

2 **Status Of Postharvest Operations In Upper East Region of Ghana:**
3 **The Case Of Maize Producers**
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7 **ABSTRACT**

8 **A baseline survey was conducted in the Upper East of Ghana to assess**
9 **current postharvest practices and factors influencing long and bulk**
10 **storage of maize. The research tools employed were field survey, farm**
11 **visits and key informant interviews. Twenty farmers were randomly**
12 **selected from each community making a total of 120 farmers. Household**
13 **structure on average is made up 7±5 individuals, mean age of household**
14 **heads was 45-47 years compared to their wives 35 to 38 years. Maize is**
15 **mostly stored in polypropylene sacs and jute sacs on raised platform in**
16 **household stores. Majority of respondents indicated that post-harvest**
17 **losses during storage are critical challenges to production and household**
18 **food security. The main causes of loss were insect pest, rodents and grain**
19 **moulds. Majority of farmers store maize for 5-8months. Though some local**
20 **and synthetic grain protectants were used, post-harvest losses in 1 year**
21 **of storage were still beyond acceptable limits. However, there was high**
22 **willingness to adopt new efficient methods of crop protection like**
23 **biological control. The idea of community storage methods was still not a**
24 **technology farmers may adopt; due to a myriad of socio-cultural reasons.**
25 **The results of the baseline study will guide the implementation of the**
26 **project as well as serve as reference point for future impact assessment.**
27 **Overall, integrated strategies involving clean farm operations, use of**
28 **appropriate storage technologies and provision of improved storage**
29 **structures are required to reduce current losses.**

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31 **Key words: Maize farmers, postharvest losses, storage and biological control**
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35 **INTRODUCTION**

36 Maize (*Zea mays* L.) has become an important staple food crop in all parts of Ghana. Currently, maize
37 based cropping systems have become dominant in drier northern savanna areas of Ghana where
38 sorghum and millet were the traditional food security crops. According to SRID (2011), maize is the
39 most cultivated in Ghana, occupying up to 1,023,000ha on arable land compared to rice (197,000ha),
40 millet (179,000ha), sorghum (243,000ha), cassava (889,013ha), yam (204,000ha) and plantain
41 (336,000) (SRID, 2012). Currently, Ghana is net-importer of maize even though it has great potential
42 to be self-sufficient and net-exporter. Per capita consumption of maize is estimated at 44
43 kg/person/year (FAOSTAT, Feb 2013). Declining yields of maize are now observed due to decreasing
44 soil fertility and high cost of fertilizer. Over the last 2 decades, a myriad of maize varieties, cultivars
45 and hybrids have been released. These genotypes possess traits such as early maturing, drought

46 resistance, diseases and pest resistance, striga resistance, as well as additional nutritional values
47 such as quality protein, yellow and sweet corn. Grains of these genotypes possess diverse textural,
48 physical and compositional characteristics which relate differently to light, moisture and temperature
49 as well as susceptibility to pests and disease pathogens; particularly during prolong storage. This
50 requires commensurate postharvest techniques and strategies to contain harvested surpluses. Also,
51 due to intensification and productivity increase, the need for bulk and prolong storage has become
52 critical. This increase can be attributed to government and donor assisted projects such as providing
53 subsidies on agricultural inputs. Nonetheless, current storage methods are suited for small-holder
54 farmers requiring storage of less than 1 ton. Interventions to introduce large storage units such as
55 community warehousing, community grain banks or metal silos which can contain several tons of
56 grain is still constrained by national agricultural policies as well as low adoption from farmers.
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58 Generally, stored maize can be damaged by insect pests if they are not properly conditioned and
59 protected (Obeng-Ofori, 2008). This challenge may be exacerbated due to cropping intensification
60 and introduction of hybrid cultivars. Maize is harvested towards the cessation of rainy season and
61 stored during the drier months of the year. Maize is often stored on cob in traditional grain silos or
62 shelled into jute and polypropylene sacs with or without protection for storage. However, pest
63 infestation is a perennial constraint; the conditions favorable for grain storage are as well suitable for
64 insect pest reproduction. On-farm infestation of notorious storage pests such as larger grain borer
65 (*Prostephanus truncatus*), lesser grain borer (*Rhyzopertha dominica*), maize weevil (*Sitophilus*
66 *zeamais*), granary weevil (*S. granarius*) as well as mycotoxins accumulation, are a threat in grain
67 storage. Indiscriminate use of common grain protectants such as Actellic (Pirimiphos methyl),
68 bioresmethrin (pyrethroid) phostoxin and Gastox (Aluminium phosphate) is widespread among small-
69 holder farmers (Sugri, et al 2010). Most farmers acquire agro-chemicals from non-accredited input
70 dealer without any training on appropriate use. There is the need to integrate production and
71 postharvest practices to achieve quality food for consumers. Integration of good agronomic
72 operations, pest management and appropriate storage techniques to minimize pest damage is
73 therefore very essential. This project seeks to improve agricultural productivity and farm family
74 livelihoods by deploying improved storage and handling practices to reduce postharvest losses of
75 smallholder farmers in the Upper East Region of Ghana (Osei-Agyeman et al 2014).
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79 MATERIALS AND METHODS

81 Study Area

82 The Upper East Region (UER) of Ghana lies between longitude 1015°W to 005°E and stretch from
83 latitude 10030°N to 1108°N. The region lies in the Sudan savanna agro-ecology, which forms the
84 semi-arid part of Ghana. The area is part of what is sometimes referred to as interior savanna and is
85 characterized by level to gently undulating topography. Important crops include millet, sorghum,
86 maize, rice, sweet potato, groundnut, cowpea, soybean, cotton onion and tomato. The sheanut tree
87 grows wild and it is an important cash crop. It has alternating wet and dry seasons with the wet
88 season occurring between May and October during which about 95% of rainfall occurs. Maximum
89 rainfall occurs in August-September, and severe dry conditions exist between November and April
90 each year. Annual rainfall ranges from 800-1200 mm. There is wide fluctuation in relative humidity
91 with as low values as 30% in dry season and above 75% in the wet season
92 (www.ghanadistricts.com).
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94 Approach

95 The study used different data collection methods. These included both quantitative methods
96 (questionnaires) and qualitative (participatory rural appraisal tools, focus group discussions, key
97 informants interviews) methods. Besides that, some secondary data were obtained through desktop
98 research of literature on existing studies already done on similar subjects. Semi-structured
99 questionnaire was developed and administered to multi-phase purposive and randomly selected
100 farmers within the project district to enable us obtained data from them.

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102 Focus group discussions (Chambers, Robert 1993) were carried out with randomly selected farmer
103 farmers within the project district. This was aimed at collecting qualitative data to support the data
104 gathered by the farmer questionnaire and also as a means of triangulation to ensure that the data is

105 realistic and reliable. This was guided by a pre-printed checklist tailored to meet some of the
106 information needs of this assignment.

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108 **Sampling Technique**

109 The population of interest for the study included all farmers in Bawku East, Binduri and Pusiga District
110 of the Upper East Region of Ghana. The unit of study is the farmer who we define for purposes of this
111 study as an individual who lives and farm within the selected communities. A purposeful and multi-
112 stage sampling approach targeting maize producing communities and households was adopted. This
113 procedure allowed us to take a representative sample with characteristics that can be generalized for
114 the entire population which it represents.

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116 The sample size was determined using the following formula:

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$$N = (Z^2PQ/D^2).$$

118 Essentially three factors determine the size of the sample for a survey within a population:
119 Estimated prevalence of the variable studied – in this case, farmers in the community. The confidence
120 level aimed at the acceptable margin of error.

121 N: required size of the sample

122 Z: confidence level of 95% (standard deviation of 1.96).

123 P: estimated prevalence of farmers in the project area (80%), i.e. the proportion of the target
124 population with a given characteristic.

125 Q: 1-P.

126 D: margin of error of 5 % (standard deviation of 0.05).

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$$N = 3.8416 \times 0.8 (0.1/0.0025) = 122$$

128 A total of 122 farmers were randomly sampled from a purposive sample of two communities in the
129 three districts of the Upper East region. The communities were selected because of their attitude to
130 farming and response to project requirement.

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132 Data was collected from farmers using structured questionnaires in a face-to-face interview.
133 Questions covered household demographics including age, household size, education and gender of
134 household members. Household assets were inventoried to include both agriculture and non-
135 agriculture assets and, crops and livestock inventories. An agricultural system module surveyed crop
136 production and agricultural land use, storage methods, post-harvest trainings, etc.

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138 **RESULTS AND DISCUSSION**

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140 **Demographic Information**

141 *Table 1-4* provide a summary of the demographic structure of the households sampled. In all, 42% of
142 respondents were female farmers and 58% male farmers (Table 4). Household structure on average
143 was made up of 7±5 individuals (Table 2). The mean age of household heads was 45-47 years
144 compared to their wives whose mean age was 35 to 38 years. The results also showed that migration
145 of household members was not common during the rainy season but up to 10% migrate down south
146 when agricultural activities decline. The observations indicate that most of the household heads (99%)
147 were involved in crop production. The annual agricultural related household income for about 26% of
148 farmers ranged from 100.00 - 2,000.00 GHS as the lowest category whereas the biggest category of
149 8100 -10,000.00 GHS constituted about 18.5% of farmers surveyed. Farmers within the income
150 brackets of 4,000.00 – 8,000.00 constituted about 43% of farmers surveyed.

151 **Table 1: Gender of Respondents**

Gender	Frequency	Percentage
Female	50	42
Male	70	58
Total	120	100

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153 **Table 2: Composition and age of households sampled**

Description	Variable	Mean	Standard Deviation	Minimum	Maximum
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Head	HH size	7	3	2	22
(N = 120)	Age (HHH)	47	14	26	78
	Age (WHH)	38	10	18	70
Partner	HH size	7	3	1	17
(wife)	Age (HHH)	45	14	27	75
(N = 120)	Age (WHH)	35	10	19	65

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155 **Table 3: Income status of households**

Income(GHS 00)	Frequency	Percentage
1-20	31	26.1
21-40	14	11.8
41-60	26	21.8
61-80	26	21.8
81-100	22	18.5
Total	119	100

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157 Majority of respondents (63%) had no formal education, only 26% had basic education and 10% had
 158 post-basic education (Table 4). Livestock rearing is considered as an occupation by very few
 159 households (1%). Majority (84.2%) of the respondents were crop farmers, 2.5% were students, a few
 160 were engaged in various forms of trade, and only 4% unemployed (Table 5).

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162 **Table 4: Educational Status of respondents**

Education level	Frequency	Percentage
None	75	63
Primary	15	13
JHS/Middle school certificate	16	13
SHS/Technical school	12	10
Non-formal	2	1
Total	120	100

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164 **Table 5: Primary Occupation of Respondents**

	Frequency	Percentage	
Student	3.0	2.5	165
Unemployed	4.0	3.3	166
Farmer	101.0	84.2	168
Teacher	1.0	8.0	169
Nurse	1.0	8.0	170
			171
Retired	1.0	8.0	172
Self employed	5.0	4.2	173
Pastor	1.0	8	174
Kente weaving	3.0	2.5	175
Total	120.0	100.0	176

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178 **Cropping Systems**

179 Majority (89%) of respondents were engaged in crop production while a little minority were involved
 180 in animal (7%) and tree (4%) production as the main livelihood strategies (Table 6). Major livelihood
 181 crops include maize, sorghum, millet, soybean, cowpea, rice, sweet potato and vegetables (Table 7).
 182 Maize is cultivated on up to 4 acres and a maximum land size of 15 acres. The range for cowpea is 2-
 183 12 acres, while bambara beans, groundnut and sweet potato recorded the least production area of 1,
 184 2 and 2 acres, respectively.

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186 **Table 6: Main farming systems in the study area**

Farming type	Frequency	Percentage
Crop production	107	89
Tree crop Production	5	4
Livestock marketing	8	7
Total	120	100

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190 **Table 7: Main crops and acreage of production**

Crops	Acreage Mean	(Ha) Min.	Max.
Maize	4	0	15
Sorghum	1	0	4
Soyabeans	2	0	5
Cowpea	2	0	12
Vegetable	2	0	3
Pearl Millet	2	0	9
Groundnut	1	1	2
Bambarabeans	1	1	1
Sweet Potato	1	1	2
Total land size of HH	8	1	45

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193 **Maize Post-Harvest Operations and Losses**

194 In Table 8 below, 95.8% perceive high levels of post-harvest losses in recent times while 4.2 % of the
 195 respondents were adamant. The main causes of maize grain damage were insect pests (69.2%),
 196 rodents (16.2%) grain moulds (6.7%), weight loss (5.7%) and loss of flavor/nutrition (1.7%). Only 1.7%
 197 of the respondents recorded no incidence of post-harvest losses and pest infestation at storage
 198 (Table 9).

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200 **Table 8: incidence and estimated maize postharvest losses under farmer storage**

Incidence of produce infestation at storage			Quantities of losses incurred (%)		
	Freq.	%		Freq.	%
Yes (incidence)	115	95.8	0 - 8	29	24.2
No (incidence)	5	4.2	10 – 25	67	55.8
			27 - 60	24	20
			TOTAL	120	100

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Table9: Description of major causes of maize postharvest losses

Main causes of losses	Frequency	Percentage
Insects infestation	83	69.2
Rodents	20	16.7
Grain moulds	8	6.7
Weight loss	5	4.2
Quality (taste/ aroma/colour)	2	1.7
No incidence	2	1.7
Total	120	100.0

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Maize Storage Methods

Table 10 describes the various storage methods used in the study area. Majority of farmers, 40% and 27.3%, store maize in poly-sacs and jute sacs respectively. The use of poly-sacs has gradually replaced jute sacs due to low cost and readily availability. Though, the use of PICS sacs has recently been introduced, only few champion farmers opt for them apparently due to high initial cost. Up to 16.7% of farmers store their maize for 1-4months, 64.2% store maize for 5-8months, and 17.5 store up to 12months (Table 11). Only 1.7% store maize store maize beyond 12 months confirming that they produce in small quantities for subsistence. Only small quantities 1-3bags are stored by 37.5 % of respondents and up to 37.5% store 4-10bags, only about 8.3% stored more than 25bags of maize (Table 11).

217 **Table 10: Maize storage methods**

Maize storage methods	Frequency	Percentage	Ranked	Reasons for selection
Bare floor	15	12.6	3	Easy to store, affordability
Stored in jute sacs	33	27.3	2	Availability, durability,
Stored in poly-sacs	48	40.3	1	Availability, durability, low cost
Stored mud silos	10	8.4	5	Common traditional method, regulate grain use
Stored in maize ban	14	14	4	Regulates use of maize/ reduce wastage
Total	119	100		

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Table 11: Duration of maize at storage

Duration of storage			Volume of produce stored		
	Frequency	Percentage	Bags	Freq.	%
Storage period					
1-4 months	20	16.7	1-3bags	45	37.5
5-8 months	77	64.2	4-10bags	45	37.5
9-12 months	21	17.5	11-25bags	20	16.7
1-2 years	2	1.7	Above 25 bags	10	8.3
Total	120	100	Total	120	100

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236 **Pest Management Strategies Adopted Farmers**

237 The focus group discussions indicated that farmers' prior knowledge on the type, severity and time of
 238 pest infestation in different commodities guided their choice of pest management. Table 12 provides a
 239 summary of approximate time of pest infestation and management options for different crops. Close
 240 44.2% of the respondents noticed pest infestation within 1-4 months, 33.3% within 5-months, while
 241 12.5% noticed no pest incidence. From the group discussions, over 50% of respondents alluded that,
 242 except in cowpea and bambara nuts, pest infestation occurred late at 6 months after storage. Farmers
 243 therefore applied postharvest chemicals few months after storage or when some level of infestation
 244 was noticed. Where storage was anticipated above 4 months, over 50% of farmers used some kind of
 245 protection in cowpea and bambara nuts. The use of biological control was not a familiar term;
 246 probably this control measure has not been introduced into the area. Only 1.7% of farmers resorted to
 247 the use of botanicals such as *neem* products, pepper, *mahogany* bark, *Jethropha* and other local oils.
 248 Majority use insecticidal dust (43.3%) and phostoxin (13.3%) for pest management. It was realized
 249 that only 1 respondent use ash to actually prevent pest attack. The common grain protectants were
 250 *Actellic* (Pyriphos methyl), *bioresmethrin* (pyrethroid) *phostoxin*, *Gastox* (Aluminium phosphate),
 251 *Wander77 powder*.
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254 **Table 12: Period of pest infestation and common pest management strategies**

Months after storage	Frequency	Percentage
1-4	53	44.2
5-8	40	33.3
After 8	12	10
No pest incidence	15	12.5
Total	120	100
Methods of maize grain protection	Frequency	Percentage
Only drying	48	40
Botanicals (neem, mahogany etc)	2	1.7
Photoxin tablet	16	13.3
Insecticidal dust	52	43.3
No measure taken	1	0.8
use of ash	1	0.8
Total	120	100

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Farmers expressed their willingness to adopt both the poly-tank storage method and the biocontrol storage method. Those who indicated they will agree to adopt the poly-tank method were about 45% while those who strongly agreed also scored 45.5%. 55.5% of the farmers indicated they will agree to adopt the biological control method while 31.1% said they strongly agree to adopt the biological control method. From all indication the farmers are willing to adopt both the poly-tank and biological control method of maize storage in the Bawku municipality as shown in table 13 below.

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Table 13: Willingness to adopt new storage techniques

I will adopt a new poly-tank storage method		
	Frequency	Percent
Strongly Disagree	1	0.8
Disagree	1	0.8
Neither agree nor disagree	9	7.5
Agree	54	45
Strongly agree	55	45.8
Total	120	100
I will adopt biocontrol storage method		
Strogly disagree	1	0.8
Disagree	2	1.7
Neither agree nor Disagree	13	10.9
Agree	66	55.5
Strongly agree	37	31.1
Total	119	100

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Conclusion and Recommendation

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In all, 42% of respondents were female farmers and 58% male farmers. Household structure on average is made up 7±5 individuals, mean age of household heads was 45-47 years compared to their wives 35 to 38 years. Majority of the household heads and their wives had no education and their primary occupation was crop production. Household wealth was largely concentrated on Livestock inventory. Maize is mostly stored in polypropylene sacs (48%) and jute sacs (33%) on raised platform in household stores. Close to 95.8% of respondents indicated that post-harvest losses during storage are critical challenges to production and household food security. The main causes of loss were insect pest (69.2%), rodents (16.2%) grain moulds (6.7%), weight loss (5.7%) and loss of flavor/nutrition (1.7%). Up to 16.7% of farmers store their maize for 1-4months, 64.2% store maize for 5-8months, and 17.5% store up to 12months. Only 1.7% store maize beyond 12 months; confirming that they produce in small quantities for subsistence.

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The idea of community storage methods is still not a technology farmers may adopt; due to a myriad of socio-cultural reasons. The results of the baseline study was expected to guide the implementation of the project as well as serve as reference point for future impact evaluation. Overall, integrated strategies involving clean farm operations, use of appropriate storage technologies and provision of improved storage structures are required to reduce current losses.

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Major crops produced include: maize, millet, peanuts, Bambara nuts, soy beans, rice, and cassava. Though some local and synthetic grain protectants were used, post-harvest loses in 1 year of storage were still beyond acceptable limits. However, there was high willingness to adopt new efficient and effective methods like biological control and poly-tank storage methods being introduce to them. The idea of community storage methods was however still not a technology farmers may adopt; due to a myriad of socio cultural reasons. Integrated strategies involving clean farm operations, use of appropriate storage technologies and provision of improved storage structures may have to be adopted to reduce current losses.

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It is recommended that integrated strategies involving clean farm operations, use of poly-tank and biological control storage technologies are used by farmers to reduce current postharvest losses in the area.

303 We wish to acknowledge the USDA- Scientific Cooperation Research Program for supporting this
304 study.
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