Y with the external evaluators for ISSD project

Report

On

Postharvest Loss Assessment Survey-in Ethiopia

Baseline Information on Maize (*Zea mays* L.)

Postharvest Loss Assessment

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1. INTRODUCTION

Maize (Zea mays L.) was originated from tropical zones of America and has now become the highest production cereal grown worldwide. It has become particularly important in developing countries and it is one of the most widely cultivated gramineous plants in East Africa (Acland, 1977). It is believed to have been introduced to Ethiopia in the 1600s to 1700s and has become an important cereal grain widely cultivated under a wide range of environmental conditions, between 500 to 2400 meters above sea level. According to the reports of the Central Statistical Authority (CSA) (2013), maize is being grown in different parts of the country; Oromia and Amhara regional states are the major producers. Ten zones found in the two regions contributed to more than half of the national maize production in 2012. The top ten maize producing zones of the country are: West Gojjam (5.6 million quintals), East Wellega (4.3 million quintals), Kaffa (3.8 million quintals), East Shewa (3.1 million quintals), West shewa (2.9 million quintals), West Arsi (2.7 million quintals), Illubabor (2.7 million quintals), East Gojjam (2.2 million quintals), West Wellega (2.1 million quintals), and West Harerghe (2.1 million quintals). In addition to the two states, maize is cultivated in South, Tigray, Benshangul Gumiz and Gambela regional states.

Maize is the leading cereal in terms of production and used as human as well as animal feed in Ethiopia. It has a good nutritional value and is one of the main sources of calories (Abebe et al., 2009). It has starch (60%-80%), protein (8%-12%), fat (3%-5%) and minerals (1 %-2%) (Sexena *al*., 2000).It is considered to be the cheapest source of calorie intake in the country, providing 20.6% of per capita calorie intake nationally (IFPRI, 2010). Hence, the maize production has been increased steadily with 6.4 million tons produced in 2013/14 by 8.8 million farmers on 1.994 million hectares of land (CSA 2014). Nevertheless, the yield of maize remained very low due to many biotic and abiotic constraints, among which insect pests and diseases are the major causes.

The damage by insect pests is not only limited to growing crops in the field but also continues after harvest at different phases of the post-harvest activities. Despite the low total agricultural productivity, post-harvest losses of the food being produced are significant (World Bank et al., 2011). Any damage done on grains and final produce is severe because there will not be compensation for the losses. In addition to the quantitative post-harvest losses, injured grains lose their viability, quality and nutritional values (Ezuch, 1983; Okilwela et. al. 1987). According to Franzel et. al. (1989) storage losses are substantial and they are one of the reasons why farmers sell most of their maize produces soon after harvest and suffer food shortage in the later time of the year in Ethiopia.

Post-harvest insect pest of maize such as S*itophilus zeamais, S. oryzae, Sitotroga cereallela, Tribolium spp. & Ephestia cautella* are the major pests of stored maize and other cereals in Ethiopia (Abraham, 1997). Among these pests, the maize weevil (*S. zeamais)* causes very serious damage and it is a cosmopolitan pest (Longstaff, 1981).

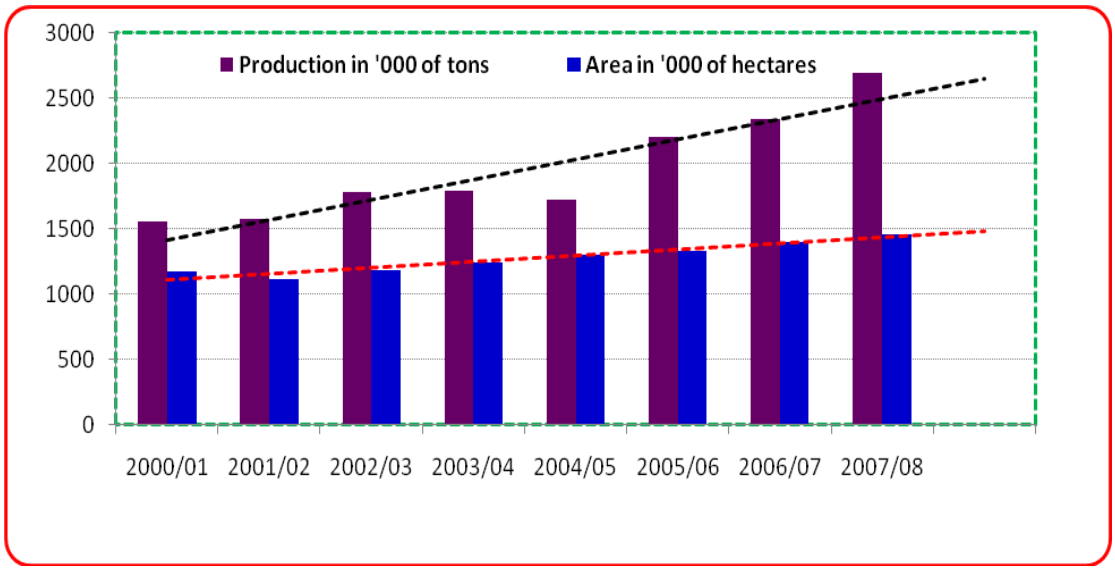

Fig 1, Mazie Production and area coverage in Ethiopia

Various levels of weight loss due to storage insect pests have been reported. Firidissa, (1999) reported that annual grain losses in Ethiopia range between 2 and 30%. Similar extents of losses were recorded on maize mainly due to *S. zeamais* and *S. cereallela* in

different parts of the country. Reports showed that crop losses due to these pests were 16.4 at Bako (Abraham, 1991), 16.1% at Awassa (Adhanom, 1990) and up to 17.3% in the Keffa and Illubabor areas (Mekuria, 1994). Sori and Ayana (2012) found that *S. zeamais* is the dominant and most important pest of maize in Jimma Zone and average grain damage of 64.50% and losses of 41 to 80% are common in the store within three to six months of storage.

In Eastern and Southern Africa alone, post-harvest losses are valued at US $1.6 billion per year, or about 13.5% of total value of grain production (World Bank et al., 2011). This calls for more reliable and verifiable data on post-harvest losses. Post-harvest losses in Africa are often estimated to be between 20 and 40% (World Bank et al., 2011). Such losses are a combination of those which occur on the field, in storage, during processing and other marketing activities. According to Rugumamu (2009) and Kereth (2013), farmers and crop handlers, especially women, do not have adequate information on proper crop harvesting and handling methods, resulting in significant damage by insect pests during storage and marketing. It is therefore timely to consider how minimizing postharvest food losses, including food waste, can help conserve resources and improve human well-being.

2. OBJECTIVE

The objective of the study was, therefore,:

1. To assess and analyze factors contributing to post-harvest problems of maize at various post harvest phases in Ethiopia
2. To develop baseline, to post-harvest loss reduction strategies.
3. To engender and identify technologies through promoting research in post-harvest management technologies aiming at minimizing crop losses between harvesting and actual consumption.

3. SCOPE OF THE STUDY

This study is based on the survey conducted in four regional states of Ethiopia (Oromiya, SNNP, Tigray and Amhara); which are the major maize production areas of the country. In the survey about 280 respondents were participating and the survey data were inserted in online system developed by the KSU team.

Following online data entry, the KSU team analyzed and sent the result; that the analysis and interpretation is made based on the analysis sent from KSU teams.

4. MATERIALS AND METHODS

A survey that helps to generate baseline information for the postharvest loss assessment study was undertaken on maize by in collaboration of Mekelle, Hawassa and Bahir Dar Universities. The survey was undertaken by three teams of enumerators one team from Bahir Dar University covered the Amhara Region, the other team from Hawassa University covered the Oromiya and SNNP regions while a team from Mekelle University collected the data from the Tigray region.

The survey locations (Zone, Woreda) were selected based on their potential in maize production and selection of peasant associations was made together with woreda agricultural experts. Maximum care was, therefore, taken to assess potential production areas, though we were constrained by time of the survey. The survey covered four major maize producing regional states; namely, Amhara, South Nations, Nationalities and Peoples (SNNP), Oromia and Tigray regions. A total of 280 farmers were interviewed in the four regions (Table 1), by considering slightly more representation for the Amhara and South Nations, Nationalities and Peoples (SNNP) regions, as the vast majority of maize comes from there.

Table 1. Number of respondents interviewed in the four regional States

No.	Region	Respondent farmers	
		Number	Percent[a]
1	Tigray	51	18.21
2	Amhara	85	30.36
3	Oromia	70	25.00
4	SNNP	74	26.43
	Total	280	100.0

[a]ercentages based on total respondents.

5. DATA ANALYSIS

The collected data were subjected to statistical analysis using --------- software. Descriptive statistics, mean comparison and multiple response analysis were employed depending on the type of the data. Some of the farmers responded to some of the questions as they "have no idea", especially in areas of giving estimates. Therefore, data from those farmers who provided full information were included in the report.

6. RESULTS AND DISCUSSIONS

6.1. Demography of Respondent Farmers

The majority of the respondent were male (84.64%) and 15.36% (n = 280) were female farmers (Table 2).

Table 2. Gender of respondent farmers

No	Gender	Respondent Farmers	
		Number	Percent
1	Male	237	84.64
2	Female	43	15.36
	Total	280	100.0

The average age of the respondents was 41.8 years old.

Out of the interviewed farmers nearly 45%, 16% and 3% had completed primary school, secondary school and diploma, respectively. None of the respondents had received a degree while almost 19% of them had completed an informal education. 19% of the interviewed farmers said that they had no education Table 3).

Table 3. Educational status of respondent farmers

No	Description	Category	Respondent farmers	
			Number	Percent[a]
1	Education level	Elementary education completed	125	44.5
		Secondary school completed	45	16.0
		Diploma received	7	2.5
		Informally educated	52	18.5
		No education	53	18.9
2	Writing Ability	Able	222	80
		Not able	56	20
3	Reading Ability	Able	226	82
		Not able	52	18

[a]Percentages based on *n* = 278.

Of the 278 respondents to 82% they said that they could read, while the rest they could not. 82% of them said that they could write, and 20% said that they could not Table 3).

6.2. Agro-ecology and Source of Income

As depicted in Table 4 below, the majority of the surveyed areas (59%; *n* = 280) were characterized as mid-land followed by low land (26%), sub-humid (11%), high lands (2%) and humid (1%), respectively. Crop production is the sole primary source of income for almost all (98%; *n* = 279) of the respondent farmers (Table 5). Multiple responses were provided by some of the farmers on their secondary source of income. Livestock production is secondary source of income for the majority (78%; *n* = 278) of

respondent farmers followed by crop production (10%) others share minor percentages (Table 6)

Table 4.Agro-ecology of the surveyed localities

No	Agro-ecology	Respondent farmers	
		Number	Percent[a]
1	Highland	6	2%
2	Midland	166	59%
3	Lowland	73	26%
4	Humid	3	1%
5	Sub-humid	32	11%
	Total	280	100%

Statistic	Value
Min Value	1
Max Value	5
Mean	2.60
Variance	0.99
Standard Deviation	1.00
Total Responses	280

[a]Percentages based on *n* = 280.

Table 5. Primary source of income of the respondent farmers, generated from multiple responses.

No	Source of primary income	Respondent farmers	
		Number	Percent [a]
1	Crop production	274	98%
2	Livestock production	3	1%
3	Petty business	2	1%
4	Self-employed	0	0%
5	Civil servant	0	0%
6	Other:	0	0%
	Total	279	100%

Statistic	Value
Min Value	1
Max Value	3
Mean	1.03
Variance	0.04
Standard Deviation	0.20

Total Responses	279

[a]Percentages based on *n* = 279.

Table 6. Secondary source of income of the respondent farmers, generated from multiple responses

No	Source of primary income	Respondent farmers	
		Number	Percent [a]
1	Crop production	27	10%
2	Livestock production	216	78%
3	Petty business	12	4%
4	Self-employed	13	5%
5	Civil servant	3	1%
6	Other:	7	3%
	Total	278	100%

Statistic	Value
Min Value	1
Max Value	6
Mean	2.17
Variance	0.80
Standard Deviation	0.89
Total Responses	278

6.3. Production of Target Crops

Table 7 depicts farming experience of the respondents their cumulative mean production of the project target crops for the 2013-14 period. The respondent farmers had mean farming experience of 38.92 years ranging from 7 to 75. The results indicated that maize had the largest production per household with mean value of 31.93 quintals followed by Bread wheat (3.94 quintals), chickpea (0.87quintals), Sesame (0.26quintals) and durum wheat (0.01quintal) respectively (Table 7).

Table 7. Farming experience (years) of respondent farmers and mean production (Quintals) of project target crops, 2013-2014.

Crop Type	Min Value	Max Value	Average	Standard

			Value	Deviation
Chickpea	0.00	105.00	0.87	6.44
Maize	0.00	500.00	31.93	45.18
Sesame	0.00	11.00	0.26	1.31
Bread wheat	0.00	102.00	3.94	11.23
Durum wheat	0.00	4.00	0.01	0.24
Sorghum (only for Sesame survey)	0.00	0.00	0.00	0.00

6.4. Causes of Grain Loss

Results on the prevalence of the various causes of grain losses discussed hereafter are based on the total number of respondents (n = 280) while findings on their severity are derived from the number of farmers who recognized the respective causes of losses as their prevalent problem**.**

6.4.1. Field and storage insect pests

The study attempted to identify causes of grain loss and rated their severity level as perceived by the farmers. Majority of respondent farmers, 93.0% (*n* = 280) and 96.07% (*n* = 280), recognized field and storage insect pests as constraints of their maize production, respectively (Table 8). As far as the severity of insect pests is considered greater majority of the farmers (60.13%; *n* = 169) categorize the problem of storage insect pests to be sever, while 40.71% and 36.79% (*n* = 260) of them considered field insect pests to have severe and moderately severe effect, respectively. Small proportion of the farmers considered both field insect pests of maize either to have moderate damage or no sever effect at all. Nearly 80% (*n* =280) of the respondent farmers appreciated the problem of termites; while 31% (*n* = 216) of them reported to have sever termite problem.

Table 8. Farmers' response on the causes of maize loss experience in a typical year and rate the severity of loss

No	Description	Farmers Response	Field insect pests		Storage insect pests		Termites	
			No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
1	Prevalence	Prevalent	260	93.00	169	96.07	216	77.4
		Not prevalent	20	7.00	11	3.93	64	22.86
2	Severity	Not sever	42	15.00	28	10.00	81	28.93
		Moderately sever	103	36.79	70	25.00	47	16.79
		Sever	114	40.71	169	60.36	87	31.07
		Not recognized	21	7.50	13	4.64	65	23.21

6.4.2. Problem of Rodents, Birds and other animals

The problem of rodents as a storage and field pest has got due consideration by 90.7% and 78.9% of the respondent farmers, respectively (Table 9). More than half (n = 221) and 20% (n = 221) of the respondent farmers considered the damage by storage and field rodents to be severe, while larger proportion of them (21.7% for storage rodents and 29.29% for field rodents) rated the effect as moderately sever. The prevalence of birds and other animals as a production constraint of maize has also been perceived by 88.57% and 80% of all the respondent farmers, respectively. Birds and other animals were reported to cause severe damage to 17.14% (n = 248) and 30% (n =224) of the respondents while no or moderately severe damage was perceived by the majority of the farmers (Table 9).

Table 9. Farmers' response on the presence and severity of rodent, birds and other animals

No	Description	Farmers Response	Field rodents		Storage rodents		Birds		Other animals	
			No. of farmers	%	No. of farmers	%	No. of farmers	%	No. of farmers	%
1	Prevalence	Prevalent	221	78.93	254	90.71	248	88.57	224	80.00
		Not prevalent	59	21.07	26	9.29	32	11.43	56	20.00
2	Severity	Not severe	81	28.93	36	12.6	96	34.29	60	21.43
		Moderately severe	82	29.29	59	21.7	103	36.79	79	28.21
		Severe	57	20.36	158	56.43	48	17.14	84	30.00
		Not recognized	60	21.43	27	.9.64	33	11.79	57	20.36

6.4.3. Field and storage mold

The prevalence and severity of both field and storage molds on maize has highly recognition by respondent farmers (Table 10). A great majority of the farmers (*n* = 280) responded to have mold problem in the field at times of unfavorable weather (untimely rain) during harvesting, while 70% (*n*= 197) of the respondents recognize storage mold, if maize are not fully dried prior to storage. About 31.7% (*n* = 179) and 25.36% (*n*= 239) of the farmers recognized severe effect of storage and field molds. It is only small proportions of farmers 29.6% and 22.14% of respondent farmers perceive that mold is less prevalent and severe on maize, both at field and storage levels, respectively.

Table 10. Farmers' response on the presence and severity of field and storage mold problem

No	Description	Farmers' Response	Field mold		Storage mold	
			No. of farmers	Percent	No. of farmers	Percent
1	Prevalence	Prevalent	239	85.36	197	70.36
		Not prevalent	41	14.64	83	29.64
2	Severity	Not sever	83	29.64	62	22.14
		Moderately sever	84	30.00	47	16.79
		Sever	71	25.36	87	31.70
		Not recognized	42	15.00	84	30.00

6.4.4. Non-pest causes of grain loss

Farmers' perception on non-pest causes of grain loss is presented in Table 11. The majority of farmers (65.7%) responded to have theft problem in maize especially while the crop is in the field. The farmers rated theft problem as not being severe (34.29%; *n* = 132), moderately severe (32.1%) and severe (22.86%). Maize farmers (85.0%) also recognized the prevalence of unfavorable weather, occasional rain particularly occurring after the crop matures, to cause damage to their crop where only 26.06% of them perceived severe effect. Grain loss due to spillage and broken grains was acknowledged by 60.36% and 73.93% of the farmers, respectively. Over 75% of the farmers realized that their traditional methods of harvesting methods cause grain loss with sever (15%) to moderate severity (25.71%). Grain loss during threshing was also perceived byabout73.93% of the respondent farmers. On the other hand, maize grain loss due to transportation was also recognized by 58.93% of the farmers (Table 11).

Table 11. Non pest causes of grain loss

No	Damage cause	Respondent farmers	Farmers Response					
			Prevalence		Severity			
			Prevalent	Not prevalent	Not severe	Moderately severe	Severe	Not recognized
1	Theft	Number	184	96	96	90	64	30
		Percent	65.71	34.29	34.29	32.14	22.86	10.71
2	Unfavorable weather	Number	238	42	66	99	73	42
		Percent	85.00	15.00	23.57	35.36	26.07	15.00
3	Spillage	Number	169	111	69	62	38	111
		Percent	60.36	39.64	24.64	22.14	13.57	39.64
4	Broken karnel	Number	207	73	110	63	33	74
		Percent	73.93	26.07	39.29	22.50	11.79	26.43
5	Harvesting method	Number	215	65	100	72	43	65
		Percent	76.79	23.21	35.71	25.71	15.36	23.21
6	Threshing method	Number	207	73	49	81	6	2
		Percent	73.93	26.07	35.5	58.7	4.3	1.4
7	Transportation means	Number	165	115	71	58	34	117
		Percent	58.93	41.07	25.36	20.71	12.14	41.79

Min and max values for the whole causes of grain loss

Statistic	Value
Min Value	1
Max Value	18
Total Responses	280

6.5. Farmers' Capacity Building

Assessment was made to investigate efforts made on building farmers' capacity in terms of knowledge related to harvest and post-harvest loss prevention. To the enquiry on whether they have ever received related training or not only 26% (*n* =280) of them provided positive response (Table 12). This might indicate that the emphasis given to post-harvest loss management is minimal. Experts from the Ministry/Bureau of Agriculture, research Institutions, colleges and NGOs were participated in giving the training.

Table 12. Farmers' training on harvest and post-harvest loss prevention

No	Farmer's response	**No. of farmers**	**Percent**
1	Yes	73	26%
2	No	207	74%
	Total	280	100%

Statistic	**Valu**
Min Value	1
Max Value	2
Mean	1.74
Variance	0.19
Standard Deviation	0.44
Total Responses	280

Respondent farmers attempted to indicate the knowledge they acquired on the trainings they received. Almost all of the farmers who received trainings responded to have been advised to harvest their maize before it is over-dried in the field to minimizes losses due to dropping of pods and allow to fully dry on threshing floor or later. Use of clean threshing floor, minimizing contamination by dung from trampling animals and covering the harvest with a canvas or similar material while beating with stick are reported by the farmers to be the lessons learnt for minimizing losses at threshing. Use of tight and clean materials for packing and transportation is one of the points raised on trainings. Concerning storage they were trained on the importance of cleaning the store before bringing in new harvest, storing in aerated and moisture free areas, piling grains in bags on a wooden platform and use of chemical (dusts and fumigants) to prevent grain losses. Farmers also responded to have been trained to sell their produce to farmers unions or sell in group looking for better market.

The study tried to investigate farmers' training needs in areas related to prevention of postharvest losses (Table 13). According to the respondent farmers areas of top training priorities are pesticide usage, handling and safety (98%; *n* =271), insect identification and control (96%), Identification and control of mold (93%). Larger majority of farmers also emphasized on the need of training on proper storage, Rodent/other animal control, harvesting, cleaning and bird control (Table 12).

Table 13. Farmers' areas of training need for postharvest loss prevention

No	Area of training need	Respondent farmers	
		Number	Percent
1	Harvesting	238	86%
2	Packing	214	77%
3	Transportation	202	73%
4	Drying	215	78%
5	Cleaning	238	86%
6	Moisture measurement	223	81%
7	Reduction of shattering	198	71%
8	Insect identification and control	267	96%
9	Identification and control of mold	257	93%
10	Use of pesticide	272	98%
11	handling and safety	271	98%
12	Proper storage	256	92%
13	Rodent/other animal control	245	88%
14	Bird control	237	86%
15	Threshing	241	87%
16	Dehulling	238	86%
17	Storage	247	89%
18	Marketing	243	88%

6.6. Application of chemicals

The majority of respondent farmers (78%), in the surveyed area do not apply chemicals in the field of maize to control pests (Table 14). Only small number of farmers, 22% (n = 280), use pesticides and of which 72% (n= 60) apply the chemical after 60 days of planting, while 13% apply between 31 to 60 days after planting.

Table 14: chemicals (pesticides) application to maize in the field before harvest and time of application

No	Chemical application before harvest	Farmer's response	No. of farmers	Percent
1	Apply chemical	Yes	60	22%
		No	217	78%

Statistic	Value
Min Value	1
Max Value	2
Mean	1.78
Variance	0.17
Standard Deviation	0.41
Total Responses	**277**

2	Time of application	Less than 30days	11	17%
		31 to 60 days	8	13%
		More than 60 days	46	72%

Statistic	
Min Value	1
Max Value	3
Total Responses	64

Drying and malathion dust are the most commonly used (each 65%) control method followed by pirimiphos-methyl (Actellic) dust (34%), application of traditional herbs (21%) and fumigant (Phosphine gas) (20%). Other methods are listed in table 15 below.

Table 15: Farmers methods of controlling pests of Maize

No	Farmer's response	No. of	Percent

		farmers	
1	Use of traditional herbs	58	21%
2	Mix with Teff	27	10%
3	Mix with ashes	31	11%
4	Mix with sawdust	4	1%
5	Clays	10	4%
6	Oils	7	3%
7	Triplex	0	0%
8	Filter cake	3	1%
9	Actellic dust	93	34%
10	Malathion dust	181	65%
11	Fumigant (phosphine gas)	55	20%
12	Use of fungicides	5	2%
13	Smoking	36	13%
14	Drying (specify type- solar dryer, on-ground (sun), on-ground (shade), flatbed dryer, other dryer type (specify)	181	65%

6.7. Grain moisture content measurement

Farmers were asked whether they measure or determine moisture content of their maize grain or not. The result indicated that 82% (*n* =279) of them do measure or determine grain moisture content (Table 16).

Table 16. Response of farmers on grain moisture content measurement

No	Farmer's response	No. of farmers	Percent
1	Yes	229	82%
2	No	50	18%
	Total	**279**	**100%**

Statistic	Value
Min Value	1

Max Value	2
Mean	1.18
Variance	0.15
Standard Deviation	0.38
Total Responses	**279**

Concerning the time of measuring moisture content, the majority of the respondent farmers (76%) replied to perform after drying and 58 % measures after harvest (Table 17). The data showed that biting with teeth (91%) and push into bag of maize (21%) were the methods commonly used by the farmers to measure or determine moisture content of their grains. Only 1% of the farmers replied to use moisture meters as method of moisture content measurement or determination

Table 17. Time of grain moisture content measurement by farmers

No	Time of measurement	Respondent farmer		Method of measurement	Respondent farmers	
		Number	Percent		Number	Percent
1	After harvest	135	58.0	Moisture meter	3	1
2	After drying	176	76	Biting with teeth	211	91
3	During storage	87	38	Salt method	1	0
				Push into bag of maize	50	21
Statistic		**Value**		**Statistic**		**Value**
Min Value		1		Min Value		1
Max Value		3		Max Value		5
Total Responses		**232**		**Total Responses**		**233**

6.8. Farmers' reasons for choosing control Options

Farmers have reasons for choosing the postharvest loss prevention method they are using. As can be seen from table 27 ease of use locally (86%; *n* = 270) and available materials (70%) are the prior reasons of the farmers for choosing postharvest management options. Following these farmers put effectiveness of method (57%), traditional custom (56%), prior positive results (39%) and affordable price (32%) of a particular management option as worth considering in making choice (Table 18).

Table 18. Farmers' reasons for choosing postharvest management options

No	Farmer's response	**No. of farmers**	**Percent**

1	Affordable price	87	32%
2	Effectiveness of method	155	57%
3	Ease of use locally	231	86%
4	Available materials	188	70%
5	Traditional practice of custom	152	56%
6	Prior positive results	104	39%
7	Received training on method	52	19%
8	Others	17	6%

Statistic	**Value**
Min Value	1
Max Value	8
Total Responses	**270**

6.9. **Storage Structures Used by Farmers**

As far as storage structure used by the farmers is considered, farmers (*n* =278) use multiple options (Table 19). Polyethylene bags (72%) are the most commonly used materials to store maize grains followed by Traditional Gotera (68%), Jute bag (47%), Gota (33%) and Fertilizer bags (26%) respectively. *Gota* is a structure made from short cylindrical ring structures constructed from a mixture of mud reinforced with straw and fixed into one another using mud as a mortar to make a bigger container. The use of improved *Gotera* (8%) and others is low (Table 19).

Table 19. Storage structures used by farmers

	Storage structure	**No of respondents**	**Percentage**
1	Gota	92	33%
2	Traditional Gotera	188	68%
3	Improved Gotera	22	8%
4	Lekota	8	3%
5	Aibet	3	1%

6	Walla	10	4%
7	Shirfa/Kefo	34	12%
8	Dibignits	12	4%
9	Underground pit	4	1%
10	Balcony	1	0%
11	Gunny bag	3	1%
12	Plastic bag	5	2%
13	Polypropylene bag	201	72%
14	Jute bag	130	47%
15	PICS Bag (triple bag)	4	1%
16	Grain Pro Superbag	1	0%
17	GrainPro cocoon	1	0
18	Plastic drum	7	3%
19	Fertilizer bags	73	26%
20	Warehouse	46	17%

Statistic	**Value**
Min Value	1
Max Value	20
Total Responses	**278**

6.10. Farmers' Storage and Pest Control Practices

Farmers were asked on the length of time they store their maize grain. The majority of the farmers (*n* = 277) responded to store their chickpea produce for a period of four months to one year (Table 20). On the other hand small proportion of the farmers reported to store for less than 4 months and longer than one year.

Table 20. Duration of maize grain storage by farmers

No	**Storage duration (months)**	**Respondent farmers**	
		Number	**Percent**
1	0 – 3	20	7
2	4 – 6	80	29
3	7 – 9	89	32
4	10 – 12	85	31
5	13 – 15	0	5.5

6	16-18	0	0
7	19-21	1	0
8	22 – 24	1	0
9	Over 24	1	0
	Total	277	100.0

Statistic	**Value**
Min Value	1
Max Value	9
Total Responses	**276**

6.11. Inspection of storage by farmers

As shown in table 21 below, 97% (*n* =267) of the farmers responded that they inspect their grain store for pest damage. On average farmers reported to inspect their store for about 16 times per annum. As to the method of inspection farmers replied to use multiple methods (Table 22). Almost all farmers (99%; *n* =271) use visual observation to inspect their store. About 69% of the farmers smell stored maize to check for pest infestation. They also inspect their stored maize by taste (50%) and others (28%).

Table 21.Farmers' inspection of storage for pest attack

Parameter	**Farmers response**	**Respondent farmers**		
		Number	**Percent**	
Store inspection		Inspect	258	97.0%
		Do not inspect	9	3.0%
		Total	**267**	**100.0**

Statistic	**Value**
Min Value	1
Max Value	2
Mean	1.03
Variance	0.03
Standard Deviation	0.18
Total Responses	**267**

Table 22. Farmers' inspection of storage for pest attack

No	Farmers response	Respondent farmers	
		Number	Percent
1	Visual	269	99%
2	Smell	188	69%
3	Taste	136	50%
4	Other	76	28%

Statistic	Value
Min	1
Max	4
Total	**271**

6.12. Farmers' maize production and Its utilization

The majority of the farmers (93%) put yield per hectare or productivity as a reason for producing the variety they are growing (Table 23). Following this 82%, 62% and 51% of them considered end use quality, growing period and drought resistance respectively, as reasons of growing their maize varieties.

Table 23. Farmers' reasons for growing maize variety

No	Reason for growing maize variety	Respondent farmers (*n* = 273)	
		Number	Percent
1	Cost of seed	72	26%
2	Yield per hectare	253	93%
3	Growing period	170	62%
4	Insect resistance	115	42%
5	Drought resistance	138	51%
6	Resistance to water logging	105	38%

7	Disease resistance	90	33%
8	Lodging resistance	113	41%
9	Salt tolerance	34	12%
10	End use quality	223	82%
11	Only variety known	10	4%
12	Crop demonstration/research data	60	22%

Statistic	**Value**
Min Value	1
Max Value	12
Total Responses	**273**

6.13. Information related to maize marketing

Farmers were asked on whether they clean their chickpea grain before sale or not and as to where they sell (Table 24) their produce. Almost all of the farmers (94% *n* = 275) reported that they do perform cleaning before sale while the remaining minority do not clean before sale except the cleaning process they perform at threshing. The large majority of respondent farmers (71%; *n* = 276) do not use hired labor for cleaning maize grain before market while 29% of them used hired labor. Most of the time all men (91%, n=168), women (92%) and children (75%) are participated in the cleaning activity. The large majority of respondent farmers (95%; *n* = 266) do sell their maize grain at market while 10% of them sell at home

Table 24. Maize grain cleaning before sale

Description	**Response**	**Respondent farmers**	
		Number	**Percent**
Cleaning grain prior to sale	Cleaned	258	94
	Not cleaned	17	6

Statistic	**Value**
Min Value	1
Max Value	2
Mean	1.06
Variance	0.06
Standard Deviation	0.24
Total Responses	**275**

	Total	275	100.0
Hired labor for cleaning	Yes	81	29

	no	195	71
	Total	**276**	**100.0**
Statistic			**Value**
Min Value			1
Max Value			2
Mean			1.71
Variance			0.21
Standard Deviation			0.46
Total Responses			**276**
Who perform the cleaning	Men	245	91
	Women	246	92
	Children	202	75
Statistic			**Value**
Min Value			1
Max Value			3
Total Responses			**268**
Place of selling maize	Market	254	95
	Home	26	10
Statistic			**Value**
Min Value			1
Max Value			2
Total Responses			**266**

Donkey, the common pack animal in the country, man power and wheel barrow are used to transport maize grain to market. Buy cloths, Household expense, buy farm inputs, Pay Tax, Educational expense, Buy animals, Land rental, Saving, Storage pest, and Health care are the main reasons for selling maize grains. On the other hand, Low yield, Low price, Emergency reserve and Pest damage are the reasons for not selling the product.

6.14. Farmers' food and feeding conditions

Assessment was made on the type of foods farmers commonly consume and if they have special diet for pregnant women, children under age of five and elderly family members. Various food types that are commonly consumed as a staple are 'Injera' (the mixture of maize, wheat, teff and finger millet), bread made of wheat and maize, qollo from maize and porridge made from barley or wheat flour. The majority of respondents take meal three times a day.

Information on whether farmers have special food to provide to pregnant women, children under age of five and elderly family members are shown in Table 25. The majority of the farmers do not provide special food for the aforementioned needy members of their family. Only 44%, 46% and 23% of the farmers reported to have special food for pregnant women, children under age of five and elderly family members, respectively. The majority food items provided for them are Porridge, Soup, Egg, Meat, Milk, Fruit and Vegetables.

Table 25. Provision of special food for women, children and elderly members of the family

Provision	Respondent farmers					
	Special food for pregnant women		Special food for children		Special food for elderly	
	Number	Percent	Number	Percent	Number	Percent
Provide	121	44	128	46	62	23
Not provide	157	56	151	54	212	77
Total	278	100.0	179	100.0	274	100.0
Statistic		**Value**		**Value**		**Value**
Min Value		1		1		1
Max Value		2		2		2
Mean		1.56		1.54		1.77
Variance		0.25		0.25		0.18
Standard		0.50		0.50		0.42
Total Responses		**278**		**279**		**274**

The majority of the respondents were not provided food aid while some are aided by food aid organizations (Table 26).

Table 26: Information on food aided individuals

Description	Response	Respondent farmers	
		Number	Percent
Food aid	Yes	31	11
	no	242	89
	Total	273	100.0
Statistic			**Value**
Min Value			1
Max Value			2
Mean			1.89
Variance			0.10
Standard Deviation			0.32
Total Responses			**273**

The family consumption of different food items per week has been investigated from the respondents. The majority of farmer's family members consume sufficient amount of Starches (86%), Legumes/pulse (64%), Dairy (68%) and Vegetables (62%) per week whereas Nuts (13%), Meat (40%), Eggs (45%) and Fruits (39%) are consumed less by farmer's family per week (Table 27).

Table 27: food items taken per week

No	Question	Respondent farmers				Total Responses	Mean
		Yes	Percent	No	percent		
1	Starches	238	86	38	14	276	1.14
2	Legumes/pulse	178	64	98	36	276	1.36
3	Nuts	31	13	204	87	235	1.87
4	Meat	110	40	164	60	274	1.6
5	Dairy	185	68	89	32	274	1.32
6	Eggs	123	45	149	55	272	1.55
7	Vegetables	169	62	102	38	271	1.38
8	Fruits	103	39	164	61	267	1.61

6.15. Availability of food and water

Inquire was made to know if farmers have food shortage in some parts of the year (Table 28) and availability of water (Table 29). The majority of the farmers (76%) had food shortage from June to August followed by 23% who reported to suffer from food shortage from September to November. According to these farmers August to September are the months of critical food shortage. The majority of them attributed food shortage to the low productivity and production of their farming.

Table 28. Period of farmers' of food shortage

No	Time of food shortage	Respondent farmers	
		Number	Percent
1	June to August	129	76
2	Sept to Nov	39	23
3	Dec to Feb	2	1
4	March to May	12	7

Statistics	Value
Min Value	1
Max Value	4
Total Responses	**169**

So long as availability of water is considered 73% of the farmers reported to have access to water while the rest have problem (Table 29). Those who have no or less access to water put absence of tap water system wreckage and failure to maintain and farness of springs and rivers from their dwellings, as major reasons for the problem.

Table 29. Farmers' access to water

No	Access to water	Respondent farmers	
		Number	Percent
1	Yes	201	73%
2	No	74	27%
	Total	275	100.0

Statistic	Value
Min Value	1
Max Value	2
Mean	1.27
Variance	0.20
Standard Deviation	0.44
Total Responses	**275**

6.16. Safety and protective measure taken by farmers

Farmers were asked about the parameters used to select grain kernels intended for consumption. Most of them use Grain color, damaged or crushed, Size of kernels, Grain not damaged by insects and grain not stained (Table 30). They were also asked if their family ever consumed maize grains having defects of various types (Table 31). Majority of the farmers (85%; *n* = 271) replied that they do not eat discolored grain while the remaining farmers do eat at times of food shortage. Considerable proportion of the farmers (46%; *n* = 276) reported to use maize grain for consumption if the damage by storage insect pest is light. Large majority of the farmers reported that they never consumed maize grain with heavy insect damage (95%; n= 273), foul odor (95%) and chemical odor (86%). In relation to consumption of damaged grain only 4% of them experienced sickness after eating such grains. This shows that farmers generally do care of consuming grain that is safe or not damaged.

Table 30: Parameters used to select grain kernels intended for consumption

No	Parameter	Respondent farmers	
		Number	Percent
1	Grain color	20	7
2	damaged or crushed	25	9
3	Size of kernels	20	7
4	Grain not damaged by insects	108	40
5	Grain not stained	97	36
	Total	270	100.0

Statistic	**Value**
Min Value	1
Max Value	5
Mean	3.88
Variance	1.46
Standard Deviation	1.21
Total Responses	**270**

Table 31. Farmers' response on the consumption of damaged grains

Response	Have your family ever consumed										Sickness from eating damaged grain	
	Discolored grain		Light insect damaged		Heavy insect damage		Foul odor		Chemical odor			
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Yes	40	15	127	46	13	5.0	15	5	39	14	12	4
No	231	85	151	54	260	95.0	258	95	240	86	265	96
Total	271	100.0	276	100.0	273	100.0	273	100.0	279	100.0	277	100.0

Statistic	Value	Value	Value	Value	Value	Value
Min Value	1	1	1	1	1	1
Max Value	2	2	2	2	2	2
Mean	1.85	1.54	1.95	1.95	1.86	1.96
Variance	0.13	0.25	0.05	0.05	0.12	0.04
Standard Deviation	0.36	0.50	0.21	0.23	0.35	0.20
Total Responses	271	278	273	273	279	277

Farmers' experience in wearing protective garments during application of pesticides either in the field or storage was found to be poor (Table 32). Only 17% and 23% of the farmers reported to wear protective devices while applying pesticides in the field and storage, respectively. Even these farmers do not use all types of protective devices and the majority of them reported to use a piece of cloth to cover their nose and mouth, while some use gloves and eye goggles and few wear overall or overcoat and boots while applying field pesticides. Considering sanitary measures taken by the farmers after pesticide application 96% of them do wash their hands and only 61% of them wash their cloth.

Efforts should, therefore, be made in creating awareness to the farmers on the use of recommended pesticides and safe application methods so that farmers avoid using pesticides that are not recommended, treating grains inside home, and wear appropriate protective devices while applying pesticides and take proper sanitary measures thereafter.

Table 32. Protective and sanitary measures taken by farmers during pesticide application

No	Response	Use protective during pesticide application				Wash after spraying pesticide			
		in the field		in storage		Hand		Cloth	
		Number	%	Number	%	Number	%	Number	%
1	Yes	48	17	63	23	269	96	171	61
2	No	232	83	211	77	10	4	108	39
	Total	280	100.0	274	100.0	279	100.0	179	100.0

Statistic	Value			
Min Value	1	1	1	1
Max Value	2	2	2	2
Mean	1.83	1.77	1.04	1.39
Variance	0.14	0.18	0.03	0.24
Standard Deviation	0.38	0.42	0.19	0.49
Total Responses	**280**	**274**	**279**	**279**

Table 33 depicts multiple responses of farmers on disposal mechanism of pesticide package. The result showed that farmers do not have safe disposal, rather dangerously dispose or use them for other purposes. Only 51% of the farmer's burry empty packages underground and 5% of them does burn them. Farmers use empty pesticide packages to store food (3%), store other products (30%) or carry water (8%) or simply leave on the ground (14%) or throw into water (1%). Concerning treatment of stored grains, farmers do treatment inside home (39%) and outside their home (61%).

Table 33. Treatment site and disposal mechanism of maize pesticide package by farmers

No	Parameter	Respondent farmers	
		Number	Percent
1	Use for storing food	8	3
2	Use for carrying water	23	8
3	Use for storing other products	83	30
4	Bury underground	141	51
5	Leave on the ground	38	14
6	Throw into water	4	1
7	Sell at market	4	1
8	Other	70	25
	Treatment		

1	Inside home	106	39
2	Outside home	167	61

Statistic	**Value**
Min Value	1
Max Value	2
Mean	1.61
Variance	0.24
Standard Deviation	0.49
Total Responses	**273**

Concerning disposal of grains unfit for consumption farmers do feed such grains to animals (65%) or burry underground (11%) or simply discard on the ground (Table 34).

Table 34. Disposal of grain unfit for food

No	**Parameter**	**Respondent farmers**	
		Number	**Percent**
1	Bury underground	29	11
2	Burn	6	2
3	Leave on the ground	18	7
4	Feed to animals	180	65
5	Throw into water	4	1
6	Sell at market	1	0

Statistic	**Value**
Min Value	1
Max Value	6
Mean	3.88
Variance	1.70
Standard Deviation	1.30
Total Responses	**276**

6.17. Membership to Organizations and support of Farmers

Majority of the respondents were members of different farmers' cooperatives (49.6%) and associations (23.1%). The cooperatives included primary cooperatives and unions. Member of seed producers' association (6.8%) and irrigation users' association (4.9%) were limited in number, according to the survey results (Table 35) . Few respondent farmers (6%) were not members of any type of organization.

Table 35. Membership of farmers to different organizations and access to information

Organizations	Respondent farmers	
	Number	Percent
1. Seed producers' association	18	6.8
2, Farmers' association	61	23.1
3. farmers' cooperatives	131	49.6
4. Associations at the lowest Admin. unit (Kebele)	5	1.9
5.Farmers' working teams	6	2.3
6.Irrigation users association	13	4.9
7.Market, saving and credit associations	2	0.8
8.Women's association	4	1.5
9.Youth association	4	1.5
10. Not members of any organization	15	5.7
Total	264	100.0

The most trusted local individuals and organizations (87%) that respondents would trust to provide information about crop production were agricultural experts (agricultural development agents rural and other experts from agriculture and rural development), development offices), Public media (3.5%), local NGO (1.7%) and ISSD Koga Irrigation user Union (1.7%) had insignificant contributions in provision of information to the farmers about maize production nevertheless they were better than the other organizations, research institutions, the Agro Big Project, primary cooperatives and farmer training center Table 36).

Table 36. Local individuals/organizations that provide information farmers would trust about crop production

Organizations	Respondent farmers	
	Number	Percent
1. Agricultural experts	100	87
2, Public media (Radeo and television)	4	3.5
3. Local NGO	2	1.7
4. ISSD Koga Irrigation User Union	2	1.7

5. Research Institutions	1	0.9
6. Agro Big Project	1	0.9
7. Primary cooperatives	1	0.9
8. Farmers Training Centers	1	0.9
Total	115	100.0

From the local organizations that provide information farmers would trust about stored grain management, agricultural experts (agricultural development agents rural and other experts from agriculture and rural development), development offices), the most dominant (91.4%) followed by NGOS (3.9%) and public media (2.3%). Research institutions, agricultural colleges and farmer training center had very little continuation in the provision of information to the farmers interviewed during the survey (Table 37).

Table 37. Local individuals/organizations that provide information farmers would trust about stored grain management

Organizations	**Respondent farmers**	
	Number	**Percent**
1. Agricultural experts	117	91.4
2, NGO	5	3.9
3. Public media (Radeo and television)	3	2.3
5. Research Institutions	1	0.8
6. Agricultural college	1	0.8
8. Farmers Training Centers	1	0.9
Total	128	100.0

The most preferred three methods for receiving new information by the respondents were large meetings (80%), demonstration trials (71%), and one-on-one delivery (52%). The other methods that were less preferred by the farmers comparing to the three methods listed above were radio programs (26%), fellow farmers (24%,), input

supplier (16%), television programs (11%), religious leaders (10%), cell phone (7%), printed materials (6%), and the Internet (1%) (Figure 2) .

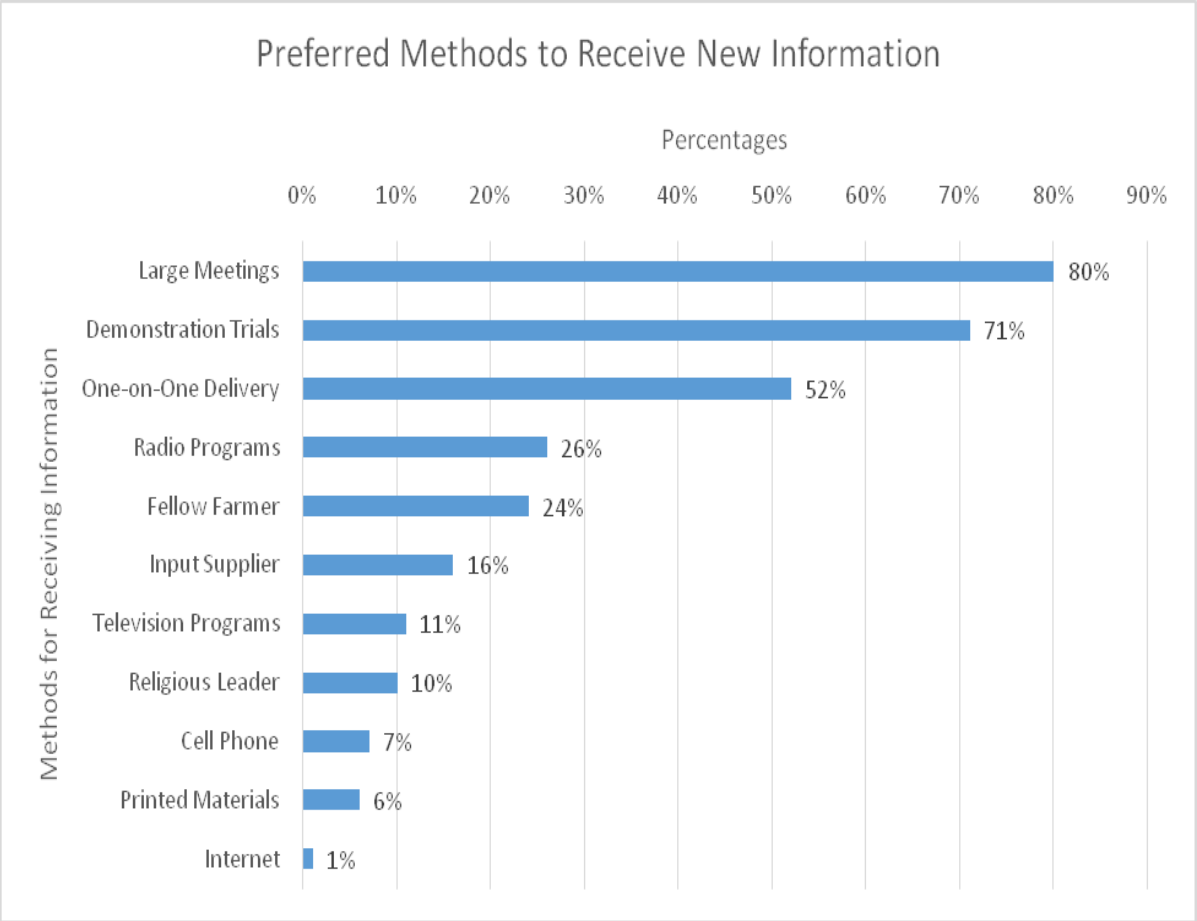

Figure 2. Farmers' preferred methods for receiving information

Roles of family members (men, women and children) in maize post-harvest activities were evaluated during the survey and the results indicated that all whole family had role in all activities. The extent of the roles of the family members in most of the maize post harvest activities especially from harvesting to storage of maize grains were almost equal with slight inclination towards the men and women. The roles of the children in inspection, decision and transportation to sell the stored maize grains as well as market negotiation, management of income and planning family meals, was very limited. The roles of the men and women were almost equal in the listed activities

except in planning of family meals which was mainly the responsibility of the women (Table 38).

Table 38. Roles of men, women and children in maize post-harvest activities (Number of respondents)

No	Activities	Male	Female	Children
1	Harvesting	261	245	215
2	Drying	241	259	206
3	Cleaning	239	239	188
4	Transportation from Field to Farm	257	227	188
5	Threshing	254	223	183
6	Dehulling	198	198	152
7	Storage of Grains	249	254	172
8	Inspecting Grain in Storage	239	245	95
9	Decision to Sell Stored Grain	256	259	25
10	Transportation from Farm to Market	245	230	56
11	Market Negotiation	242	217	49
12	Managing Income	243	236	11
13	Planning Family Meals	181	271	8

Addition information was collected during the survey from the respondent maize producing farmers. Three of them said that some of the post harvest activities, cleaning, threshing, transporting the maize grains from farm to home, harvesting, de-hulling, were done by daily laborers. Another two respondents said that community members helped each other during harvesting, storage of grains and de-hulling. One more informed that permanently hired laborer was used for harvesting and

transporting to market. Therefore, according to the six respondents the identification of male, female or children did not apply for some of these farm tasks.

During the survey assessment was made to identify the e average amounts of money allocated for planned expenditure on different family categories. The category with the highest expenditure was for food (8,156 ETBs), followed by savings (3840 ETBs), and clothing (2170 ETBs). Expenditure on holidays (2072 Birr), education (1285 Birr), ceremonies (1254 Birr) and personal care (1141 Birr) was not small amount (Table 39).

Table 39. Amount of money (Eth. Birr) allocate by the farmers for the following each year

Clothing	Education	Food	Personal Care	Transportation	Ceremonies	Holidays	Savings	Social Value
2.170	1.285.	8.156	1.141	0.711	1.254	2.072	3.840	0.697

The amount = x 1000 Birr

The respondents were forwarded additional information related to the planned expenditure and there were 14 text responses. Three of them indicated that the respondents did not have budgetary plans. Another one wrote that the respondents would plan the budget but not implement, specifically, "they always plan to allocate for the mentioned each issue in table 39 but still no implementation." Another wrote, "no allocation of money for each and single issues but for the next year allocated a total of 30000 birr"; another had a similar message but indicated 50000 birr. One elaborated about the education expenditures: "the respondent pay for education for his son learning in private sector for diploma level". Another one said family will allocate grains for costs, not actual birr ("on allocation of birr they allocate grains for the following year but not birr"). Finally, one responded, "no allocation of birr for the future. if something happen, they took it if they have on cash unless marketing from the produced one and cover for what they want".

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