoma, Tanzania 98 p.

Verstraete S, Meirvenne MV (2008). A multi-stage sampling strategy for the delineation of soil pollute on in a contaminated brownfield. Environmental pollution 154(2):184-191.

World Bank (2011). Missing food: The case of Post-harvest grain losses in Sub-Saharan Africa. Economic and Sector Work. Washington, DC: World Bank.

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. Report No. 60371. The World Bank, Washington DC. 10 p.