FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

KNOWLEDGE MANAGEMENT & LEARNING STUDY

EFFECTS OF TECHNOLOGIES PROMOTED ON POST-HARVEST AND HARVEST LOSSES ASSESSMENT PROTOCOL:

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USAID
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Expanding Opportunities Worldwide

GHANA ADVANCE II PROJECT

COOPERATIVE AGREEMENT NO. AID-641-A-14-00001

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ACRONYM LIST

ADVANCE	Agricultural Development and Value Chain Enhancement
APHIL	African Post Harvest Losses Information System
FtF	Feed the Future
MoFA	Ministry of Food and Agriculture
NF	Nucleus Farmer
OB	Outgrower Business
PH	Post-Harvest
PHH	Post-Harvest and Harvest
SHFs	Small-Holder Farmers
USAID	United States Agency for International Development

EXECUTIVE SUMMARY

ADVANCE is a USAID-Feed the future funded project that is being implemented by ACDI/VOCA and its partners namely, TechnoServe, ACDEP and PAB Consult. The project aims to increase the competitiveness of the maize, rice and soya value chains through the achievement of the intermediate results enumerated below:

1. Increased agriculture productivity in targeted commodities
2. Increased market access and trade of targeted commodities
3. Strengthening capacity for advocacy and activity implementation

The project is targeting a total of 113,000 small-holder farmers, with 45% projected to be women, in the Northern, Upper West, Upper East, Ashanti, Brong Ahafo and Eastern regions of Ghana.

Implementing interventions to increase the productivity of crops, while at the same time not paying attention to directly promote interventions to deal with and reduce post-harvest losses is counter-productive. Reducing post-harvest losses, which are generally high in Ghana, is a quicker and cheaper way of increasing the amount of food retained, consumed and/or sold by smallholder farmers. This observation underscores the importance of reducing post-harvest losses. Currently, most projects promote productivity increasing interventions while less attention is given to post-harvest loss reduction interventions. The promotion of various post-harvest reduction techniques and technologies needs to be more explicit and integrated into the implementation of yield-increasing technologies. In order to do this, however, it is important to identify the various causes of post-harvest losses and the stages in the value chain where these losses occur and to design appropriate interventions alongside the efforts being made in promoting production and productivity improvement interventions so that more of the food that is produced is retained by the farmers long after the harvest season when prices are relatively higher and the need for food by farm households become greater. Ability to safely store harvested produce until the market prices are higher has the potential for making more food available for consumption and for increasing incomes.

The Proven Ag Solutions team was awarded the assignment of conducting a post-harvest and harvest losses survey to assess the impact of ADVANCE'S intervention on losses of grains of farmers in six regions of Ghana. The PHH study's methodology was drawn from the APHIL approaches and used the African Post Harvest Losses Information System – APHILS' tools (Hodges, 2013). It is a rapid method that involves the use of visual scales accompanied by a formal questionnaire survey of representative samples of ADVANCE project maize farmers.
The study involved both desk and field research. It began with initial and extensive review of reports; literature and research work on maize production and post-harvest losses. This was subsequently complimented with a field survey to gather data on various parameters, using a structured questionnaire.

The study covered 6 regions broken down into 2 zones; Northern zone, consisting of Northern, Upper West and Upper East regions and Southern zone, comprising Ashanti, Brong Ahafo and Eastern regions of Ghana. A total of 59 districts and sample of 640 smallholder maize farmers (160 male and 160 female each for ADVANCE north and ADVANCE south) were selected to participate in the survey.

This report details the results of the survey conducted by Proven Ag Solutions to determine the post-harvest practices and post-harvest management difficulties encountered by farmers in the intervention areas of ADVANCE in the northern and southern zones of Ghana. The survey also identifies the various factors that contribute to post-harvest losses of smallholder farmers and proposes various interventions for reducing these losses in order to increase the quantity of maize saved and to increase the income and livelihood of farmers receiving assistance from the ADVANCE project.

Various observations were made during the survey and the major findings are summarized below:

Summary of Findings

- *Sample size and Composition:* A total of 513 farmers drawn from the Northern, Upper West, Upper East, Ashanti, Brong Ahafo and Eastern Regions were interviewed. This consisted of 262 farmers (51.1%) from the Northern Zone and 251 (48.9%) farmers from the Southern Zone. Males represented 51 percent of the sample and females represented 49 percent of the sample.

- *Maize Farming Experience*: Most maize farmers (83.43%) have been farming for more than five years. More males (89.7%) have also farmed more than five years as compared to their female (76.9%) counterparts. With respect to zones, more southern zone farmers (90.4%) have farmed more than five years compared to the northern zone farmers (76.7%). The farmers surveyed are, therefore, quite experienced in farming maize and are also linked to nucleus farmers with whom they have working relationships that allow the farmers to enjoy the benefits accrued from participating in the out-grower business model.

- *Different Farms Operated*: Generally, farmers in the target areas operate one farm. |Ownership of multiple farms has implications on the efficiency and effectiveness of maintenance and harvesting and post-harvest operations that are time and weather-dependent

- *Total Land Size:* Total farm size for maize production ranges from 0.65 hectares to 1.37 hectares with an average of 1.00 hectares. In the Northern Zone, the farm sizes

range from 0.65 – 1.21 hectares whiles southern zone maize farms ranges from 0.89 – 1.37 hectares. On average, maize farm size in the southern zone (1.25 hectares) is relatively larger than northern zone maize farms (0.98 hectares). Maize farms cultivated by males range from 1.21 to 1.37 hectares whiles females maize farm sizes range from 0.65 – 0.89 hectares. Males (average 1.23 hectares) generally farm larger maize farms than females (average 0.66 hectares).

- *Timing of harvesting*: Most farmers (65.0%) delay in harvesting their maize produce as a result of harvesting from many fields. However, this was independent of gender but more prevalent among southern zone farmers, where the farms are more and sizes larger and where the rains are more prevalent at the end of harvest, than northern zone farmers where rains at the end of the season is less likely.

- *Harvesting methods:* Most farmers prefer to harvest by hand plucking the cob from the plant and removing the cob (56.5%). Another 43 percent prefer to use the cutlass to harvest the cob. However, this was also independent of gender but dependent on zone

- *Time of maize harvesting*: Most farmers (62.0%) harvest their maize after the cobs fall on their side. 43.08% of the farmers harvest when the silk at the apex turns brown and 16.96% harvest their maize before the cobs fall on their side. A majority of the farmers are harvesting at the right time i.e. when the black layer has been formed and the silk has turned brown shortly before the cobs fall on their side on the maize stalk.

- *Losses during Harvesting:* The losses that occur at harvesting are mainly caused by Birds (20.3%), Bush fire (2.7%), others (17.0%), Pest/insect infestation (51.3%), Rodents (35.1%), Rotting due to moist conditions (34.5%) and Theft (2.7%). Insect pests and rodents are the predominant causes of loss during harvesting.

- *Temporary storage:* Most farmers (84.8%) do not undertake temporary storage on the farm and those who store do so with the maize in the husk (11.5%). The remaining farmers (2.53%) shell and de-husk the maize but small proportion of farmers(1.17%)leave it on the cob. Most farmers (43.3%) store their maize in a heap under protected area in the house. Another 21.6 percent store their maize in bags under protected shed or area.

- *Maize drying methods*: Most farmers (40%) dry their maize on clean cemented floor. Thirty two percent (32%) dry maize on the stalk in the field and another 32% on a covered platform . In general, most of the farmers harvest and protect their produce safely out of the farm while the rest leave their maize to dry on the stalk in the farm.

- *Methods of Shelling Maize:* Most farmers (61%) shell their maize mechanically by using a Sheller from service providers. Traditional hand shelling is also commonly practiced among 38 % of the farmers. The predominant method of shelling of maize in the southern zone is mechanized shelling whilst that of the northern zone is traditional hand method.

- *Processing of Maize:* Most farmers in the Northern Zone (95.4%) process maize into other products than farmers in the Southern Zone (79.7%). Most of the processed maize is transformed into whole maize flour (52.0%) and corn dough (47.1). In all, it is observed that not much of the maize produced is processed into secondary products and this leaves the rest of the maize in storage if the farmer has a surplus.

- *Ownership of storage facility*: Most of the farmers (68.6%) have their own storage facilities and these facilities are located mainly in the farmers' house (74.7%).

- *Long term storage facilities:* Home crib and mud silo are the most predominant, depending on the zone. The rest are the following: Earthen Pot (1.0%), Home crib (27.1%), Insecticide impregnated sack (0.6%), Metal silo (0.2%), Mud silo (16.2%), Normal sack (10.3%), Open weave jute sack (cocoa sack) (4.9%), Other eg. Cemented room, living room, veranda, community warehouse (33.9%), other hermetic grain sack (5.5%), PICS or triple sack (0.2%), Plastic silo/Poly tank (0.2%).

- *Condition of storage facility:* Only 26.7% of farmers have their storage facilities in good condition. Most farmers (61.4%) have their storage facilities in fair condition and 11.9% have theirs in poor a condition.

- *Capacity of storage facility:* Less than half of the farmers (42.9%) have storage structures that can accommodate more than 50 of 100kg bags. About half of them (50.5) have structures that can accommodate less 50 bags and 6.6% of them have storage capacity with less than 10 bags.

- *Storage facility rental:* It is not a common practice for farmers to rent storage facilities. Only 5.5% indicated they rented storage facilities even though 31.4% of farmers do not own storage facilities. This means that 25.9% of farmers do not entirely store their maize and perhaps sell their maize right after harvesting and drying.

- *Application of storage protectant:* Half the farmers use storage protectants and the other half does not. The storage protectants usually used are biological pesticides (neem extract, smoke, pepper etc.) (3.8%), chemical pesticide (Actellic, etc.) (88.6%) and organic pesticide (7.6%).

- *Period of maize storage:* Most farmers (68%) store their maize for more than 5 months after harvesting while 32% stored for less than 5 months. 3 months (16.8%), 4 months (4.3%) and about 5 months (10.9%).

- *Transport of maize to market:* Half of all farmers (52.4%) do not transport their maize from the production area to market centres outside their communities but keep the produce in storage. However, with regard to zones, more farmers in the Northern Zone (67.2%) are more likely to transport their maize outside their areas of production for sale as compared to their southern counterparts (27.1%).

- *Types of transportation used:* The most common types of transportation among farmers are open trucks, donkey carts and motorized tricycles (37.8%), individual-hired vehicle/truck (30.0%) and group hired vehicle to market centres (25.0%).

- *Packaging of maize for transport to the market:* Maize is mostly transported in either new jute sacks (41.7%) or new synthetic (fertilizer) sacks (26.7%). The form maize is transported to the market is dependent on zone (0.000) and gender (p=0.035). The use of new jute sacks or new synthetic sacks is common among farmers in the Southern Zone (59.0%) and (30.7%) respectively than farmers in the Northern Zone (new jute sacks, 22.9%; new synthetic sacks, 22.9%). However the use of used jute sacks (24.4%) and used synthetic (fertilizer) sacks (21.4%) is prevalent in the Northern zone than in the Southern Zone.

- *Loss arising from transport of maize to the market:* About 98% of the farmers indicate that they lose about 2–5% of their maize to the market and most farmers (86%) attribute the loss to physical spillage during transportation.

- *Purchasers of farmers' surplus maize:* Most farmers (67.6%) mostly sell their produce to market women/retailers. The rest of farmers sell to the following: aggregator/warehousing agents 3%, consumers 27.8%, lead farmer 0.8 and processors, 0.6%.

- *Level of training in agriculture:* Most of the farmers have not been formally trained in agriculture production. Only 18 percent of female farmers have received formal training in agricultural production.

- *Support received from ADVANCE:* About 55% of the farmers reported receiving support from ADVANCE with slightly more males (58.0%) receiving support than females (51.8%). More farmers in the Northern Zone (61.5%) had received support from ADVANCE than farmers in the Southern Zone (48.2%).

- *Types of support received from ADVANCE:* Most of the farmers mentioned at least one technical assistance or support received. Most farmers (86.2%) mentioned receiving extension services or technology transfer. Extension services or technology transfer represent 67 percent of all the types of technical assistance or support received by farmers. Material benefits in the form of supply of seed, fertilizer, inputs construction materials was also mentioned by 108 farmers (21.1%) as the next type of support received by the farmers after extension services. Far less farmers (3.7%) and (1.2%) received financial assistance and access to storage facility or infrastructure respectively.

- *Frequency of Technical Financial and post-harvest Training:* Most farmers (70.8%) mentioned receiving irregular technical training assistance whilst 18.3 percent received regular technical assistance. The remaining 10.9 percent received a special one off package.

- *Post-harvest Management Training*: About 61% of the farmers indicated that they received training in post-harvest management. However, more males (65.3%) received post-harvest training as compared to 55.8% of females. Training of farmers in post-harvest management has mainly been provided by ADVANCE (63.2%) and MOFA (28.1%). A farmer's location determines the training provider for post-harvest management training. More than 85% of farmers in the Northern Zone received their training in post-harvest management from ADVANCE compared 39% in the South. Most farmers in the south 49.2% received their training in post-harvest management from MOFA.

- *Stages at which loss is experienced:* Farmers indicated that the harvesting stage is where most losses occur (54%). This is followed by shelling 22%, storage 15%,drying 4%, transporting before storage 3% and transport to market 1%. Shelling and harvesting losses were found to be higher in the northern zone as compared to shelling and harvesting in the south. In the case of gender, females recorded relatively higher

losses in storage and transport to market and lower losses in drying, harvesting and shelling as compared to their male counterparts.

Estimated Relative Maize Losses: Generally, The total estimated relative loss is 18.57% per acre. In the case of zones, the southern zone recorded a lower total relative loss of 15.63% as compared to the northern zone figure of 21.39% per acre. For gender, women recorded relatively lower losses totalling 17.73% compared with 19.37% recorded for males.

This level of estimated loss of 18.57% is still high and needs to be better managed in the ADVANCE program through targeted interventions.

- *Estimated Relative Maize Losses from Visual Scale Generated Information*: In the case of the visual scale loss estimates, average relative loss per farmer for the Northern zone farmers for sampled maize was recorded as 0.08% and 0.21% for classes 2 and 3 respectively. The southern zone recorded relatively higher loss values of 0.23%, 0.48% and 0.75% for classes 2, 3 and 4, respectively. In relation to gender differences, average relative losses for male farmers were 0.20%, 0.72% and 0.75% for classes 2, 3 and 4 respectively. Female farmers on the other had relatively lower losses as compared to their male counterparts. They recorded 0.13%, 0.17% for classes 2 and 3 respectively.

  These estimates would appear to be very low and not consistent with the general observations. Based on the several problems associated with the use of this methodology for estimating losses per this survey, the relative loss values were not computed.

Recommendations

Introduction of interventions to mitigate the causes of post-harvest losses of maize is a key strategy for reducing these losses among smallholder farmers. The recommendations on interventions that ADVANCE should promote and implement are the following:

i. The provision of training and technical support to smallholder farmers by ADVANCE is expected to result in production and yield increases. ADVANCE needs to complement these current interventions with tailored training and support services to reduce post-harvest losses so that the expected increased production, as a result of ADVANCE'S production and yield increasing interventions, would not be lost to the farmers.

ii. There are various technologies for reducing post-harvest losses; farmers do not easily adopt them because they are not convinced of the benefits. It is important to increase

the knowledge of farmers, since most of the farmers have not been formally trained in agriculture production. The project should provide more training and sensitization programs on post-harvest loss-reduction in order for them to understand and appreciate the critical stages in the value chain where the losses occur, the causes of losses and how to develop strategies and practices to mitigate the causes that will reduce post-harvest losses that farmers encounter in their operations.

iii. Although a large proportion of the farmers own their own storage facility (home crib and mud silo), there is still a large number who do not have appropriate and safe storage facilities. Also, most of the storage facilities of those surveyed are not in good condition. ADVANCE should promote and assist farmers to rehabilitate dilapidated structures or construct simple, appropriate storage facilities. This effort must be complemented with training in post-harvest grain handling techniques.

iv. For small-scale producers and those who are not in a position to rehabilitate or construct new storage structures, an opportunity also exists for ADVANCE to introduce and promote the improved hermetic grain storage bags such as the Purdue Improved Crop Storage (PICS) bags which provide low-cost method of reducing post-harvest losses due to insect infestation. This intervention is considered a quick way to respond to the problem of losses during the long grain storage period.

v. Several farmers were observed to be using crop storage chemical insecticides to treat their maize prior to long-term storage. It is imperative for the project to provide training in the safe use of such pesticides to lower the risk of misuse and poisoning.

vi. Generally, not much of the maize produced is processed into secondary products and this leaves the rest of the maize in storage, if the farmer has a surplus. Most of the grain loss after harvest could be avoided if value-addition and processing of produce into more stable and storable forms are practiced by farmers. In order to ensure that the maize lost would be available for human consumption, the ADVANCE program should promote primary processing at the household-level through training and facilitate access to simple processing technologies that will add value to the maize produce and reduce the quantity of maize that would be exposed to various post-harvest loss factors.

vii. Although much work has gone into ADVANCE's interventions of linking farmers to markets through the operation of the outgrower business model, the predominant purchasers of farmers' surplus maize the predominant buyers are the market women/retailers. This dependence on market women and retailers is fraught with many problems related to pricing and evacuation. the project should intensify its

efforts in developing new strategies to get farmers to work closely with the outgrower businesses they are associated with since the relationship appears to be weak and would impact on the delivery of other services through the relationship.

viii. Most of the farmers have not been formally trained in agriculture production. Provision of training is a major feature of the work of ADVANCE with its farmers. The program should develop a comprehensive training package which deals with the following, among others:

- Stages in the harvesting and post-harvest cycle that losses occur.
- The types of losses and causes of the loss
- Time of harvesting and harvesting methods
- Principles and practices of appropriate short and long-term storage
- Safe use of storage pesticides

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1 BACKGROUND

ACDI/VOCA a Washington-based non-profit international development organization is in the business of delivering technical and management assistance in agribusiness, financial services and enterprise development, community and food security in order to promote broad-based economic growth and vibrant civil society.

ADVANCE is a USAID-Feed the Future (FtF) funded project that is being implemented by ACDI/VOCA and its partners namely, TechnoServe, ACDEP and PAB Consult. The project aims to increase the competitiveness of the maize, rice and soya value chains through the achievement of the intermediate results enumerated below:

1. Increased agriculture productivity in targeted commodities
2. Increased market access and trade of targeted commodities
3. Strengthening capacity for advocacy and activity implementation

The project is targeting a total of 113,000 small-holder farmers, with 45% projected to be women, in the Northern, Upper West, Upper East, Ashanti, Brong Ahafo and Eastern regions of Ghana. To increase the productivity and the profit of those smallholders, ADVANCE supports them to reduce their harvest and post-harvest losses, among others. For that purpose, they benefit from trainings, linkage with harvest and post-harvest equipment dealers and service providers, grants, and storage access facilitation etc.

Implementing interventions to increase the productivity of crops, while at the same time not paying attention to directly promote interventions to deal with and reduce post-harvest losses is counter-productive. Reducing post-harvest losses, which are generally high in Ghana, is a quicker and cheaper way of increasing the amount of food retained, consumed and/or sold by smallholder farmers. This observation underscores the importance of reducing post-harvest losses. Currently, most projects promote productivity increasing interventions while less attention is given to post-harvest loss reduction interventions. The promotion of various post-harvest reduction techniques and technologies needs to be more explicit and integrated into the implementation of yield-increasing technologies.

In order to do this, however, it is important to identify the various causes of post-harvest losses and the stages in the value chain where these losses occur and to design appropriate interventions alongside the efforts being made in promoting production and productivity improvement interventions so that more of the food that is produced is retained by the farmers long after the harvest season when prices are relatively higher and the need for food by farm households become greater. Ability to safely store harvested produce until the market prices are higher has the potential for making more food available for consumption and for increasing incomes.

The Proven Ag Solutions team was awarded the assignment of conducting a post-harvest and harvest losses survey to access the effect of ADVANCE'S intervention on losses of grains of farmers in six regions of Ghana. This report details the results of a survey to determine the post-harvest practices and difficulties encountered by farmers in the intervention areas of ADVANCE in the northern and southern zones of Ghana. The survey also identifies the various factors that contribute to post-harvest losses of smallholder farmers and proposes various interventions for reducing these losses in order to increase the quantity of maize saved and to increase the income and livelihood of farmers receiving assistance from the ADVANCE project.

1.1 Scope of the Survey

The study covered 6 regions broken down into 2 zones; Northern zone, consisting of Northern, Upper West and Upper East regions and Southern zone, comprising Ashanti, Brong Ahafo and Eastern regions of Ghana. A total of 59 districts and sample of 640 smallholder maize farmers (160 male and 160 female each for ADVANCE north and ADVANCE south) were selected to participate in the survey.

2 METHODOLOGY

The PHH study's methodology was drawn from the APHIL approaches and used the African Post Harvest Losses Information System – APHILS' tools (Hodges, 2013)[1]. It is a rapid method that involves the use of visual scales accompanied by a formal questionnaire survey of representative samples of ADVANCE project maize farmers. The study involved both desk (secondary) and field (primary) research. It began with initial and extensive review of reports; literature and research work on maize production and post-harvest losses. This was subsequently complemented with a field survey to gather data on various parameters, using structured questionnaires uploaded on electronic tablets.

2.1 Planning and Preparatory Activities

This involved initial management team meetings to discuss the project RFP, terms of reference, information-sharing, brainstorming and finally building a common understanding of the needs of the client. Identification of key activities and the resource requirement to deliver the output was also considered.

2.2 Selection of Districts and Communities and data collection approach

The zones, regions, districts and respondents/farmer were pre-selected by ADVANCE to be representative enough to cover the main ecological zones of Ghana where ADVANCE currently operates. The quantitative study administered a structured questionnaire to the selected farmers in the specified target zones, regions and districts. A total of 640 households were to be interviewed and the breakdown of the numbers for each region. The questionnaire was mainly administered to the pre-determined farmer/respondent.

2.3 Survey Questionnaire Development

A questionnaire was developed to gather information from the targeted farmers. This questionnaire was reviewed by the ADVANCE team and subsequently revised and finalized by the consultant (see annex 3 for the questionnaire)

2.4 Selection and Training of Enumerators

For the purposes of ensuring the collection of credible and accurate field data and information from the respondents, the consultant selected eleven (11) enumerators. A total period of 2-days was devoted to the training of the enumerators in the use of the visual scale, questionnaire, interview guide, assessment tools and equipment to be used in the field. Simulated practical runs were organized for them to ensure they had enough practice, exposure and fully grasped the use of the various tools before commencement of the actual assessment.

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[1]Hodges R., *How to assess postharvest cereal losses and their impact on grain supply: rapid weight loss estimation and the calculation of cumulative cereal losses with the support of APHLIS.* UK: APHLIS, 2013

2.5 Data Collection Teams

There were five teams, consisting of 2 enumerators for four teams and three enumerators for the last team. There were 2 supervisors assigned to work with the five teams to ensure the smooth conduct of the survey.

2.6 Testing of Questionnaire and Interview Guide

The questionnaire and interview guide were pre-tested on a selected sample of respondents in Techiman by the enumerators at the end of the training to ensure the questions were clear and appropriate to the selected respondents. After the field testing, the questionnaire was revised accordingly, based on suggestions obtained from the pre-test.

2.7 Development of Visual Scale

The visual scale is a rapid method of determining the weight loss and/or quality of grain sample. It is a pre-determined quality standard developed for the rapid assessment of losses due to bio-deterioration i.e. insect/pest infestation of maize samples. For the purposes of the survey, the consulting team developed a visual scale representing six (6) classes of maize samples of different quality levels of percentage (%) insect infestation. The detailed process in the construction of the visual scale, involved 10 steps adapted from APHLIS and the application in the calculation of the %weight loss.

Briefly, visual scales are a series of visual quality standards of maize samples of different quality levels of insect damage. In this survey, grain samples that represented the range of grain qualities likely to be encountered in the field were purchased. A few farmers and traders were contacted to determine the end use of grain at the different quality stages as well as information on other criteria for quality assessment. As a result the six (6) classes of visual scale were developed ranging from class 1 to class 6, representing specified degrees of damage, weight loss and contamination with class 1 being the best quality. Pictures were taken of the 6 classes used as a standard by the enumerators to determine the status of maize encountered in grain stores of the farmers they interviewed. The visual scale classes have been described in Table 1 below.

Table 1: Tabular Representation of the Visual Scale for the survey

Class	% insect damage (%weight loss**)	Contamination None	End Use	Sample photo
1.	0% (0%*)	None	For house hold consumption	Class 1 – Refer to Annex 4
2.	15% (7.4%)	1.5% frass/sand, almost no moth webbing	For house-hold consumption	Class 2 – Refer to Annex 4
3.	30% (13.9%)	3% frass/sand, moth webbing, frequent small portions, occasional rodent pellets	Not so good for household consumption	Class 3 – Refer to Annex 4
4.	60% (24%)	Large amounts of moth webbing, frequent rodent pellets	To be hand-picked, infested material as feed	Class 4 – Refer to Annex 4
5.	80% (41.8%)	Vast amount of moth webbing, frequent rodent pellets, straw/mu	To be fed to animals	Class 5 – Refer to Annex 4
6.	100%	Huge amounts of rodent pellets/moth webbing	Not fit for animals, total reject.	Class 6 – Refer to Annex 4

** % weight loss calculated by Count and Weigh method

2.7.1 Loss estimation methodology

A method proposed for the assessment of weight loss due to storage pests in stored maize seeds is adapted from a rapid method proposed by Compton and Sherington[2] (1999).The method involves scoring each cob in the sample on a visual damage scale and then using a simple equation to estimate overall sample weight loss. The consultants purchased maize from the market and developed a six-class damage scale by sorting and constituting maize of different qualities into visual classes which roughly reflected farmer use categories. Reference photographs were taken of each class to be used by the study enumerators to assess the quality of stored maize by respondent-farmers involved in the study. Below is the description of visual scale categories and farmer use of the maize that has been stored.

The scale was then calibrated to estimate weight loss. The model used to estimate using the six-class scale is shown in equation 1 below:

$$Visloss \quad \frac{aN_1 + bN_2 + cN_3 + dN_4 + eN_5 + fN_6}{N_T}$$

where: *Visloss* is the weight loss estimated using the visual scale,

[2]A rapid assessment methods for stored maize cobs: weight losses due to insect pests

N1 - *N6*=Number of cobs in classes 1 to 6 in sample,
NT=Total number of cobs in sample
And *a* - *f* are damage coefficients for each class.

This method was not, however, used in the survey, since the samples encountered during the survey in the field were all threshed maize stocks. For this reason, the count and weigh method was used. The count and weigh method is found in the methodology in chapter 2 of this report.

2.8 Conduct of loss assessment study

The questionnaire was administered to the selected farmers to collect the required quantitative data to initiate the data-gathering process. . The assessment of grain quality of each farmer interviewed was undertaken using the developed visual scale instrument which consisted of pictures of the various maize classes, 1to 6. Samples in transparent plastic bags of each class captured in the pictures given to each enumerator were compared to a sample of grain obtained from the farmer's grain store in order to match the visual scale class and the sample of the various classes in the plastic bags. The weight loss associated with each class is determined using the "count and weigh technique".

The consultants took note of potential challenges to be encountered by the enumerators and crafted strategies to mitigate any adverse impact on the work. The consultant also created a "Whatsapp" platform that enhanced information flow and problem solving in real time.

2.9 Data Analysis

The questionnaire contained many pre-coded questions in addition to few open-ended questions. The electronic data was downloaded into Excel and cleaned. The data analysed using well-established quantitative statistical tools/methods including, SPSS and Excel to compute descriptive statistics such as frequency, counts, scores, percentages arithmetic means and cross tabulations.

2.10 Survey limitations and mitigation strategies

It is important to state that, a number of limitations and risks were identified that had the potential to undermine the effective delivery of the survey work. The team drew the attention of the ADVANCE and engaged in a series of consultations and discussions as to the way forward. The risks and assumptions with potential adverse impact on the survey included but were not limited to the following:

1. Timely release of list of sampled farmers and their contact information and advance notification of the selected nucleus farmers and out-growers.
2. Large sample size of respondents numbering 640 fragmented and dispersed across 6 regions with long distances.
3. Season of targeted survey being 2015 crop season was rather belated.

4. The survey was conducted at the time that it was impracticable for farmers to recall volumes of maize available at various stages of production. Loss computations were therefore based on total volumes produced rather than specific volumes at each stage of production (as ascribed with the usage of the visual scale).

These risks and limitations were brought to the fore and generated a lot of discussions with the client. In spite of these issues, the team took the initiative to kick-start the project whiles following up and continuing deliberations on unresolved issues with the client.

Apart from the various risk identified prior to the field work, there was a litany of others that emerged but unavoidable which the enumerators were confronted with unforeseen operational challenges during the farmer survey. These challenges varied from zone to zone and enumerator to enumerator in intensity and scope. Specific challenges cited included poor location information, poor outreach, farmer access, logistics problems, poor road-network and flooded conditions which undermined the zeal to work and frustrated access to communities. In other cases the list of respondents provided were obsolete, with some farmers dead and others relocated. Notwithstanding all these issues, the work progressed.

3 FINDINGS

This section presents the detailed findings of the quantitative survey of the selected farmers in the various locations. In all, 513 farmers, out of the 640 targeted were interviewed representing 80% coverage. Narratives have been provided under various thematic areas below:

3.1 Demographic Information

This section considers data relating to location and characteristics of the farmers.

3.1.1 Sample size and Composition

Table 2 presents a summary of the sample size by gender and zone. A total of 513 farmers drawn from the Northern, Upper West, Upper East, Ashanti, Brong Ahafo and Eastern Regions were interviewed. This consisted of 262 farmers (51.1%) from the Northern Zone and 251 (48.9%) farmers from the Southern Zone. Males represented 51 percent of the sample and females represented 49 percent of the sample.

Table 2: Sample Composition of interviewees by zone

Zone	FY 15 Population			PHH Study Plan			PHH Study Actuals			PHH study Actuals Weight		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
ADVANCE SOUTH	**2127**	**587**	**2714**	**160**	**160**	**320**	**124**	**127**	**251**	**13**	**13**	**26**
ADVANCE NORTH	**27299**	**23182**	**50481**	**160**	**160**	**320**	**138**	**124**	**262**	**249**	**238**	**487**
Northern Region	11653	8793	20446	69	46	115	64	33	97	106	90	197
Upper East Region	8143	7419	15562	39	53	92	27	39	66	74	76	150
Upper West Region	7503	6970	14473	52	61	113	47	52	99	68	72	140
Grand Total	**29426**	**23769**	**53195**	**320**	**320**	**640**	**262**	**251**	**513**	**262**	**251**	**513**

3.2 Crop Production

Food production in Ghana as a whole has not kept pace with the increase in demand for food. On the demand side, growth in population, increasing incomes and other factors are responsible for the situation. On the supply side, there are numerous production, processing and marketing constraints, which have to be tackled using innovative methods. Also, there is a need for agricultural production to be linked to reduction in post-harvest losses through various small-scale industrial set-ups so that value can be added to the primary agricultural

products and higher incomes can be gained. The ability to couple production improvement intervention with post-harvest loss reduction strategies is all that is required to ensure sustainable agricultural production which in the long run will result in the attainment of better incomes and hence reduction in poverty levels and food insecurity among smallholder farmers. Farming is the major activity that most households are engaged in on small parcels of land of less than one hectare per household. Farming practices remain subsistence in nature, with a majority of the farmers using the traditional technologies for production. ADVANCE has been implementing various productivity increasing interventions among its target smallholder farmers in its target areas and it is expected that these efforts will result in increases in production and yield.

3.2.1 Maize Farming Experience

Table 3 presents a summary of maize farming experience by zone and by gender. Most maize farmers (83.43%) have been farming for more than five years. More males (89.7%) have also farmed more than five years as compared to their female (76.9%) counterparts. With respect to zones, more southern zone farmers (90.4%) have farmed more than five years compared to the northern zone farmers (76.7%). The farmers surveyed are, therefore, quite experienced in farming maize and are also linked to nucleus farmers with whom they have working relationships that allow the farmers to enjoy the benefits accrued from participating in the out-grower business model. This asset presents a good opportunity for ADVANCE to transfer additional post-harvest loss-reduction technologies to the smallholder farmers, through the nucleus farmers who are also engaged in the training of farmers.

Table 3: Maize Farming Experience by Zone and by Gender

Maize Farming Experience	Zone				Gender				Total	
	Northern		Southern		Female		Male			
	Count	%	Count	%	Count	%	Count	%	Count	%
Above Five Years	201	76.7%	227	90.4%	193	76.9%	235	89.7%	428	83.4%
Under Five Years	61	23.3%	24	9.6%	58	23.1%	27	10.3%	85	16.6%
Total	**262**	100.0%	**251**	100.0%	**251**	100.0%	**262**	100.0%	**513**	100.0%

Fisher's Exact Test (Zone) = 0.000 Fisher's Exact Test (Gender) = 0.000

3.2.2 Different Farms Operated and Total Land Size

Generally, most farmers (68.2%) in the target areas operate one farm. About a quarter of all farmers (31.8%) however operate more than one farm and this has implications on the efficiency and effectiveness of maintenance, harvesting and post-harvest operations that are time and weather-dependent. In the southern zone, farmers (37%) plant maize on 2-6 plots whiles 2-5 plots is common among 27% of northern zone farmers. Women with more than one farm (25%) plant maize on 2-4 plots whiles the males with more than one farm (38%) plant on 2-6 plots. Table 4 below presents the number of different farms maize is harvested from.

Table 4: Number of maize farms operated by zone and gender

Number of different maize farms operated	Zone		Gender		Total
	Northern	Southern	Female	Male	
Minimum	2	2	2	2	**2**
Maximum	5	6	4	6	**6**
Mean	2.5	4	2	5	**3.25**
One farm	73.3	62.9	74.9	61.8	**68.2**
More than one farm	26.7	37.1	25.1	38.2	**31.8**

Total farm size for maize production ranges from 0.65 hectares to 1.37 hectares with an average of 1.00 hectares. In the Northern Zone, the farm sizes range from 0.65 – 1.21 hectares whiles southern zone maize farms ranges from 0.89 – 1.37 hectares. On average, maize farm size in the southern zone (1.25 hectares) is relatively larger than northern zone maize farms (0.98 hectares). Maize farms cultivated by males range from 1.21 to 1.37 hectares whiles females maize farm sizes range from 0.65 – 0.89 hectares. Males (average 1.23 hectares) generally farm larger maize farms than females (average 0.66 hectares). Table 5 presents total maize land size by zone and gender.

Table 5: Perceived Land size by zone and gender

Total Land Area (Ha)			
	Male	**Female**	**Total**
Southern zone	2,874.14	598.39	3,472.53
Northern zone	27,212.85	10,281.90	37,494.75
Total Area	30,086.99	10,880.29	40,967.28
Number of ACDI/VOCA Beneficiaries			
	Male	**Female**	**Total**
Southern zone	2,098	671	2,769
Northern zone	22,413	15,734	38,147
Total Area	24,511	16,405	40,916
Average Land Size (Ha)			
	Male	**Female**	**Total**
Southern zone	1.37	0.89	1.25
Northern zone	1.21	0.65	0.98
Average Hectarage	**1.23**	**0.66**	**1.00**

Source: ACDI/VOCA 2015 Gross Margin Survey

3.3 Timing of harvesting and harvesting methods

Maize harvesting processes by farmers is presented in Table 6. Most farmers (65.0%) delay in harvesting their maize produce as a result of harvesting from many fields. However, this was independent of gender but more prevalent among southern zone farmers, where the farms are more and sizes larger and where the rains are more prevalent at the end of harvest, than northern zone farmers where rains at the end of the season is less likely. Most farmers prefer to harvest by hand plucking the cob from the plant and removing the cob (56.5%). Another 43 percent prefer to use the cutlass to harvest the cob. However, this was also independent of gender but dependent on zone. Whiles southern zone farmers prefer to use the cutlass to harvest their maize, the northern zone farmers prefer to use their hands to pluck the cob. Most farmers (54.1%) do not experience rainfall during harvest. Experiencing rainfall during harvest is independent of gender but dependent on zone (p=0.000). About 78 percent of farmers in the southern zone experience rainfall during their maize harvesting and this situation is likely to cause fungal infections to develop and lead to spoilage and loss of the grain.

Table 6: Harvesting by zone and by gender

Harvesting	Zone		Gender		Total
	Northern	Southern	Female	Male	
Harvest maize from several farms	Fisher's Exact Test = 0.014		Fisher's Exact Test = 0.002		
No	73.3	62.9	74.9	61.8	68.2
Yes	26.7	37.1	25.1	38.2	31.8
Harvesting delay as a result of several farms harvested	Fisher's Exact Test = 0.014		Fisher's Exact Test = 0.238		
No	24.3	43.0	41.3	31.0	35.0
Yes	75.7	57.0	58.7	69.0	65.0
Harvesting Method	LR Chi-square test = 482.613; p-value = 0.000		LR Chi-square test = 0.409; p-value = 0.815		
By hand -pluck cob from plant/open husk on stalk and remove cob	98.1	13.1	57.4	55.7	56.5
Mechanized (e.g. combine harvester)	1.1	0.0	0.4	0.8	0.6
With the aid of a cutlass (care to avoid damage on cob)	0.8	86.9	42.2	43.5	42.9
Experience rainfall during harvesting or drying of maize	Fisher's Exact Test = 0.000		Fisher's Exact Test = 0.425		
No	85.4	21.5	52.2	55.9	54.1
Yes	14.6	78.5	47.8	44.1	45.9

Figures are in percentages

A one-way between-group analysis of variance was conducted to explore the impact of farmers' method of harvesting on harvesting losses (measured in kg). Farmers harvest maize

usually by hand plucking, using combine harvester or with the aid of cutlass. There was no statistically significant difference at the p<0.05 level in harvest losses for the different methods of harvesting: F (2, 510) = 1.061, p=0.347. This was also confirmed by the effect size (0.004), which was calculated using the eta squared[3].

Table 7: Losses by Methods of harvesting maize

Method of Harvesting	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
By hand -pluck cob from plant/open husk on stalk and remove cob	290	18.92%	13.47%	0.79%	33.50%	83.50%	5.00%	165.50%
Mechanized (e.g. Combine harvester)	3	14.83%	1.15%	0.67%	15.50%	15.50%	13.5%	15.50%
With the aid of a cutlass (care to avoid damage on cob)	220	18.52%	15.56%	1.04%	42.25%	97.50%	8.5%	118.5%
Total	513	18.73%	14.31%	0.63%	35.00%	85.00%	5.00%	160.50%

Table 8: Test of Homogeneity of Variances for Harvest Losses

Test of Homogeneity of Variances						
Harvest Loss						
Levene Statistic	df1	df2	Sig.			
1.009	2	510	.365			
ANOVA						
Harvest Loss						
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**	
Between Groups	3235.130	2	1617.565	1.061	.347	
Within Groups	777295.046	510	1524.108			
Total	780530.176	512				
Multiple Comparisons						

[3] The eta squared is computed as the ratio of sum of squares between groups to total sum of squares. Cohen (1998) classifies eta square as <0.01 as small effect, <0.06 as medium effect and <0.14 as large effect.

Dependent Variable:		Harvest Loss					
LSD							
(I) Q7		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval		
					Lower Bound	Upper Bound	
By hand -pluck cob from plant/open husk on stalk and remove cob	Mechanized (eg. Combine harvester)	11.49609	22.65594	.612	-33.0144	56.0065	
	With the aid of a cutlass (care to avoid damage on cob)	4.87412	3.49046	.163	-1.9833	11.7316	
Mechanized (e.g. Combine harvester)	By hand -pluck cob from plant/open husk on stalk and remove cob	-11.49609	22.65594	.612	-56.0065	33.0144	
	With the aid of a cutlass (care to avoid damage on cob)	-6.62197	22.69281	.771	-51.2049	37.9609	
With the aid of a cutlass (care to avoid damage on cob)	By hand -pluck cob from plant/open husk on stalk and remove cob	-4.87412	3.49046	.163	-11.7316	1.9833	
	Mechanized (e.g. Combine harvester)	6.62197	22.69281	.771	-37.9609	51.2049	

Table 9 summarizes the time when maize is harvested by zone among farmers. Most farmers (62.0%) harvest their maize after the cobs fall on their side. Harvesting maize before the cobs fall on their side represents 16.96% of all the time of harvesting responses mentioned by the farmers. 43.08% of the farmers harvest when the silk at the apex turns brown. The rest 1.95%, 1.36% and 4.48% harvest 115 days after planting, any convenient time and when there are helpers available for harvesting respectively.

Table 9: Time of harvesting by zone

Time of Harvesting	Northern		Southern		Total	
	Count	%	Count	%	Count	%
115 days after planting	0	0.00%	10	3.98%	10	1.95%
After the cobs falls on their side	90	34.35%	228	90.84%	318	61.99%
Any convenient time	2	0.76%	5	1.99%	7	1.36%
Before the cobs fall on their side	73	27.86%	14	5.58%	87	16.96%
The silk at the apex turns brown	173	66.03%	48	19.12%	221	43.08%

When there are helpers available for harvesting	5	1.91%	18	7.17%	23	4.48%

A majority of the farmers are harvesting at the right time i.e. when the black layer has been formed and the silk has turned brown shortly before the cobs fall on their side on the maize stalk. The farmers who harvest earlier try to avoid the late rains and generally allow the harvested maize to dry properly later.

3.3.1 Losses occurring during Harvesting

The losses that occur at harvesting are mainly caused by Birds (20.3%), Bush fire (2.7%), Others (17.0%), Pest/insect infestation (51.3%), Rodents (35.1%), Rotting due to moist conditions (34.5%) and Theft (2.7%). Insect pests and rodents are the predominant causes of loss during harvesting. Table 10 summarizes the results below.

Table 10: Causes of loss occurring at harvesting by Zone and Gender

Causes of loss occurring at harvesting	Northern Zone		Southern Zone		Female		Male		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
Birds	54	20.61%	50	19.90%	51	20.32%	53	20.23%	104	20.27%
Bush fire	7	2.67%	7	2.80%	6	2.39%	8	3.05%	14	2.73%
Others	62	23.66%	25	10.00%	35	13.94%	52	19.85%	87	16.96%
Pest/insect infestation	120	45.80%	143	57.00%	133	52.99%	130	49.62%	263	51.27%
Rodents	95	36.26%	85	33.90%	91	36.25%	89	33.97%	180	35.09%
Rotting due to moist conditions	39	14.89%	138	55.00%	85	33.86%	92	35.11%	177	34.50%
Theft	9	3.44%	5	2.00%	8	3.19%	6	2.29%	14	2.73%

3.4 Temporary Storage and Transportation Activities

From Table 11, most farmers (84.8%) do not undertake temporary storage on the farm. In the case of zone and gender, all variables recorded were above 80% of farmers not storing their maize on their farms.

Table 11: Temporary Farm Storage of Maize

Storing of maize on farm	Northern Zone		Southern Zone		Male		Female		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
No	228	87.02%	207	82.47%	216	82.44%	219	87.25%	435	84.80%

Yes	34	12.98%	44	17.53%	46	17.56%	32	12.75%	78	15.20%

From Table 12, farmers generally temporarily store their maize with the husk (11.5%). The remaining farmers shell (2.53%) and de-husk the maize but leave it on the cob (1.17%).

Table 12: Form in which maize is temporarily stored by zone and gender

Form maize is stored	Northern Zone		Southern Zone		Male		Female		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
De-husked/ On Cob	8	3.1%	27	10.8%	17	6.5%	18	7.2%	35	6.8%
Shelled	251	95.8%	192	76.5%	230	87.8%	213	84.9%	443	86.4%
With Husk	3	1.1%	32	12.7%	15	5.7%	20	8.0%	35	6.8%
Total	262	100.0%	251	100.0%	262	100.0%	251	100.0%	513	100.0%

3.4.1 Temporary Storage of Maize

The data on temporary storage of maize by farmers is presented in Tables 13. Most farmers (43.3%) store their maize in a heap under protected area in the house. Another 21.6 percent store their maize in bags under protected shed or area. Where maize is stored in the house is independent of gender (p=0.450) but dependent on the location where the farmer resides in relation to the location of the farm. Whilst equal percentage (43%) of farmers in both Northern and Southern Zones store their maize in a heap under protected area, the next alternative storage form differs. About 36 percent of farmers in the Southern Zone prefer storing their maize in bags under protected area or shed while 29 percent of farmers in the Northern Zone prefer different types of storage.

Table 13: Temporary Storage of Maize On-Farm

Maize Shelling/Storage	Zone		Gender		Total
	Northern	Southern	Female	Male	
Where maize is stored in the homestead	**Chi-square = 73.278; p-value = 0.000**		**Chi-square = 2.640; p-value = 0.450**		
In heap outside	19.5	8.4	15.9	12.2	14.0
In a heap under protected area	43.5	43.0	43.0	43.5	43.3
In bags under protected area/shed	8.0	35.9	22.3	21.0	21.6
Other	29.0	12.7	18.7	23.3	21.1
Days maize is temporarily stored before shelling	**Chi-square = 85.750; p-value = 0.000**		**Chi-square = 2.786; p-value = 0.594**		
Few days	51.5	51.4	55.0	48.1	51.5
About a week	26.3	11.2	17.5	20.2	18.9
Two weeks	10.3	0.8	5.2	6.1	5.7

One month	6.9	5.6	6.4	6.1	6.2
More than one month	5.0	31.1	15.9	19.5	17.7
Dry homestead maize before shelling or storing	**Fisher's exact test = 0.057**		**Fisher's exact test = 0.650**		
No	34.0	42.2	39.0	37.0	38.0
Yes	66.0	57.8	61.0	63.0	62.0

Fifty one percent (51.5%) of the farmers store the maize for few days before shelling. About 19 percent also store their maize for about a week before shelling and additional 18 percent store their maize for more than a month before shelling. Days maize is stored before shelling is independent of gender (p=0.594) but dependent on zone (p=0.000). For example, whilst 31 percent of southern farmers prefer to store their maize for more than a month before shelling only 5 percent of northern farmers prefer to store their maize for more than a month before shelling. Moreover, more farmers in the Northern zone (26.3%) prefer to store their maize for about a week before shelling whilst only 11 percent of southern farmers prefer to store their maize for about a week before shelling. Southern farmers delay their shelling most probably because they are normally engaged in farming during the minor raining season and do not have the time to shell their maize until later, Second, they normally store their maize as cobs in ventilated cribs and shell as and when needed. Third, Farmers in the south have alternative farming activities because of the protracted raining season and availability of alternative income earning sources.

Northern farmers shell sooner after harvesting because they have to put the shelled maize into the traditional storage structures for safe keeping and/or shell quickly to sell to interested buyers due to the harsh economic conditions

Farmers were further asked if they dry their homestead maize before shelling or storing. About 62 percent of the farmers responded in the affirmative, however drying of homestead maize is independent of zone (p=0.057) and gender (p=0.650). The drying of maize before shelling and final storage is very critical if infection by fungal diseases such as *Aspergillus flavus* that produces Aflatoxin and severe grain losses should be avoided. Farmer need to know about these hidden causes of grain spoilage and quality deterioration and attention has to be paid to this during training of farmers in post-harvest loss reduction techniques. About 65% of the farmers try to protect their maize from losses after harvesting but this is not good enough. Efforts need to be made to train farmers to protect the harvest at this stage since the procedure for reducing such loses, which can be exacerbated by rainfall and moist conditions as well as pest and vermin attacks, is very simple and can be afforded by every farmer

3.5 Methods of Drying Maize in the Field and the House

3.5.1 Methods of maize drying

Table 14 summarizes the forms of maize drying among farmers. Most farmers dry their maize on clean cemented floor. Drying maize on clean cemented floor represent 40 percent of all the maize drying types mentioned by the farmers. Drying of maize on the stalk in the field (32%) and on a covered platform (32%) follows drying maize on a clean cemented platform. So in general, most of the farmers harvest and protect their produce safely out of the farm while the rest leave their maize to dry on the stalk in the farm. Leaving the cobs to dry in the field on the stalk over a long period is considered a bad practice that predisposes the maize to lodging, late pest infestation and increased exposure to the late rains.

Table 14: Methods of maize drying

Forms of maize drying	Count	% of Cases
Clean cemented floor	206	40%
Cob in a narrow crib loosely up to about 3 months	5	1%
On a covered platform	162	32%
On plastic sheets in a covered place	55	11%
On the stalk in the field	163	32%
Suspended in a storehouse	12	2%

Table 15 shows the various methods of maize drying by zone and gender. The results show that all 262 farmers in the Northern Zone and 251 farmers in the Southern Zone mentioned more than one maize drying method. Most northern zone farmers (64.5%) dried their maize on clean cemented floor whilst most Southern zone farmers dried their maize on a covered platform (49.8%).

Table 15: Methods of maize drying by zone and gender

Forms of maize drying	Northern Zone		Southern Zone		Female		Male		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
Clean cemented floor	169	64.50 %	37	14.70 %	96	38.20%	110	42.00 %	206	40.20%
Cob in a narrow crib loosely up to about 3 months	0	0.00 %	5	2.00%	3	1.20%	2	0.80 %	5	1.00 %
On a covered platform	37	14.10 %	125	49.80 %	72	28.70%	90	34.40 %	162	31.60%

On plastic sheets in a covered place	34	13.00 %	21	8.40%	26	10.40%	29	11.10 %	55	10.7 0%
On the stalk in the field	71	27.10 %	92	36.70 %	95	37.80%	68	26.00 %	163	31.8 0%
Suspende d in a storehous e	0	0.00 %	12	4.80%	4	1.60%	8	3.10 %	12	2.30 %

Most farmers dry their maize on a clean cemented floor (40.2%). A majority of farmers leave their maize on the stalk in the field to dry (31.8%). This is a bad practice since insect and pest could infest the produce on the field. The rest of the farmers iterated drying their maize on covered platforms (31.6%), on plastic sheets in a covered place (10.7%), suspended in a storehouse (2.3%) and on cob in a narrow crib loosely up to about 3 months (1%). The method of drying maize disaggregated by gender is presented in Table 15. The results show that both female and male farmers use more than one maize drying approach to dry their maize. The most common approach mentioned by both males and females include drying maize on a clean cemented floor, drying maize on a covered platform and drying maize on the stalk in the field. These three represent a larger percentage of the total responses from both male and female farmers. It appears that although many of the farmers are doing the right thing, there are still a lot of them who are not drying their maize safely and there is a need for training to sensitize all the farmers on how to reduce the losses during the drying process.

Table 16: Drying maize practices and losses

		Dry loss						
Drying maize practices	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
					Lower Bound	**Upper Bound**		
On the stalk in the field	108	10.6536	61.79854	5.94657	-1.1348	22.4420	0.00	597.10
Suspended in a storehouse	3	0.0000	0.00000	0.00000	0.0000	0.0000	0.00	0.00
On plastic sheets in a covered place	31	70.1966	178.83861	32.12036	4.5981	135.7951	0.00	665.34
On a covered platform	127	50.2974	185.78361	16.48563	17.6728	82.9219	-485.46	1293.00
Clean cemented floor	155	53.7398	223.16977	17.92543	18.3283	89.1513	0.00	2385.60

Cob in a narrow crib loosely up to about 3 months	3	46.9280	64.12980	37.02536	-112.3793	206.2353	0.00	120.00
More than one type	86	18.9006	48.02977	5.17918	8.6030	29.1982	0.00	271.46
Total	513	38.6167	164.15972	7.24783	24.3775	52.8558	-485.46	2385.60

Table 16 above details maize drying practices and losses, majority of farmers (155) prefer drying their maize on a clean cemented floor. This is closely followed by 127 farmers preferring to dry maize on a covered platform and 108 on the stalk in the field.

Table 17: Test of Homogeneity of Variances for Drying Losses

Test of Homogeneity of Variances					
Dry Loss					
Levene Statistic	df1	df2	Sig.		
3.939	6	506	.001		
ANOVA					
Dry Loss					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	206253.512	6	34375.585	1.280	.265
Within Groups	13591334.812	506	26860.345		
Total	13797588.324	512			

3.5.2 Methods of Shelling Maize

Table 18 summarizes the methods by which maize is shelled among farmers. A number of maize shelling methods were mentioned by the farmers. The results show that the 513 farmers mentioned at least one maize drying form. Most farmers (61%) shell their maize mechanically by using a sheller from a service provider. Traditional hand shelling is also commonly practiced among 38 percent of the farmers. Shelling maize mechanically represents a large percentage of all the maize shelling forms used by the farmers. This observation is not unexpected since the out-grower business model of ADVANCE provides a mechanism by which the farmers benefit from the shelling equipment owned by the nucleus farmer supported by the project.

Table 18: Methods of Shelling Maize

Methods of shelling maize	Count	% of Cases
Mechanized (owned or from a service provider)	312	61%

Semi-mechanical using hand-held equipment	49	10%
Traditional hand shelling	193	38%

Table 19 shows the various methods of maize shelling by zone. The results show that all 262 Northern Zone farmers and 251 Southern Zone farmers use more than one form for shelling their maize. Most Northern zone farmers (66%) shell their maize traditionally by hand whilst most Southern zone farmers (85.7%) shell their maize mechanically with a sheller from a service provider. The predominant method of shelling of maize in the southern zone is mechanized shelling whilst that of the northern zone is traditional hand shelling and this may be the result of the larger farm size and preponderance of private on-farm shelling services available. It could also be attributed to the two (2) farming seasons in the south as compared to one (1) season in the north.

Table 19: Methods of maize shelling by zone and gender

Forms of maize shelling	Northern Zone		Southern Zone		Female		Male		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
Mechanized (owned or from a service provider)	97	37%	215	85.70%	142	56.60%	170	64.90%	312	60.80%
Semi-mechanical using hand-held equipment	6	2%	43	17.10%	27	10.80%	22	8.40%	49	9.60%
Traditional hand shelling	173	66%	20	8.00%	96	38.20%	97	37.00%	193	37.60%

Methods of shelling of maize by gender, is also presented in Table 19. The results show that both female and male farmers used more than one maize shelling approach to shell their maize. The most common approach mentioned by both males (64.9%) and females (56.6%) is the mechanized shelling. This is followed by the traditional hand shelling (males 37.0%; females 38.2%). There is, therefore, not much difference in the methods used for shelling maize for males and females.

3.5.3 Estimated loss during shelling/winnowing

Table 20 summarizes estimated maize loss during storage in the homestead. More than 4 out of 5 farmers lose about 5 percent of their total harvest during shelling and winnowing. Only 1.2 percent lose more than 10 percent of their total harvest during shelling and winnowing. The likelihood ratio test (LR) revealed that loss during shelling and winnowing is independent of gender (p= 0.394) but dependent on a farmers location. For example, all farmers who loss more than 1.2 percent of their total harvest at winnowing were in the southern zone.

Table 20: Estimated loss during shelling

Maize Shelling/	Zone		Gender		Total
	Northern	Southern	Female	Male	
	LR = 9.127; p-value = 0.028		LR = 2.983; p-value = 0.394		
Below 5%	88.9%	84.9%	88.0%	85.9%	86.9%
Below 10%	11.1%	12.7%	11.2%	12.6%	11.9%
Below 15%	0.0%	1.6%	0.8%	0.8%	0.8%
Below 20%	0.0%	0.8%	0.0%	0.8%	0.4%

3.5.4 Form maize is stored on the farm and storage losses

There are three forms farmers store maize: with the husk, shelled, and on cob. Storage losses are measured in kilograms (kg). A one-way ANOVA test revealed that there is no statistically significant difference between the form farmers store maize and storage losses, F (2, 75) = 0.560, p=0.574. The effect size was computed as 0.015.

Table 21: Form maize is stored on the farm and storage losses

Form maize stored	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
De-husked/On Cob	6	67.6800	60.53702	24.71413	4.1503	131.2097	12.77	150.28
Shelled	13	42.1867	28.34464	7.86139	25.0582	59.3152	0.00	85.30
With Husk	59	50.0446	50.99289	6.63871	36.7558	63.3334	0.00	269.00
Total	78	50.0915	48.54362	5.49648	39.1466	61.0364	0.00	269.00

Table 22: Test of Homogeneity of Variances for Storage Losses

Test of Homogeneity of Variances						
Storage Loss						
Levene Statistic	df1	df2	Sig.			
1.588	2	75	.211			
ANOVA						

Storage Loss						
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**	
Between Groups	2668.579	2	1334.290	.560	.574	
Within Groups	178780.630	75	2383.742			
Total	181449.209	77				
Multiple Comparisons						
Dependent Variable:	Storage loss					
LSD						
(I) Q13		**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
De-husked/ On Cob	Shelled	25.49331	24.09678	.293	-22.5099	73.4966
	With Husk	17.63538	20.92111	.402	-24.0416	59.3124
Shelled	De-husked/ On Cob	-25.49331	24.09678	.293	-73.4966	22.5099
	With Husk	-7.85793	14.95885	.601	-37.6575	21.9416
With Husk	De-husked/ On Cob	-17.63538	20.92111	.402	-59.3124	24.0416
	Shelled	7.85793	14.95885	.601	-21.9416	37.6575

3.6 Processing of Maize

Table 23 summarizes the results of maize processing by farmers. Fisher's exact test revealed that maize processing was dependent on zone (p=0.000) but independent of gender (p=0.347). Most farmers in the Northern Zone (95.4%) process maize into other products than farmers in the Southern Zone (79.7%). Most of the processed maize is transformed into whole maize flour (52.0%) and corn dough (47.1%). The form in which the maize is

processed is dependent on the farmers location (p=0.000). Whilst most farmers in the Southern Zone prefer to process their maize into corn dough (89.5%), most farmers in the Northern Zone prefer to process their maize into whole maize flour (86.0%). This could be attributed to the kind of food mostly eaten in each of the zones. The Northern Zone farmers eat *tuozaafi* which is prepared with whole maize flour whilst the Southern Zone farmers prefer *banku* prepared from corn dough. However, a farmer's gender does not determine the form into which his or her maize is processed (p=0.995).

Most farmers (45.4%) process about 5 percent of their harvested maize whiles another 38 percent process more than 10 percent of their harvested maize. The quantity of maize processed is independent of gender (p=0.576) but dependent on zone (p=0.000). While 7 out of 10 farmers in the Northern Zone process above 10% of their maize, more than 7 out of 10 farmers in the Southern Zone process only about 5 percent of their maize produce.

Table 23: Maize Processing

Maize Processing	Zone		Gender		Total
	Northern	Southern	Female	Male	
Process maize into other products	Fisher's exact test = 0.000		Fisher's exact test = 0.347		
No	4.6	20.3	10.8	13.7	12.3
Yes	95.4	79.7	89.2	86.3	87.7
Products maize processed into	LR = 297.554; p-value = 0.000		LR = 0.010; p-value = 0.995		
Corn dough	13.2	89.5	46.9	47.3	47.1
Roasted corn meal	0.8	1.0	0.9	0.9	0.9
Whole maize flour	86.0	9.5	52.2	51.8	52.0
% of maize processed	Chi-square = 252.460; p-value = 0.000		Chi-square = 2.026; p-value = 0.576		
Less than 5%	4.6	7.6	6.4	5.7	6.0
About 5%	16.0	76.1	45.0	45.8	45.4
About 10%	9.5	12.4	12.7	9.2	10.9
Above 10- 15%	69.8	4.0	35.9	39.3	37.6

Figures in percentages

This could be due to differences in climatic conditions where farmers in the Northern Zone have only one major rainy season whiles farmers in the Southern Zone have two rainy seasons – major season and minor season. As a result, farmers in the Northern Zone have a tendency to process more of their harvested maize for household consumption. In all, it is observed that not much of the maize produced is processed into secondary products and this leaves the rest of the maize in storage, if the farmer has a surplus. Promotion of improved processing technologies and services to increase value addition and efficiency of processing activities has the potential to reduce the volume of maize that is exposed to conditions that increase post-harvest losses.

3.7 Maize Storage

From Table 24 and 25, most of the farmers (68.6%) own their storage facilities and these facilities are located mainly in the farmers' house (74.7%), on the farm (4.3%) and other locations (21.1%). 82.1% of farmers in the southern zone own storage facilities as compared to 55.7% in the northern zone. However there isn't much significant difference in the case of gender. 69.3% of female farmers own storage facilities as compared to 82.1% of their male counterparts.

Table 24: Ownership of storage facilities by farmers

Ownership of storage facility	Northern Zone		Southern Zone		Female		Male		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
No	116	44.3%	45	17.9%	77	30.7%	84	32.1%	161	31.4%
Yes	146	55.7%	206	82.1%	174	69.3%	178	67.9%	352	68.6%
Total	**262**	100%	**251**	100%	**251**	100%	**262**	100%	**513**	100%

Table 25: Location of farmers' storage facilities

Location of storage facility	Northern Zone		Southern Zone		Female		Male		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
In the house	185	70.61%	198	78.88%	184	73.31%	199	75.95%	383	74.66%
On the farm	0	0.00%	22	8.76%	12	4.78%	10	3.82%	22	4.29%
Other	77	29.39%	31	12.35%	55	21.91%	53	20.23%	108	21.05%
Total	262	100%	251	100%	251	100%	262	100%	513	100%

3.7.1 Long term storage facilities

From Table 26, home crib and mud silo are the most predominant storage facilities, depending on the zone. The rest are the following: Earthen Pot (1.0%), Home crib (27.1%), Insecticide impregnated sack (0.6%), Metal silo (0.2%), Mud silo (16.2%), Normal sack (10.3%), Open weave jute sack (cocoa sack) (4.9%), Other (33.9%), other hermetic grain sack (5.5%), PICS or triple sack (0.2%), Plastic silo/Poly tank (0.2%). The other structures mentioned include but are not limited to cemented room, cemented ventilated room, community maize market, community storage facility, community warehouse, covered with tarpaulin, veranda and living room.

Table 26: Types of long term storage facilities

Long term storage facilities	Northern Zone		Southern Zone		Female		Male		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
Earthen Pot	5	1.90%	0	0.00%	2	0.80%	3	1.10%	5	1.00%
Home crib	6	2.30%	133	53.00%	68	27.10%	71	27.10%	139	27.10%
Insecticide impregnated sack	1	0.40%	2	0.80%	1	0.40%	2	0.80%	3	0.60%
Metal silo	1	0.40%	0	0.00%	1	0.40%	0	0.00%	1	0.20%
Mud silo	16	6.10%	67	26.70%	35	13.90%	48	18.30%	83	16.20%
Normal sack	42	16.00%	11	4.40%	25	10.00%	28	10.70%	53	10.30%
Open weave jute sack (cocoa sack)	25	9.50%	0	0.00%	16	6.40%	9	3.40%	25	4.90%
Other	136	51.90%	38	15.10%	85	33.90%	89	34.00%	174	33.90%
Other hermatic grain sack	28	10.70%	0	0.00%	17	6.80%	11	4.20%	28	5.50%
PICS or triple sack	1	0.40%	0	0.00%	1	0.40%	0	0.00%	1	0.20%
Plastic silo/ Poly tank	1	0.40%	0	0.00%	0	0.00%	1	0.40%	1	0.20%
Total	262	100%	251	100%	251	100%	262	100%	513	100%

3.7.2 Condition of storage facility

From Table 27, only 26.7% of the storage facilities are in good condition, 61.4% are in fair condition and 11.9% are in poor condition. This characterizes the importance farmers place on the storage of their produce. Farmers would have to be sensitized to see the importance of keeping good storage facilities so store their maize to ensure longevity of the produce, thereby reducing post-harvest losses.

Table 27: Condition of storage facility

Condition of storage facility	Northern Zone		Southern Zone		Female		Male		Total	
	Count	%	Count	%	Count	Count	Count	%	Count	%
Fair	170	64.90%	145	57.80%	315	61.40%	161	61.50%	315	61.40%
Good	55	21.00%	82	32.70%	137	26.70%	73	27.90%	137	26.70%
Poor	37	14.10%	24	9.60%	61	11.90%	28	10.70%	61	11.90%
Total	**262**	**100%**	**251**	**100%**	**513**	**100%**	**262**	**100%**	**513**	**100%**

3.7.3 Capacity of storage facility

From Table 28, about half of the farmers (42.9%) have storage structures that can accommodate more than 50 - 100kg bags. The rest have structures that can accommodate less than 10 bags (6.6%), less than 50 bags (50.5%).

Table 28: Capacity of storage facility

Capacity of storage facility	Northern Zone		Southern Zone		Female		Male		Total	
	Count	%	Count	%	Count	Count	Count	%	Count	%
Less than 10 bags	14	5.30%	20	8.00%	20	8.00%	14	5.30%	34	6.60%
Less than 50 bags	143	54.60%	116	46.20%	142	56.60%	117	44.70%	259	50.50%
More than 50 bags	105	40.10%	115	45.80%	89	35.50%	131	50.00%	220	42.90%
Total	**262**	**100%**	**251**	**100%**	**251**	**100%**	**262**	**100%**	**513**	**100%**

3.7.4 Storage facility rental

From Table 29, it is not a common practice for farmers to rent storage facilities. Even though 31.4% do not own storage facilities only 5.5% rent storage facility services. This means that 25.9% of farmers do not entirely store their maize and perhaps sell their maize right after harvesting and drying.

Table 29: Storage facility rental by Zone and gender

Storage facility rental	Northern Zone		Southern Zone		Female		Male		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
No	260	99.2%	225	89.6%	242	96.4%	243	92.7%	485	94.5%
Yes	2	0.8%	26	10.4%	9	3.6%	19	7.3%	28	5.5%
Total	262	100.0%	251	100.0%	251	100.0%	262	100.0%	513	100.0%

3.7.5 Application of storage protectant

Table 30 below indicates that half the farmers use storage protectants and the other half do not. The storage protectants usually used are biological pesticides (neem extract, smoke, pepper etc.) (3.8%), chemical pesticide (actellic, etc.) (88.6%) and organic pesticide (7.6%).

Table 30: Application of storage protectant

Application of storage protectant	Northern Zone		Southern Zone		Female		Male		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
No	149	56.90%	128	51.00%	135	53.80%	142	54.20%	277	54.00%
Yes	113	43.10%	123	49.00%	116	46.20%	120	45.80%	236	46.00%

Total	**262**	**100%**	**251**	**100%**	**251**	**100%**	**262**	**100%**	**513**	**100%**

3.7.6 Period of maize storage

From Table 31, most farmers (68%) store their maize for more than 5 months after harvesting while 32% stored for less than 5 months. 3 months (16.8%), 4 months (4.3%) and about 5 months (10.9%).

Table 31: Period of maize storage

Length of storing maize	Northern Zone		Southern Zone		Female		Male		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
About 3 months	41	15.60%	45	17.90%	42	16.70%	44	16.80%	86	16.80%
About 4 months	2	0.80%	20	8.00%	11	4.40%	11	4.20%	22	4.30%
About 5 months	8	3.10%	48	19.10%	29	11.60%	27	10.30%	56	10.90%
More than 5 months	211	80.50%	138	55.00%	169	67.30%	180	68.70%	349	68.00%
Total	**262**	**100%**	**251**	**100%**	**251**	**100%**	**262**	**100%**	**513**	**100%**

3.8 Transportation and Marketing

From the results presented in Table 32, it is observed that most farmers (52.4%) do not transport their maize from the production area to outside market centers to sell their produce but keep the produce in storage. However, with regard to zone, more farmers in the Northern Zone (67.2%) are more likely to transport their maize outside their areas of production for sale as compared to their southern counterparts (27.1%). This implies that transportation of maize is dependent on zone (p=0.000) but not gender (p=0.064). The northern zone farmers generally, have their customers located in distant markets compared to the southern zone farmer.

The most common types of transportation among farmers are open trucks, donkey carts (and motorized tricycles (37.8%), individual-hired vehicle/truck (30.0%) and group hired vehicle to market centers (25.0%). How maize is transported is dependent on both zone (p=0.000) and gender (p=0.007). Whilst most Northern Zone farmers (61.1%) prefer to transport maize in open truck/donkey cart /motorized tricycles, most Southern Zone farmers (47.8%) prefer group hired vehicle to the market centres. The “Nnoboa”, practice in the south, which is a community-support mechanism for mutual assistance among farmer is very predominant in the south compared to the north. Both equal percentages of males (37.8%) and females (37.8%) prefer to transport their maize in open truck/donkey/motorized tricycles. The next preference of males is individual-hired vehicle/truck (34.4%) while the next preference of

females is group-hired vehicle to market centres. The group-hired vehicle allows farmers to enjoy economies of scale in the form of reduced price per bag of maize.

3.8.1 Packaging of maize for transport to the market

Maize is mostly transported in either new jute sacks (41.7%) or new synthetic (fertilizer) sacks (26.7%). The form maize is transported to the market is dependent on zone (0.000) and gender (p=0.035). The use of new jute sacks (59.0%) or new synthetic sacks (30.7%) is common among farmers in the Southern Zone than farmers in the Northern Zone (new jute sacks, 22.9%; new synthetic sacks, 22.9%). The use of used jute sacks (24.4%) and used synthetic (fertilizer) sacks (21.4%) is prevalent in the Northern zone than in the Southern Zone. Comparable observation can be made from the packaging of maize is transported to the market and gender. The use of new jute sacks (45.4%) and new synthetic (fertilizer) sacks (28.2%) was common among male farmers than female farmers. Although most farmers use new sacks, it is important to impress upon all farmers that using old sacks would increase the incidence of attacks by pests and diseases and hence increase post-harvest losses they encounter.

Table 32: Maize transport to the market and marketing

Is maize transported to markets outside production area for sales	**Zone**		**Gender**		**Total**
	Northern	**Southern**	**Female**	**Male**	
	Fisher's exact test = 0.000		Fisher's exact test = 0.064		
No	32.8	72.9	48.2	56.5	52.4
Yes	67.2	27.1	51.8	43.5	47.6
Type of transport used to get to market	Chi-square = 213.177; p-value = 0.000		Chi-square = 213.177; p-value = 0.007		
Group hired vehicle to market centres and covered	3.1	47.8	25.9	24.0	25.0
In opened truck/donkey/motor king etc	61.1	13.5	37.8	37.8	37.8
Individual hired vehicle/truck	22.9	37.5	25.5	34.4	30.0
Private passenger vehicle with mixed load	13.0	1.2	10.8	3.8	7.2
Form in which maize is transported to market	Chi-square = 121.863; p-value = 0.000		Chi-square = 10.329; p-value = 0.035		
In jute sacks (used)	24.4	2.4	13.9	13.4	13.6
Jute sacks (new)	25.2	59.0	37.8	45.4	41.7
Synthetic (fertilizer) sacks new	22.9	30.7	25.1	28.2	26.7
Synthetic (fertilizer) sacks used	21.4	2.4	16.3	8.0	12.1
Others	6.1	5.6	6.8	5.0	5.8
Loss from transporting maize to the market	Fisher's exact test = 0.373		Fisher's exact test = 0.545		
2 to 5%	98.5	97.2	98.4	97.3	97.9

5 to 10%	1.5	2.8	1.6	2.7	2.1
Types of losses observed during transportation to market	LR = 44.013; p-value = 0.000		LR = 4.876; p-value = 0.181		
Biodegradation	2.3	16.3	6.8	11.5	9.2
Mechanical	4.6	2.0	3.2	3.4	3.3
Physical spillage of grain	90.5	81.7	89.2	83.2	86.2
Physiological	2.7	0.0	0.8	1.9	1.4
Who buys your surpluses	LR = 85.482; p-value = 0.000		LR = 5.047; p-value = 0.282		
Aggregator/Warehousing agent	0.8	5.6	2.4	3.9	3.1
Consumer	44.4	10.8	31.9	23.9	27.8
Lead farmer	0.4	1.2	0.8	0.8	0.8
Market women/Retailer	54.4	81.3	64.1	71.0	67.6
Processor	0.0	1.2	0.8	0.4	0.6

Figures are in percentages

3.8.2 Post-harvest loss arising from transport to market

Most farmers (97.9%) lose 2 to 5 percent of their harvested produce during transportation of maize to the market. This observation is ubiquitous with both zones (p=0.373) and gender (p=0.545). More than 9 out of 10 farmers in both Northern and Southern zones lose 2 to 5 percent of their harvested produce during transportation of maize to the market. More than 9 out of 10 males and lose 2 to 5 percent of their harvested produce during transportation of maize to the market.

3.8.3 Types of losses observed during transportation to market

The most common type of loss observed during transportation of maize to the market is physical spillage of grains from burst sacks (86.2%). Few farmers' lose maize through biodegradation[4] (9.2%) and mechanical[5] (3.3%). Type of maize loss during transportation to the market is independent of gender (p=0.282) but dependent on zone (p=0.000). More farmers in the Northern Zone (90.5%) lose maize through physical spillage of grain than Southern Zone farmers (81.7%). Additional 16.3 percent of farmers in the Southern Zone lose maize during transportation to the market centre though biodegradation mainly because of moist conditions in that zone.

3.8.4 Purchasers of farmers' surpluses

From Table 32, farmers' surpluses are mainly purchased by market women (67.6%) and consumers (27.8%). Purchasing of farmers' surpluses is independent of gender (p=0.285) but dependent on the location of the farmer (p=0.000). More than 80% farmers in the Southern

[4]Biodegradation is caused by bacteria, fungal, pest/insect infestation on account of poor drying, high temperature, poor ventilation and high humidity.

[5]Mechanical damage to maize during transportation to market center include broken/cracked, rains, cracked grains and pitted grains from insect and other pest damages.

Zone have their maize surpluses purchased by market women whilst 54.4 percent of farmers in the Northern Zone have their maize surpluses purchased by market women. Additional 44.4 percent of Northern Zone farmers have their maize surpluses purchased by consumers.

3.8.5 Form of transportation and transportation losses

In transporting harvested maize from the farm to homestead, farmers use either one type of transportation or multiple forms. The transportation forms include head potting, donkey carts, use of motor king, use of tractor and a combination of any of these forms. A one-way ANOVA test revealed that there is no statistically significant difference between the form of transportation used to cart harvested produce to homestead and transportation losses (measured in kg), $F(4, 505) = 0.456$, $p=0.768$. The effect size was computed as 0.004.

Table 33: Transportation loss and form of transportation

Form of transportation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
More than one form	117	41.4454	64.54067	5.96679	29.6274	53.2634	-566.37	240.55
Head potting only	83	40.1374	26.33302	2.89042	34.3874	45.8874	0.00	119.97
Donkey carts only	22	51.5211	26.34663	5.61712	39.8397	63.2026	0.00	106.45
Motor king only	69	45.4756	26.64142	3.20725	39.0756	51.8755	0.00	166.85
Tractor only	219	40.4308	43.47145	2.93753	34.6412	46.2204	0.00	395.40

Table 34: Test of Homogeneity of Variances for Transportation Loss and Forms of Transportation

Test of Homogeneity of Variances					
Transport Loss					
Levene Statistic	df1	df2	Sig.		
.146	4	505	.965		
ANOVA					
Transport Loss					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	3665.612	4	916.403	.456	.768
Within Groups	1014869.042	505	2009.642		
Total	1018534.654	509			

3.9 Post-harvest Management Information

In agriculture, post-harvest handling is the stage of crop production immediately following harvest, including drying, shelling, bagging, storage and transport. The most important goals of post-harvest handling are keeping the product safe and avoiding physical damage such as bruising, to delay spoilage. Sanitation is also an important factor, to reduce the possibility of pathogens, vermin and insects. It is important to have a sense of the level of information that famers in the ADVANCE project have received and their level of knowledge of post-harvest loss reduction information and technologies.

3.9.1 Farmers Knowledge and Support received from ADVANCE

3.9.1.1 Farmers' agricultural training

A quarter of all farmers (25.7%) have received formal training in agricultural production indicating that farmers' level of knowledge is low. Generally, male farmers have more training and knowledge in agriculture than female farmers (p=0.000). From Table 35 whilst 67 percent of male farmers have knowledge in agricultural production only 18 percent of female farmers have received formal training in agricultural production. Most of the farmers have not been formally trained in agriculture production and so there is an opportunity to provide basic training to them in good agricultural practices as well as in post-harvest management to supplement their practical knowledge.

3.9.1.2 Support received from ADVANCE

About 55 percent of the farmers reported receiving direct support from ADVANCE with more males (58.0%) receiving support than females (51.8%). More farmers in the Northern Zone (61.5%) had received support from ADVANCE than farmers in the Southern Zone (48.2%) as seen in Table 35. This may be due to the more intensive targeting of farmers in the northern zone by the ADVANCE project.

Table 35: Farmers Knowledge and Support received from ADVANCE by Gender and Zone

Variables	Zone		Gender		Total
	Northern	Southern	Male	Female	
Farmers Knowledge in Agriculture	Fisher's exact = 0.000		Fisher's exact = 0.000		
No	89.3	58.6	33.2	82.1	74.3
Yes	10.7	41.4	66.8	17.9	25.7
Received Support from ADVANCE	Fisher's exact = 0.003		Fisher's exact = 0.183		
No	38.5	51.8	42.0	48.2	45.0
Yes	61.5	48.2	58.0	51.8	55.0

3.9.1.3 Types of support received from ADVANCE

Table 36 summarizes the types of support from ADVANCE technical assistance received by farmers by zone. The results show that the 513 farmers mentioned at least one technical

assistance or support received. Most farmers (86.2%) mentioned receiving extension services or technology transfer. Extension services or technology transfer represent a large percentage of all the types of technical assistance or support received by farmers. Material benefits in the form of supply of seed, fertilizer, inputs construction materials was also mentioned by 108 farmers (21.1%) as the next type of support received by the farmers after extension services. The least type of support provided to farmers was financial assistance (3.7%) and access to storage facility or infrastructure (1.2%). Other data from Table 36 indicate that the farmers did not receive any specific training on post-harvest loss reduction and management.

Table 36: Types of Support Received

Types of Support	Count	% of Cases
Access to storage facility/infrastructure	6	1.2%
Coaching	60	11.7%
Extension services / Technology transfer	442	86.2%
Funding	19	3.7%
Market Access	24	4.7%
Material benefits (Supply of seed, fertilizer, inputs construction materials)	108	21.1%

Table 37 shows the types of technical assistance received by farmers by zone. Most farmers in both the Southern (90%) and Northern (82.4%) zones mentioned extension services or technology transfer as the most support received. This is followed by material benefits in the form of seed supply, fertilizer and inputs construction materials (Northern, 31.7%; Southern, 10%). The least type of assistance provided to farmers was financial assistance or funding (Northern, 4.6%; Southern, 2.8%), access to storage facility or infrastructure (Northern, 1.1%; Southern, 1.2%) and access to market (Northern, 1.9%; Southern, 7.6%).

Table 37: Types of Support Received by Zone

Types of Support	Northern		Southern	
	Count	% in zone	Count	% of Cases
Access to storage facility/infrastructure	3	1.1%	3	1.2%
Coaching	41	15.6%	19	7.6%
Extension services / Technology transfer	216	82.4%	226	90.0%
Funding	12	4.6%	7	2.8%
Market Access	5	1.9%	19	7.6%
Material benefits (Supply of seed, fertilizer, inputs construction materials)	83	31.7%	25	10.0%

3.9.1.4 Types of support received by gender

Different types of support received by farmers by gender are presented in Table 38. The results show that all 251 female farmers and 262 male farmers mentioned more than one type

of support received. Most female (89.6%) and male (82.8%) farmers mentioned extension services or technology transfer as the most received technical assistance or support received. This is followed by material benefits in the form of seed supply, fertilizer and inputs construction materials (females, 17.5%; males, 24.4%). The least type of assistance received by both male and female farmers was access to storage facility or infrastructure (1.5% and 0.8% respectively).

Table 38: Types of Support by Gender

Types of Support	Female		Male	
	Count	% in Gender	Count	% in Gender
Access to storage facility/infrastructure	2	0.8%	4	1.5%
Coaching	30	12.0%	30	11.5%
Extension services / Technology transfer	225	89.6%	217	82.8%
Funding	8	3.2%	11	4.2%
Market Access	11	4.4%	13	5.0%
Material benefits (Supply of seed, fertilizer, inputs construction materials)	44	17.5%	64	24.4%

3.9.1.5 Frequency of Technical Financial and post-harvest Training

Table 39 summarizes the frequency of training, post-harvest training and training provider by zone and gender. Respondents were asked how often they receive technical assistance. Most farmers (70.8%) mentioned receiving irregular technical training assistance whilst only 18.3 percent mentioned receiving regular technical assistance. The remaining 10.9 percent received a special one off package. A similar trend was observed among both male and female farmers. Frequency of technical assistance received was independent of gender (p=0.172). However, frequency of technical assistance received was found to be associated with the zone in which a farmer is located (p=0.003). Southern farmers received more regular (21.1%) and a special one off package (14.7%) technical assistance than Northern farmers (regular, 15.6%; special one off package, 7.3%). Financial assistance received by farmers has been irregular (56.8%) and a special one off package (41.4%). A likelihood ratio (LR) chi-square test revealed that frequency of financial assistance received is independent of gender (p=0.892) but dependent of zone (p=0.000). Whilst more farmers in the northern zone (70.9%) received irregular financial assistance, more farmers in the southern zone (50.2) received a special one off financial assistance package. There is an opportunity to increase the regularity of provision of technical assistance to the farmers in the project areas.

3.9.2 Post-harvest Management Training

About 60% of the farmers agreed that they (60.6%) have received training in post-harvest management. However, more males (65.3%) received post-harvest training (p=0.030) as compared to the 55.8% of females receiving the post-harvest management training. There was no association between the zone in which a farmer resides and receiving post-harvest

management training. Training of farmers in post-harvest management has mainly been provided by ADVANCE (63.2%) and MOFA (28.1%). A farmer's location determines the training provider for post-harvest management training (p=0.000). More than 85% of farmers in the Northern Zone received their training in post-harvest management from ADVANCE whilst 49.2% of farmers in the Southern Zone received their training in post-harvest management from MOFA. Providers of training in post-harvest management is independent of gender (p=0.502). More than half (55%) of the farmers have also received training in the use of grain storage chemicals. Training in the use of grain storage chemicals was dependent on zone (p=0.005) and gender (0.026). More farmers in the Southern Zone (61.4%) received training in the use of grain storage chemicals than farmers in the Northern Zone (48.9%).

Table 39: Frequency of training, Post-harvest training and Training Provider by Zone and Gender

Technical Training and Assistance	Zone		Gender		Total
	Northern	**Southern**	**Female**	**Male**	
Frequency of technical assistance received	**Chi-square = 11.718; p-value = 0.003**		**Chi-square = 3.516; p-value = 0.172**		
A special one off package	7.3	14.7	13.5	8.4	10.9
Irregular	77.1	64.1	68.9	72.5	70.8
Regular	15.6	21.1	17.5	19.1	18.3
Frequency of financial assistance received	**LR = 24.737; p-value = 0.000**		**LR = 0.228; p-value = 0.892**		
A special one off package	25.4	50.2	42.4	40.4	41.4
Irregular	70.9	49.0	56.0	57.5	56.8
Regular	3.7	0.8	1.6	2.1	1.9
Received training in post-harvest management?	**Fisher's exact test = 0.786**		**Fisher's exact test = 0.030**		
No	40.1	38.6	44.2	34.7	39.4
Yes	59.9	61.4	55.8	65.3	60.6
Provider of Post-harvest training	**LR = 97.285; p-value = 0.000**		**LR = 4.480; p-value = 0.345**		
ADVANCE	87.2	39.0	65.5	61.4	63.2
Cooperative	0.0	1.9	0.0	1.8	1.0
MoFA	7.1	49.4	26.6	29.2	28.1
Other donor-funded projects	5.8	5.8	6.5	5.3	5.8
Other farmer	0.0	3.9	1.4	2.3	1.9
Received training in the use of grain storage chemicals?	**Fisher's exact test = 0.005**		**Fisher's exact test = 0.026**		
No	51.1	38.6	50.2	40.1	45.0
Yes	48.9	61.4	49.8	59.9	55.0
Provider of grain storage training	**Chi-square 107.721; p-value = 0.000**		**Chi-square 4.737; p-value = 0.315**		
ADVANCE	82.8	24.0	52.8	49.0	50.7
Cooperative	0.0	3.9	1.6	2.5	2.1
MoFA	6.3	52.6	31.2	31.8	31.6

Other donor-funded projects	6.3	4.5	2.4	7.6	5.3
Other farmer	4.7	14.9	12.0	8.9	10.3

Figures are in percentages

Similarly, more male farmers (59.9%) received training in the use of grain storage chemicals than female farmers (40.1%). Providers of training in the use of grain storage chemicals is dependent of zone (p=0.000) but independent of gender (p=0.315). Whilst most of the training in the use of grain storage chemicals was provided by ADVANCE (82.8%) in the Northern Zone, the Southern Zone training was mostly provided by MOFA (52.6%) More than half (55%) of the farmers have also received training in the use of grain storage chemicals. About 40% of the farmers interviewed indicated that they have not received any explicit training in post-harvest loss management and this number is quite high. There is a need to increase the coverage of farmers to benefit from this training.

3.10 Post-Harvest Losses

3.10.1 Stages where loss is experienced

From Table 40, farmers indicated that the harvesting stage is where they thought most losses occurred (54%) against drying 4%, harvesting 54%, shelling 22%, storage 15%, transport to market 1% and transporting before storage 3%.

Table 40: Stage at which most loss is experienced

Stage at which most loss is experienced	Northern Zone		Southern Zone		Female		Male		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
Drying	4	2%	15	6%	7	3%	12	5%	19	4%
Harvesting	143	55%	132	53%	127	51%	148	56%	275	54%
Shelling	53	20%	61	24%	55	22%	59	23%	114	22%
Storage	51	20%	26	10%	49	20%	28	11%	77	15%
Transport to market	0	0%	7	3%	5	2%	2	1%	7	1%
Transporting before storage	7	3%	9	4%	8	3%	8	3%	16	3%

Storage, shelling and harvesting losses were found to be higher in the northern zone as compared to shelling and harvesting in the south. In the case of gender, females recorded relatively higher losses in storage and transport to market and lower losses in drying, harvesting and shelling as compared to their male counterparts. In the case of transporting before storage, both gender groups recorded 2% loss.

3.10.2 Estimated Relative Maize Losses

Data was collected on the percent grain loss at each stage in the post-harvest chain (harvesting, transportation, drying, shelling and storage). The percentage loss was multiplied by the average production per farmer for the 2015 maize season to obtain the estimated relative losses at the various stages. Table 41 summarizes the estimated relative losses at the various stages and disaggregated by Zone and gender. The estimated total loss of 18.5 % per acre is obtained. Generally, estimated losses in both zones were observed to be relatively low at all the stages. However, the shelling stage recorded the highest losses in both zones at 6.45% and 4.94% for the northern and southern zone respectively, whiles the least losses of 2.23% and 1.60% were recorded at the harvesting stage for the northern and southern zones respectively. It is also observed that losses at the storage stage are equally high after the shelling stage in both zones with the value of 5.35% and 3.25% for the northern and southern zones respectively.

Summaries of estimated losses related to gender show that both male and female recorded their highest losses at the shelling stage, though the males recorded slightly higher value of 5.78% and 5.64% respectively. The least loss of 2.25% for males was recorded at the harvesting stage, while the female 1.58% was also recorded at the harvesting stage.

Table 41: Estimated relative losses at various stages disaggregation by Zones and Gender

Stage of loss	Estimated relative loss at various stages per Acre									
	Male		Female		Northern Zone		Southern Zone		Total	
	wt.(kg)	%wt. loss	wt. (kg)	%wt. loss	wt. (kg)	%wt. loss	wt. (kg)	%wt. loss	wt. (kg)	%wt. loss
Harvesting	27.26	2.25	19.18	1.58	27.06	2.23	19.38	1.60	23.31	1.92
Transporting	43.21	3.56	40.23	3.31	45.71	3.77	37.62	3.10	41.75	3.44
Drying	39.66	3.27	37.53	3.09	43.72	3.60	33.29	2.74	38.62	3.18
Shelling	70.17	5.78	68.46	5.64	78.28	6.45	60.00	4.94	69.33	5.71
Storage	54.90	4.52	49.88	4.11	64.95	5.35	39.40	3.25	52.45	4.32
Total	**235.20**	**19.37**	**215.28**	**17.73**	**259.71**	**21.39**	**189.69**	**15.63**	**225.45**	**18.57**

*** Data obtained from field survey**

Table 42: Hypothesis Testing

Stage of Loss	Wt. (kg)		Wt. (%)	
	Gender	Zone	Gender	Zone
Harvesting	0.001	0.014	0.084	0.029
Transportation	0.526	0.130	0.093	0.399
Drying	0.225	0.080	0.652	0.582
Shelling	0.091	0.043	0.032	0.664
Storage	0.195	0.023	0.544	0.085

3.10.3 Estimated Relative Maize Losses from Visual Scale Generated Information

Table 43 summarizes the results of the respondents who used the visual scale in the loss assessment of their maize samples on zonal, and gender basis. In the Northern Zone the

majority of 100% or almost all respondent surveyed had Class 1 grain quality; 44% for female and 56% in the case of male. In the results were the same, but the majority of 48% female was higher than in the North, but majority of 52% males who scored were less than their male counterparts in the North with class 1. Nevertheless the picture showed the dominance in the loss for class 1, of 54.2% male over 45.8% for female counterparts within the two zones.

Class 2 losses were also observed and recorded, intra and inter zones. In the North, this class recorded 47.4% of the female, whiles 52.6% of the male surveyed score an estimated loss corresponding to class 2. Similarly, in the South, 57% and 52% of the female and male surveyed also scored an estimated loss in category Class 2. However, the % respondents that belong to this class are higher, 57% against 47.4% female, but lower, 52% against 52.6% compared to the North.

For Class 3, it is observed that the estimated loss achieved among all the respondents surveyed with the visual scale. In the North, the highest loss was recorded among 66.7% of the female relative to that of 33.3%. In the south, the highest loss recorded among 63.2% of the female whiles only 36.8% of the male recorded loss in class 3. For Class 4, there was no loss estimates recorded in neither of the two Zones nor among the gender respondents surveyed. None of the respondents observed had his/her estimated losses in the class 4 category.

Table 43: Visual scale loss classification by zone and gander

Using the visual scale aid the farmer in grading the sampled maize						
				Choose gender		Total
				Female	Male	
Class 1	ZONE	NORTHERN	Count	59	75	134
			% within ZONE	44.0%	56.0%	100.0%
			% within Choosegender	54.6%	58.6%	56.8%
			% of Total	25.0%	31.8%	56.8%
		SOUTHERN	Count	49	53	102
			% within ZONE	48.0%	52.0%	100.0%
			% within Choosegender	45.4%	41.4%	43.2%
			% of Total	20.8%	22.5%	43.2%
	Total		Count	108	128	236
			% within ZONE	45.8%	54.2%	100.0%
			% within Choosegender	100.0%	100.0%	100.0%
			% of Total	45.8%	54.2%	100.0%
Class 2	ZONE	NORTHERN	Count	45	50	95
			% within ZONE	47.4%	52.6%	100.0%
			% within Choosegender	44.1%	49.0%	46.6%

			% of Total	22.1%	24.5%	46.6%
		SOUTHERN	Count	57	52	109
			% within ZONE	52.3%	47.7%	100.0%
			% within Choosegender	55.9%	51.0%	53.4%
			% of Total	27.9%	25.5%	53.4%
	Total		Count	102	102	204
			% within ZONE	50.0%	50.0%	100.0%
			% within Choosegender	100.0%	100.0%	100.0%
			% of Total	50.0%	50.0%	100.0%
Class 3	ZONE	NORTHERN	Count	10	5	15
			% within ZONE	66.7%	33.3%	100.0%
			% within Choosegender	45.5%	41.7%	44.1%
			% of Total	29.4%	14.7%	44.1%
		SOUTHERN	Count	12	7	19
			% within ZONE	63.2%	36.8%	100.0%
			% within Choosegender	54.5%	58.3%	55.9%
			% of Total	35.3%	20.6%	55.9%
	Total		Count	22	12	34
			% within ZONE	64.7%	35.3%	100.0%
			% within Choosegender	100.0%	100.0%	100.0%
			% of Total	64.7%	35.3%	100.0%
Class 4	ZONE	SOUTHERN	Count		1	1
			% within ZONE		100.0%	100.0%
			% within Choosegender		100.0%	100.0%
			% of Total		100.0%	100.0%
	Total		Count		1	1
			% within ZONE		100.0%	100.0%
			% within Choosegender		100.0%	100.0%
			% of Total		100.0%	100.0%
Class 6	ZONE	SOUTHERN	Count	1	2	3
			% within ZONE	33.3%	66.7%	100.0%
			% within Choosegender	100.0%	100.0%	100.0%
			% of Total	33.3%	66.7%	100.0%
	Total		Count	1	2	3
			% within ZONE	33.3%	66.7%	100.0%
			% within Choosegender	100.0%	100.0%	100.0%
			% of Total	33.3%	66.7%	100.0%
Total	ZONE	NORTHERN	Count	114	130	244
			% within ZONE	46.7%	53.3%	100.0%
			% within Choosegender	48.9%	53.1%	51.0%

			% of Total	23.8%	27.2%	51.0%
		SOUTHERN	Count	119	115	234
			% within ZONE	50.9%	49.1%	100.0%
			% within Choosegender	51.1%	46.9%	49.0%
			% of Total	24.9%	24.1%	49.0%
	Total		Count	233	245	478
			% within ZONE	48.7%	51.3%	100.0%
			% within Choosegender	100.0%	100.0%	100.0%
			% of Total	48.7%	51.3%	100.0%

For Class 5, no respondent in the North had losses recorded in this class 5. On the contrary estimated losses of 33.3% and 66.7% attributed to the female and male respondents respectively in the Southern zone were recorded in this class 5.

Class 6 represents the worst scenario in the estimated loss due to bio-degradation or insect/pest infestation. In this class is found a high number of respondents registering estimated losses in both the North and Southern Zones as well as within the genders. In the North, the estimated losses in this category by gender female and male are 46.7% and 53.3% respectively. On the contrary estimated losses in the south attributed to the relative proportion female and male respondents was 50.9% and 49.1%. Comparing the gender impact between the two zones, the North has a relatively higher female respondent in this class than the male. However the reverse is the situation in the Southern zone.

In an attempt to calculate the relative losses that occur using the visual scale, data on the various stages was inexistent since farmers could not recall the grade of the maize for all of these stages. These estimates would have appeared to be very low and not consistent with the general observations. There were several problems associated with the use of this methodology for estimating losses including inexistent of data since this was not collected from farmers as these operations were performed.

4 LEVERAGING THE ADVANCE PROJECT'S INTERVENTIONS TO PROMOTE POST-HARVEST LOSS REDUCTION OF ITS TARGET SMALLHOLDER FARMERS

4.1 DEMONSTRATING THE IMPACT OF ADVANCE INTERVENTIONS ON POST-HARVEST LOSES OF ITS TARGET SMALLHOLDER FARMERS

4.1.1 Overview of the ADVANCE project's Nucleus Farmer (NF)/Out-grower Business (OB) Model

There are various constraints facing agricultural development in Ghana which is characterized by an on-going struggle to attain food security, higher incomes and the search for ways to increase production and productivity and reduce post-harvest losses that are known to be very high among all crop-categories. Most of the strategies and interventions provided by ADVANCE, using the out-grower business model promote practices that can be leveraged to promote post-harvest loss reduction technologies. Under the NF/OB model, out-growers are linked to NFs, aggregators and/or processors that have standing relationships across the value chains in which they operate. NF/OBs are direct beneficiaries of the promotion and dissemination of improved agronomic practices through ADVANCE'S interventions, a model that allows for a broad audience of out-growers to indirectly benefit in turn. These relationships and linkages serve to provide both the NF/OBs and the out-growers with the various services required to strengthen their production, productivity, and income.

They also serve to provide opportunities for NFs/OBs to provide training in harvesting, post-harvest handling, enhance access to credit for improving post-harvest infrastructure at the farm-level and, through the buy-back arrangements, ensure quick evacuation of produce from farmers and thereby reduce the high post-harvest losses due to poor storage at the farmers' level.

ADVANCE is leveraging this NF/OB model as a means to directly access and strengthen robust systems in which out-growers and NF/OBs cooperate to mutual benefit – out-growers able to boost their production and NFs or OBs able to increase profits by serving as aggregation points or technical assistance providers. As for-profit enterprises with revenue relying in whole or in part on the yields generated by their out-growers, NF/OBs have an ongoing incentive to provide high quality services, including the introduction of post-harvest loss-reduction technologies to their out-growers, allowing for a virtuous cycle able to increase efficiency across the agricultural value chain within these systems. ADVANCE strengthens these systems by 1) refining or improving the quality and types of technical assistance provided by the OBs and NFs – such as demonstrating improved varieties or more efficient and effective agronomic techniques (e.g., burying fertilizer rather than broadcasting) and 2) building into the system additional linkages from across the agricultural value chain, such as financial intermediaries, agro-processing facilities, commodity storage facilities or

warehouses, or new markets all of which could have and impact of post-harvest loss reduction.

Figure 1 below is an example that illustrates the various relationships at play between SHFs, NF/OBs, and relevant service providers or value chain actors operating within the model.

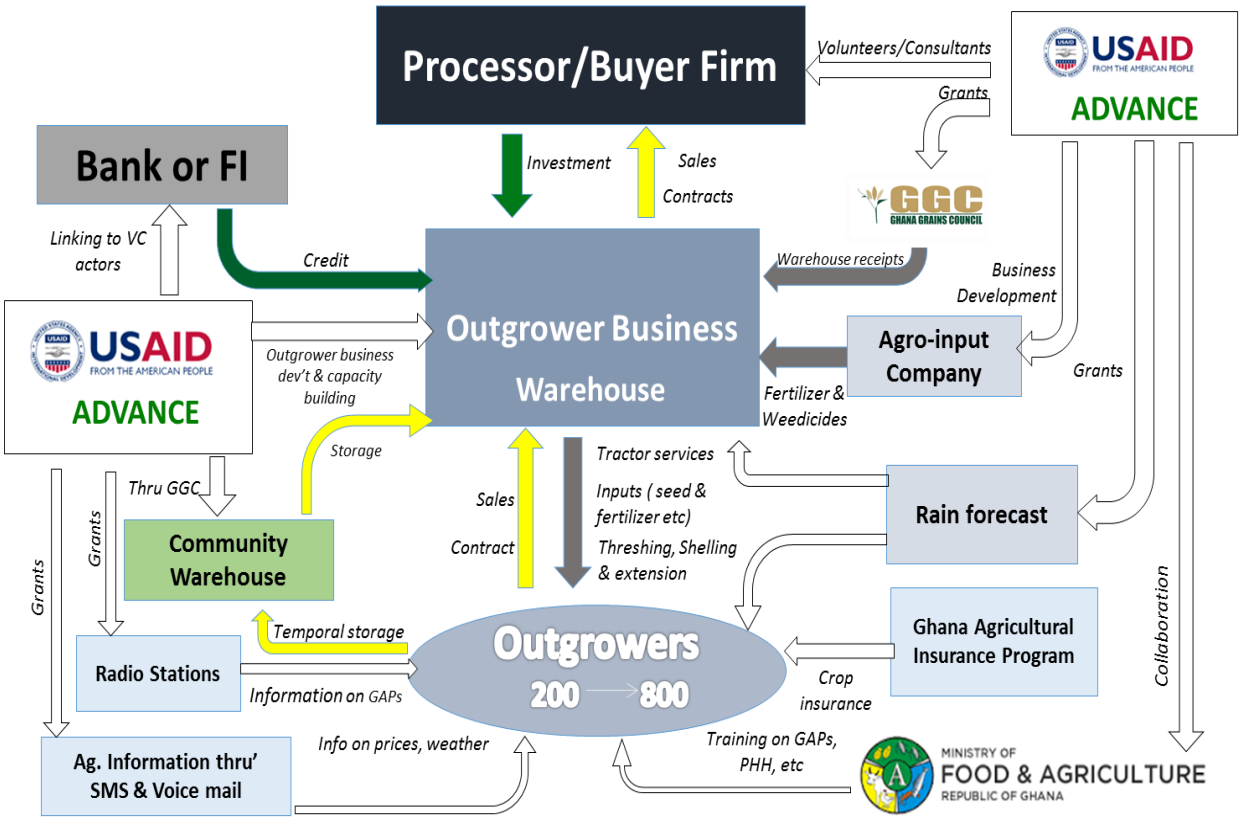


Figure 1: Out-grower Business (OB) Model

Specifically, ADANCE's use of the NF (Nucleus Farmer)/OB model enables provision of targeted support across the agricultural value chain. These strategies, which could be leveraged to promote post-harvest management by smallholder-farmers, are the following:

1. Promoting integrated approach to agricultural interventions;
2. Increasing access to information;
3. Strengthening extension services;
4. Increasing access to and availability of agricultural mechanization;
5. Increasing access to and availability of agricultural credit;
6. Linking farmers to markets (Marketing) and
7. Improving dissemination of agricultural and processing technologies.

These strategies are discussed in detail:

Promoting integrated approach to delivery of agricultural interventions: The limited or non-provision of integrated agricultural services is a key factor that has greatly hindered agricultural development in Ghana. Integrating interventions provide a holistic strategy for removing key constraints in the crops value chain.

Increasing access to information: Agriculture is an information-dependent sector, with emerging and rather complex problems that farmers face on a daily basis. Often, the agricultural systems in which SHFs operate are not sufficiently robust to ensure that out-growers have the information they need in a timely manner. The primary information needs of SHFs include effective management of problems such as pest threats, weed control, moisture insufficiency, soil fertility, farm credit and high post-harvest loses.

Strengthening extension services: Limited awareness among SHFs regarding new agricultural innovations, proper use of agricultural inputs, improved post-harvest loss reduction or agronomic best practices can be attributed in part to limited access to information and high levels of illiteracy. Commonly, a key service to combat such constraints is the availability of agricultural extension services. ADVANCE is using a strategy for bridging literacy and/or numeracy gaps and conveying the essential information farmers need in a meaningful and digestible form via demonstrations and field training by OBs, to provide these extension services to their out-growers.

Increasing access to and availability of agricultural mechanization: ADVANCE is implementing interventions to increase access to agricultural technology for SHFs helps minimize the drudgery of farm tasks and to improve their overall operations. To maximize gains from technological alternatives farmers need information about available technologies to support cultivation, fertilizing, pest control, harvesting and post-harvest management.

Increasing access to and availability of agricultural credit: Agricultural credit encompasses all funds (loans, credit lines, and advances) granted to borrowers to support undertakings anywhere along the agricultural value chain, including procurement and use of agricultural inputs or equipment, expanding agro-processing capacity, boosting marketing efforts, supporting storage capabilities, and/or distribution of produce and finished goods. Although SHFs are among the potential beneficiaries of agricultural credit, they are typically considered high risk by institutions that offer such services, and consequently oftentimes do not receive the benefits of these services. The OB model enables out-growers to have access to credit through their associated out-grower businesses.

Improving postharvest handling – agro-processing and storage: One of the primary contributors to agricultural losses, or a failure to realize full benefits from agricultural production, is the lack of availability of adequate post-harvest agro-processing and/or storage facilities. Without access to proper post-harvest services, crops may be destroyed by vermin, insect pests and/or diseases and smallholder farmers may be forced to rely on informal

marketplaces and/or middlemen to sell their produce at well below value to avoid taking a total loss. By contrast, the model being used by ADVANCE to increase availability of—or access to—agricultural processing facilities creates formal buyers for agricultural produce, increase prices for SHFs. Similarly, storage facilities can offer a service—allowing SHFs store their production until market conditions are more favorable or can likewise serve as another formal buyer, using storage capacity as a means to aggregate and resell to commercial buyers interested in bulk purchase. The NF/OB model's support helps strengthen existing linkages between SHFs and OBs such as agro-processors and storage facilities by helping SHFs develop higher quality products that, in turn, result in higher quality produce sold by the OBs. Where these linkages don't exist, ADVANCE'S work within the NF/OB model allows for identification of those gaps and discovery of opportunities to eliminate those gaps.

Linking farmers to markets - Increased marketing: Market information services systematically and continuously collect and process market data, and make this data available to market participants in a form relevant to their decision making. SHFs generally lack access to adequate or efficient storage and processing facilities and struggle to access markets and distribute and market their produce. Increased access to agricultural market information provided by ADVANCE through the OB model enable the SHFs to make rational and relevant decisions for their enterprise. Invariably, improved marketing is one of the best strategies for reducing post-harvest loses of farmers.

Improving dissemination of agricultural and processing technologies: There are many innovative agricultural and post-harvest management technologies available in Ghana. These existing innovations are capable of boosting the SHF's agricultural production, productivity and post-harvest handling if introduced in a way that leads to sustainable adoption by the farmers. Investing in new agricultural technologies or planting new seed varieties is often an essential step in order for SHFs to be successful. Unfortunately, most of these innovations do not reach the farmer's field due to a lack of effective dissemination. The ADVANCE OB model seeks to increase the dissemination of these technologies and the effort could be intensified

4.2 ADVANCE INTERVENTIONS

Most of these strategies listed could and do have both direct and indirect effects on the level of post-harvest loses experienced by small-holder farmers who receive assistance from the ADVANCE project. The key activities and core agricultural practices encouraged and implemented by ADVANCE through the NF/OB model and their linkage to post-harvest loss reduction are shown in the matrix below:

Table 44: Advance Interventions and Relationship with Post-Harvest Loss Reduction

ADVANCE INTERVENTIONS	**RELATIONSHIP WITH POST-HARVEST MANAGEMENTPOST-HARVEST LOSS REDUCTION *(Harvesting, transporting, drying, shelling, storage, transport to market)***
Provision of technological packages (e.g., improved seed varieties, improved fertilizers, innovative/improved fertilizer application techniques, or other best/improved agronomic practices) to mitigate the effects of climate change, decreased soil fertility, or poor agronomic techniques;	Technological packages that are provided to improve productivity also have components that improve the harvesting, drying, shelling and safe storage of produce
Establishment of demonstration plots and field trials for testing the performance of seeds and ISFM;	The establishment of demonstrations also offers the opportunity to show good harvesting and post-harvest practices and effective post-harvest and storage infrastructure.
Provision of grants to businesses to safely bulk-up crop varieties and/or NF/OBs in procurement of efficient processing equipment (e.g., shellers, huskers);	Enables farmers to improve their post-harvest activities and storage facilities and to add value as well as process their farm produce to reduce storage loses.
Capacity building in technical and managerial skills, including improved agricultural practices and entrepreneurship training;	Serves to increase the farmers' skills in managing farming as a business and applying the various skills acquired in managing harvesting and post-harvest activities to reduce loses at various stages in the value chain
Rehabilitation of irrigation facilities;	Irrigation is key to water availability, management and crop maintenance; preventing water –stress and drought that has the adverse impact of undermining crop resistance to crop pest/disease with high post-harvest losses.
Development and management of a seed laboratory;	Ensure availability of sound and high quality and disease—free seeds and planting material to farmers for planting therefore impacting positively on loss reduction.
Creation or improvement of linkages between farmers and markets; and	Results in improved off-taking of produce from smallholder farmers into safe storage facilities.
Creation or improvement of linkages between out-growers and technical assistance providers (e.g., USAID/Ghana FTF IPs, Ministry of Agriculture extension services	Exposes farmers to other sources of information on both production and productivity improvement, as well as, post-harvest management technologies and marketing

Although ADVANCE is using the OB model successfully to increase agricultural production and productivity it is important that the current strategies and interventions should be used as levers in wide-scale promotion of post-harvest loss reduction technologies among the smallholder farmers it is working with. There is also a need for a mechanism that consolidates and coordinates the post-harvest management needs of SHFs so that the farmer can access the menu of interventions that will add value to their overall production, processing, and marketing operations.

5 SUMMARY OF FINDINGS AND RECOMMENDATIONS

5.1 Summary of Findings

As productivity goes up the chances of post-harvest losses also increases. Increasing productivity without a concomitant capacity to safely store the produce would result in high post-harvest losses and less food availability and income. The key questions to consider would be what are the key causes of PH losses, where do these losses occur and how can these causes be mitigated. Below are related key finds that summarize the results from the survey.

- *Sample size and Composition:* A total of 513 farmers drawn from the Northern, Upper West, Upper East, Ashanti, Brong Ahafo and Eastern Regions were interviewed. This consisted of 262 farmers (51.1%) from the Northern Zone and 251 (48.9%) farmers from the Southern Zone. Males represented 51 percent of the sample and females represented 49 percent of the sample.

- *Maize Farming Experience*: Most maize farmers (83.43%) have been farming for more than five years. More males (89.7%) have also farmed more than five years as compared to their female (76.9%) counterparts. With respect to zones, more southern zone farmers (90.4%) have farmed more than five years compared to the northern zone farmers (76.7%). The farmers surveyed are, therefore, quite experienced in farming maize and are also linked to nucleus farmers with whom they have working relationships that allow the farmers to enjoy the benefits accrued from participating in the out-grower business model.

- *Different Farms Operated*: Generally, farmers in the target areas operate one farm. Ownership of multiple farms has implications on the efficiency and effectiveness of maintenance and harvesting and post-harvest operations that are time and weather-dependent

- *Total Land Size:* Total farm size for maize production ranges from 0.65 hectares to 1.37 hectares with an average of 1.00 hectares. In the Northern Zone, the farm sizes range from 0.65 – 1.21 hectares whiles southern zone maize farms range from 0.89 – 1.37 hectares. On average, maize farm size in the southern zone (1.25 hectares) is relatively larger than northern zone maize farms (0.98 hectares). Maize farms cultivated by males range from 1.21 to 1.37 hectares whiles females maize farm sizes range from 0.65 – 0.89 hectares. Males (average 1.23 hectares) generally farm larger maize farms than females (average 0.66 hectares).

- *Timing of harvesting*: Most farmers (65.0%) delay in harvesting their maize produce as a result of harvesting from many fields. However, this was independent of gender but more prevalent among southern zone farmers, where the farms are more and sizes

larger and where the rains are more prevalent at the end of harvest, than northern zone farmers where rains at the end of the season is less likely.

- *Harvesting methods:* Most farmers prefer to harvest by hand plucking the cob from the plant and removing the cob (56.5%). Another 43 percent prefer to use the cutlass to harvest the cob. However, this was also independent of gender but dependent on zone

- *Time of maize harvesting*: Most farmers (62.0%) harvest their maize after the cobs fall on their side. 43.08% of the farmers harvest when the silk at the apex turns brown and 16.96% harvest their maize before the cobs fall on their side. A majority of the farmers are harvesting at the right time i.e. when the black layer has been formed and the silk has turned brown shortly before the cobs fall on their side on the maize stalk.

- *Losses during Harvesting:* The losses that occur at harvesting are mainly caused by Birds (20.3%), Bush fire (2.7%), Others (17.0%), Pest/insect infestation (51.3%), Rodents (35.1%), Rotting due to moist conditions (34.5%) and Theft (2.7%). Insect pests and rodents are the predominant causes of loss during harvesting.

- *Temporary storage:* Most farmers (84.8%) do not undertake temporary storage on the farm and those who store do so with the maize in the husk (11.5%). The remaining farmers shell (2.53%) and de-husk the maize but leave it on the cob (1.17%). Most farmers (43.3%) store their maize in a heap under protected area in the house. Another 21.6 percent store their maize in bags under protected shed or area.

- *Maize drying methods*: Most farmers (40%) dry their maize on clean cemented floor. Drying of maize on the stalk in the field (32%) and on a covered platform (32%) follows drying maize on a clean cemented platform. In general, most of the farmers harvest and protect their produce safely out of the farm while the rest leave their maize to dry on the stalk in the farm.

- *Methods of Shelling Maize:* Most farmers (61%) shell their maize mechanically by using a sheller from a service provider. Traditional hand shelling is also commonly practiced among 38 percent of the farmers. The predominant method of shelling of maize in the southern zone is mechanized shelling whilst that of the northern zone is traditional hand.

- *Processing of Maize:* Most farmers in the Northern Zone (95.4%) process maize into other products than farmers in the Southern Zone (79.7%). Most of the processed maize is transformed into whole maize flour (52.0%) and corn dough (47.1). In all, it

is observed that not much of the maize produced is processed into secondary products and this leaves the rest of the maize in storage, if the farmer has a surplus.

- *Ownership of storage facility*: Most of the farmers (68.6%) own their own storage facility and these facilities are located mainly in the farmers' house (74.7%).

- *Long-term storage facilities:* Home crib and mud silo are the most predominant, depending on the zone. The rest are the following: Earthen Pot (1.0%), Home crib (27.1%), Insecticide impregnated sack (0.6%), Metal silo (0.2%), Mud silo (16.2%), Normal sack (10.3%), Open weave jute sack (cocoa sack) (4.9%), Other eg. Cemented room, living room, veranda, community warehouse (33.9%), other hermetic grain sack (5.5%), PICS or triple sack (0.2%), Plastic silo/Poly tank (0.2%).

- *Condition of storage facility:* Only 26.7% of the storage facilities are in good condition, 61.4% are in fair condition and 11.9% are in poor condition.

- *Capacity of storage facility:* About half of the farmers (42.9%) have storage structures that can accommodate more than 50 - 100kg bags. The rest have structures that can accommodate less than 10 bags (6.6%), less than 50 bags (50.5%).

- *Storage facility rental:* It is not a common practice for farmers to rent storage facilities. Those who said they did not rent storage facilities were 25.9% and only 5.5% indicated that they did.

- *Application of storage protectant:* Half the farmers use storage protectants and the other half does not. The storage protectants usually used are biological pesticides (neem extract, smoke, pepper etc.) (3.8%), chemical pesticide (actellic, etc.) (88.6%) and organic pesticide (7.6%).

- *Period of maize storage:* Most farmers (68%) store their maize for more than 5 months after harvesting while 32% stored for less than 5 months. 3 months (16.8%), 4 months (4.3%) and about 5 months (10.9%).

- *Transport of maize to market:* Farmers (52.4%) do not transport their maize from the production area to outside market centers to sell their produce but keep the produce in storage. However, with regard to zone, more farmers in the Northern Zone (67.2%) are more likely to transport their maize outside their areas of production for sale as compared to their southern counterparts (27.1%).

- *Types of transportation used:* The most common types of transportation among farmers are open trucks, donkey carts (and motorized tricycles (37.8%), individual-hired vehicle/truck (30.0%) and group hired vehicle to market centers (25.0%).

- *Packaging of maize for transport to the market:* Maize is mostly transported in either new jute sacks (41.7%) or new synthetic (fertilizer) sacks (26.7%). The form maize is transported to the market is dependent on zone (0.000) and gender (p=0.035). The use of new jute sacks (59.0%) or new synthetic sacks (30.7%) is common among farmers in the Southern Zone than farmers in the Northern Zone (new jute sacks, 22.9%; new synthetic sacks, 22.9%). The use of used jute sacks (24.4%) and used synthetic (fertilizer) sacks (21.4%) is prevalent in the Northern zone than in the Southern Zone.

- *Loss arising from transport of maize to the market:* About 98% of the farmers indicate that they lose about 2–5% of their maize to the market and the main cause is physical spillage according to 86% of the farmers.

- *Purchasers of farmers' surplus maize:* The predominant buyers are the market women/retailers (67.6%). The rest are: aggregator/warehousing agent 3%, consumer 27.8%, lead farmer 0.8, processor 0.6%.

- *Level of training in agriculture:* Most of the farmers have not been formally trained in agriculture production. Only 18 percent of female farmers have received formal training in agricultural production.

- *Support received from ADVANCE:* About 55% of the farmers reported having received support from ADVANCE with more males (58.0%) receiving support than females (51.8%). More farmers in the Northern Zone (61.5%) had received support from ADVANCE than farmers in the Southern Zone (48.2%).

- *Types of support received from ADVANCE:* Most of the farmers mentioned at least one technical assistance or support received. Most farmers (86.2%) mentioned receiving extension services or technology transfer. Extension services or technology transfer represent 67 percent of all the types of technical assistance or support received by farmers. Material benefits in the form of supply of seed, fertilizer, inputs construction materials was also mentioned by 108 farmers (21.1%) as the next type of support received by the farmers after extension services. The least type of support provided to farmers was financial assistance (3.7%) and access to storage facility or infrastructure (1.2%).

- *Frequency of Technical Financial and post-harvest Training:* Most farmers (70.8%) mentioned receiving irregular technical training assistance whilst only 18.3 percent

mentioned receiving regular technical assistance. The remaining 10.9 percent received a special one off package.

- *Post-harvest Management Training*: About 60% of the farmers agreed that they (60.6%) have received training in post-harvest management. However, more males (65.3%) received post-harvest training as compared to the 55.8% of females receiving the post-harvest management training. Training of farmers in post-harvest management has mainly been provided by ADVANCE (63.2%) and MOFA (28.1%). A farmer's location determines the training provider for post-harvest management training. More than 85% of farmers in the Northern Zone received their training in post-harvest management from ADVANCE whilst 49.2% of farmers in the Southern Zone received their training in post-harvest management from MOFA.

- *Stages at which loss is experienced:* Farmers indicated that the harvesting stage is where most losses occur (54%). drying 4%, harvesting 54%, shelling 22%, storage 15%, transport to market 1% and transporting before storage 3%. Storage, shelling and harvesting losses were found to be higher in the northern zone as compared to shelling and harvesting in the south. In the case of gender, females recorded relatively higher losses in storage and transport to market and lower losses in drying, harvesting and shelling as compared to their male counterparts.

- *Estimated Relative Maize Losses*: The total estimated relative loss is **18.57%** of the production for every acre cultivated. In the case of zones, the southern zone recorded a lower total relative loss of 15.63% as compared to the northern zone figure of 21.39% per acre. For gender, women recorded relatively lower losses totalling 17.73% against 19.37% being recorded for the males for every acre cultivated. This level of estimated loss of 18.57% is still high and needs to be better managed in the ADVANCE program through targeted interventions.

  Summaries of estimated losses related to gender show that both male and female recorded their highest losses at the shelling stage, though the males recorded slightly higher value of 5.78% and 5.64% respectively. The least loss of 2.25% for males was recorded at the harvesting stage, while the female 1.58% was also recorded at the harvesting stage.

- *Estimated Relative Maize Losses from Visual Scale Generated Information*: In the case of the visual scale loss estimates, average relative loss per farmer for the Northern zone farmers for sampled maize was recorded as 0.08% and 0.21% for classes 2 and 3 respectively. The southern zone recorded relatively higher loss values of 0.23%, 0.48% and 0.75% for classes 2, 3 and 4, respectively. In relation to gender differences, average relative losses for male farmers were 0.20%, 0.72% and 0.75%

for classes 2, 3 and 4 respectively. Female farmers on the other had relatively lower losses as compared to their male counterparts. They recorded 0.13%, 0.17% for classes 2 and 3 respectively.

These estimates would appear to be very low and not consistent with the general observations. Based on the several problems associated with the use of this methodology for estimating losses per this survey, the relative loss values were not computed.

5.2 Recommendations

Introduction of interventions to mitigate the causes of post-harvest losses of maize is a key strategy for reducing these losses among smallholder farmers. The recommendations on interventions that ADVANCE should promote and implement are the following:

i. The provision of training and technical support to smallholder farmers by ADVANCE is expected to result in production and yield increases. ADVANCE needs to complement these current interventions with tailored training and support services to reduce post-harvest losses so that the expected increased production, as a result of ADVANCE'S production and yield increasing interventions, would not be lost to the farmers.

ii. There are various technologies for reducing post-harvest losses, farmers do not easily adopt them because they are not convinced of the benefits. It is important to increase the knowledge of farmers, since most of the farmers have not been formally trained in agriculture production. The project should provide more training and sensitization programs on post-harvest loss-reduction in order for them to understand and appreciate the critical stages in the value chain where the losses occur, the causes of losses and how to develop strategies and practices to mitigate the causes that will reduce post-harvest losses that farmers encounter in their operations.

iii. Although a large proportion of the farmers own their own storage facility (home crib and mud silo), there is still a large number who do not have appropriate and safe storage facilities. Also, most of the storage facilities of those surveyed are not in good condition. ADVANCE should promote and assist farmers to rehabilitate dilapidated structures or construct simple, appropriate storage facilities. This effort must be complemented with training in post-harvest grain handling techniques.

iv. For small-scale producers and those who are not in a position to rehabilitate or construct new storage structures, an opportunity also exists for ADVANCE to introduce and promote the improved hermetic grain storage bags such as the Purdue Improved Crop Storage (PICS) bags which provide low-cost method of reducing post-

harvest losses due to insect infestation. This intervention is considered a quick way to respond to the problem of losses during the long grain storage period.

v. Several farmers were observed to be using crop storage chemical insecticides to treat their maize prior to long-term storage. It is imperative for the project to provide training in the safe use of such pesticides to lower the risk of misuse and poisoning.

vi. Generally, not much of the maize produced is processed into secondary products and this leaves the rest of the maize in storage, if the farmer has a surplus. Most of the grain loss after harvest could be avoided if value-addition and processing of produce into more stable and storable forms are practiced by farmers. In order to ensure that the maize lost would be available for human consumption, the ADVANCE program should promote primary processing at the household-level through training and facilitate access to simple processing technologies that will add value to the maize produce and reduce the quantity of maize that would be exposed to various post-harvest loss factors.

vii. Although much work has gone into ADVANCE's interventions of linking farmers to markets through the operation of the outgrower business model, the predominant purchasers of farmers' surplus maize the predominant buyers are the market women/retailers. This dependence on market women and retailers is fraught with many problems related to pricing and evacuation. the project should intensify its efforts in developing new strategies to get farmers to work closely with the outgrower businesses they are associated with since the relationship appears to be weak and would impact on the delivery of other services through the relationship.

viii. Most of the farmers have not been formally trained in agriculture production. Provision of training is a major feature of the work of ADVANCE with its farmers. The program should develop a comprehensive training package which deals with the following, among others:

- Stages in the harvesting and post-harvest cycle that losses occur.
- The types of losses and causes of the loss
- Time of harvesting and harvesting methods
- Principles and practices of appropriate short and long-term storage
- Safe use of storage pesticides

6 ANNEXES

Annex 1 - TERMS OF REFERENCE (TOR)

Background

Based in Washington, D.C., ACDI/VOCA is a non-profit international development organization that delivers technical and management assistance in agribusiness, financial services, enterprise development, community development and food security in order to promote broad-based economic growth and vibrant civil society.

ADVANCE is a USAID/Feed the Future funded project being implemented by ACDI/VOCA and its partners TechnoServe, ACDEP and PAB. It aims at increasing the competitiveness of the maize, rice and soya value chains through:

- Increased agricultural productivity in targeted commodities
- Increased market access and trade of targeted commodities
- Strengthened capacity for advocacy and activity implementation

The project targets 113,000 smallholders, out of which 45% are women, in the Northern, Upper East, Upper West, Ashanti, Brong Ahafo and Eastern regions.

To increase the productivity and the profit of those smallholders, ADVANCE supports them to reduce their harvest and post-harvest losses, among others. For that purpose, they benefit from trainings, linkage with harvest and post-harvest equipment dealers and service providers, grants, and storage access facilitation etc. Kansaki (2015)[6] estimated maize post-harvest loss at around 40% in the Upper West region.

2.2 Objectives of the Consultancy

ADVANCE would like to assess the effect of its interventions on the losses experienced by its farmer beneficiaries. The assessment's objectives are to

1. Measure the quantity of post-harvest loss among the project's beneficiaries
2. Assess the effectiveness of the project's intervention towards post-harvest loss reduction
3. Recommend concrete actions and quick win strategies for the project to significantly reduce beneficiaries' post-harvest loss.

Specifically, the objectives of the assignment will be achieved through the performance of the following tasks:

[6] Kansaki J. K., *Assessment of postharvest losses of maize in the Sissala East and West Districts of the Upper West Region of Ghana*. Ghana: KNUST, 2015

1. Undertaking extensive review of the relevant documents and literature relating to harvest and post-harvest loss investigation including Hodges (2013) APHILS document.

2. Engage in consultations with the ACDI/VOCA especially the ADVANCE project team and other relevant stakeholders, either by in-person or phone interviews to identify current status, future challenges and individual recommendations to gain a wide perspective on the assignment.

3. Definitions: The definitions to be used are that which ADVANCE uses that has been adapted from Global Strategy, Improving Agricultural and Rural Statistics (2015).

4. Stages to assess: The stages to assess are harvesting and field drying, transport to homestead, drying, shelling, winnowing, on-farm/homestead storage and transport to market.

5. Factors of grain weight loss to assess: These include; rain being scattered or spilt during postharvest handling (harvesting, threshing, transport), bio-deterioration that results from the activities of mould, insects or rodents; mechanical damage during handling; insufficient drying and insufficient protection during storage.
   Other factors include theft/losses during/due to 'social' obligations, (unauthorised portion deductions/right to scattered grain for/after providing winnowing/threshing services. The following seasonal factors will also be considered as influencing the post-harvest lost quantity; rain/damp cloudy weather at harvest time that may hinder grain drying, control/access to self-owned and/or commercial mechanical dryers, control/access to labour/machines for timely harvesting, the proportion of the crop that is marketed in the first three months after harvest time, the total length of the period of farm storage and the incidence of pests that attacks mature maize. Other factors are farmer's knowledge and access to harvest and post harvesting tools, equipment and facilities and incentives/contractual requirements to live up to or work towards by farmers.

6. Data to collect: The main datasets to be collected to estimate the PHH loss include crop production, percentage of grain lost at each stage in the postharvest chain and the seasonal factors. Additional data will be gathered on ADVANCE's support received by the farmers, farmers knowledge and access to harvesting and post harvesting tools, equipment and facilities.

7. Loss measurement method: Loss measurement would be conducted through the use of visual scales and farmers surveys.

8. Sample size and composition: The sample size of farmers to survey will be 640 (160 male and 160 female each for ADVANCE north and ADVANCE south). North includes Northern, Upper East and Upper West regions, while South comprises Ashanti, Eastern and Brong Ahafo regions. The farmers will be randomly selected from the 1,600 maize farmers visited in the south and in the north during the FY15 gross margin survey.

9. Seasons of interest are the 2015 maize season production for the north and the 2015 major season for the south.

10. Data analysis which consists of producing the estimated absolute and relative loss values, disaggregated by stage, by zone north/south, by gender, and describing the sources of loss. Statistical tests and modelling will be performed to assess the significance of the influence on the loss of ADVANCE's support (in general and by type of support), of the access to harvesting and post harvesting tools, equipment and facilities. Other factors potentially having such influence will also be tested.

11. Limitations: The study team should try and mitigate the several limitations that the study presents. These include the use of farmers' recall to obtain the different produce quantities at each critical stage of the assessment and limited availability and use of weighing scales by the farmers. To address these limitations, data will be collected right after harvest, procurement of weighing scales to use during data collection.

12. Reporting: Presentation of the required documents to ACDI/VOCA which should be fully understood and accepted by the ADVANCE team and these include:
    a. An inception report that demonstrates understanding of the assignment, describes the visual scale, overall methodology and field visits plan, to be submitted by end April
    b. Bi-monthly meeting notes submitted a week after each meeting takes place
    c. Draft report in mid-October
    d. Final report by end October

Annex 2 - WORKPLAN

ACTIVITIES	MONTHS (weeks)								
	July					August			
	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th
Contract Signing									
Consultation with ACDI/VOCA									
Planning Process									
Desk review									
Procurement of all equipment and tools									
Development of assessment tools									
Testing of assessment tools									
Recruitment of enumerators									
Enumerator training and test-run of instruments									
Finalization of questionnaire									
First visit of farmers and administration of the questionnaire									
Second to fifth visits and partial data analysis									
Inception report									
Bi-weekly meeting notes									
Draft report									
Final report									

Annex 3 - QUESTIONNAIRE FOR THE STUDY

QUESTIONNAIRE FOR HARVEST AND POST-HARVEST LOSSES ASSESSMENT FOR MAIZE PRODUCTION IN ADVANCE NORTH AND SOUTH ZONES OF GHANA

A. QUESTIONNAIRE IDENTIFICATION (to be filled in prior to interview)	
Date of interview *(dd/mm/yyyy)*	***__ __ / 07 / 2016***
Cropping season	2015 crop
Enumerator code	[__ __]
Respondent code	[__ __ __ __]
B. LOCATION, CROP, FARM SCALE, HEAD OF HOUSEHOLD GENDER (to be filled in by enumerator)	
Region:	
District:	
Community:	
GPS co-ordinates:	
How many harvests are there each year	
In which month(s) is/are the harvest(s)?	

Harvesting

1. How long have you been a maize farmer?
    a. Under five years
    b. Above five years

2. What is your total land size you use to crop maize?
    a. Number of acres

3. Do you harvest your maize from several farms?
    a. Yes
    b. No

4. If YES how many farms? Please specify ……

5. Does this pose problems for you in delaying your harvesting?
    a. Yes
    b. No

6. When do you harvest (time of harvesting)?
    a. Just before the cobs fall on their side
    b. After the cobs fall on their side
    c. When there are helpers available for harvesting
    d. Any convenient time
    e. 115 days after planting
    f. The silk at the apex turns brown

7. What is the main method you use for harvesting the maize?
    a. By hand – pluck cob from plant/open husk on stalk and remove cob
    b. With the aid of cutlass (care to avoid damage on cob)
    c. Mechanical (e.g. Combine harvester)

8. Do you generally have rainfall during harvesting and/or drying of your grain?
    a. Yes
    b. No

9. How many bags do you harvest per season?
    a. No of bags (fertilizer bag)
    b. Number of kilograms

10. What percentage of your total yield were you unable to harvest?
    a. Below 2%
    b. Below 4%
    c. Below 6%
    d. Above 6%
    e. None of the above

Pre-transport and farm storage activities

11. If loss occurred at harvesting, what caused the loss?
    a. Rodents
    b. Birds
    c. Bush fire
    d. Pest/insect infestation
    e. Rotting due to moist conditions
    f. Theft
    g. Others

12. Do you store your maize on the farm?
    a. Yes
    b. No

13. If yes in what form is the maize stored?
    a. With husk
    b. De-husked / On-cob
    c. Shelled

14. Do you de-husk the maize on the farm?
    a. Yes
    b. No

15. Do you thresh the maize on the farm?

a. Yes
b. No

Transporting from farm to homestead

16. Do you have problems with transport?
    a. Yes
    b. No

17. How do you transport the maize from the farm to your storage structure?
    a. By head-loading
    b. Donkey carts
    c. In tricycle (motor king)
    d. With a tractor
    e. Other (please specify) ……

18. When do you normally transport crop from farm after harvesting to homestead?
    a. When adequate transport is ready
    b. Within 3 days
    c. After a week
    d. Immediately after harvesting
    e. When the weather is bad
    f. Other (please specify) ……

19. When transporting maize from the farm to homestead storage in what container or form is it conveyed?
    a. In Heap/bulk using a tractor/motor king
    b. Used/old jute/fertilizer sacks or baskets (untreated)
    c. Good bags/sacks
    d. Baskets
    e. Other (please specify) …….

20. Which of these types of PHH loss occur during farm to home transport?

Type of loss	**Percentage of loss**
Spillage from bursting weak sacks	
Contamination of produce with lubricants	
Tainting with objectionable odor from poorly maintained container sanitation and hygiene	
Tipping over of maize from overfilled truck/containers	
Others (please specify)	

21. What percentage of maize is lost during the transportation from farm to homestead storage?
    a. 2.5%- 5%
    b. 6% -10%

c. 11% -15%
d. 16%-20%
e. 21% - 25%
f. Above 26%

Shelling / storage

22. If you transport your maize to your house, where do you store it before shelling?
    a. In heap outside
    b. In a heap under protected area
    c. In bags under protected area/shed
    d. Other (please specify) …….

23. If you store the maize before shelling, how long does it take before you start the shelling process?
    a. Few days
    b. About a week
    c. Two weeks
    d. One month
    e. More than one month

24. When you bring your maize home, do you dry it again before shelling or storing?
    a. Yes
    b. No

Drying of Maize (after de-husking/sorting)

25. How do you dry your maize?
    a. On the stalk in the field
    b. Suspended in a storehouse
    c. On plastic sheets in a covered place
    d. On a covered platform
    e. Mechanical dryer
    f. Clean cemented floor
    g. Cob in a narrow crib loosely up to about 3 months

26. How do you shell your maize?
    a. Traditional hand shelling
    b. Semi-mechanical using hand-held equipment
    c. mechanized(owned or from a service provider)

27. Can you give an estimate of how much you lose during the shelling/winnowing process?
    a. Below 5%
    b. Below 10%

c. Below 15%
d. Below 20%

Homestead pre-storage and Storage

28. Is the maize generally dry before storage?
    a. Yes
    b. No

29. If yes what is the indicative industry moisture level accepted for dry maize?
    a. Below 5%
    b. 10% -13%
    c. Above 15%
    d. Below 20%

30. If yes, how is dryness of maize determined before storage?
    a. Manually (by feel and sound)
    b. Visually inspection ,
    c. Moisture meter
    d. Texture
    e. Other

31. In what form do you store your grain/maize?
    a. Unshelled grain (in husk)
    b. Shelled grain (on cob)
    c. Threshed

32. Do you use sacks to store your grain?
    a. Yes
    b. No

33. If you use sacks to store your grain do you use new sacks every year?
    a. Yes
    b. No

34. If the answer is no and you use the old sacks do you treat them with insecticide?
    a. Yes
    b. No

35. Do you own storage facility?
    a. Yes
    b. No

36. If YES, where is the storage facility located?
    a. In the house

b. On the farm
c. Other (please specify) ……..

37. How do you store your maize in the long-term? (In what structure do you store? What type)
    a. Earthen Pot
    b. Basket
    c. Open weave jute sack (cocoa sack)
    d. Normal sack
    e. Insecticide impregnated sack
    f. PICS or triple sack
    g. Other hermetic grain sack
    h. Metal silo
    i. Metal drum
    j. Plastic silo / Poly tank
    k. Mud silo
    l. Home crib
    m. Other (please specify) ……

38. In what condition is the storage facility (quality)?
    a. Good
    b. Fair
    c. Poor

39. What is the capacity (MT) of the storage facility?
    a. Less than 10 bags
    b. Less than 50 bags
    c. More than 50 bags

40. If NO to question 35 above do you rent any storage facilities?
    a. Yes
    b. No

41. If yes, from whom?
    a. Another farmer
    b. Farmer group or cooperative
    c. Buyer
    d. Private warehouse
    e. Private individual
    f. Government
    g. Others (please specify) …….

42. Generally, what are the weather conditions at the time of storing the produce?
    a. Rainy
    b. Sunny

c. Dry

43. Do you apply any storage protectant before storing the produce?
    a. Yes
    b. No

44. If yes, what type of pesticide do you use? (please specify type)
    a. Chemical pesticide (actelic, etc.)
    b. Biological pesticide (Neem extract, smoke, pepper etc.)
    c. Organic pesticide

45. For how long do you keep your maize in storage until it is sold? (how long does the grain stay in storage)
    a. Soon after harvesting
    b. About 1 month after harvesting
    c. About 2 months after harvesting
    d. About 3 months after harvesting
    e. After more than 3 months

46. For how long do you normally keep your maize until it is all consumed?(when does the stored maize get finished in the storage structure?)
    a. About 3 months
    b. About 4 months
    c. About 5 months
    d. More than 5 months

47. Who is responsible for managing the stored grain
    a. Male adult
    b. Female adult

48. Has the person received any training in post-harvest management?
    a. Yes
    b. No

49. If YES, from whom?
    a. ADVANCE
    b. MoFA
    c. Other donor-funded projects
    d. Other farmer
    e. Cooperative

50. What problems do you normally face during the storage period in keeping the produce fresh?
    a. Rodent attacks on maize
    b. Insects damage to maize seed

c. Fungi discoloration
d. Rot from damp conditions (Moisture)

51. Do you have losses in storage?
    a. Yes
    b. No

52. If YES, what percentage of your stock is lost in storage? (before selling)
    a. 5%
    b. 10%
    c. 15%
    d. 20%
    e. Above 25%

53. At which stages from harvesting to the post-harvest stages do you have the most losses?
    a. Harvesting
    b. Drying
    c. Transporting before storage
    d. Shelling
    e. Storage
    f. Transport to market

54. What percentage of your harvested stock do you think you lose during harvesting?
    What percentage of your harvested stock do you think you lose during drying?
    What percentage of your harvested stock do you think you lose during transporting?
    What percentage of your harvested stock do you think you lose during shelling?
    What percentage of your harvested stock do you think you lose during storage?

55. What are the key challenges of harvesting and post harvesting periods? (You can tick more than one challenge in each stage)

Stage	**Challenge(s)**	**Please Tick as Appropriate**
Harvesting	a. Labor	
	b. Tools and equipment	
	c. Large farm size	
	d. Bad weather conditions	
	e. Not applicable	
Drying	a. Labor	
	b. Tools and equipment	
	c. Large quantity harvested	
	d. Bad weather conditions	
	e. Not applicable	

Transporting	a. Labor	
	b. Available means of transport	
	c. Large quantity harvested	
	d. Bad weather conditions	
	e. Not applicable	
Shelling	a. Labor	
	b. Tools and equipment	
	c. Large quantity harvested	
	d. Bad weather conditions	
	e. Not applicable	
Bagging	a. Labor	
	b. Supplies	
	c. Large quantity harvested	
	d. Bad weather conditions	
	e. Not applicable	
Storing	a. Labor	
	b. Quality of storage facility	
	c. Large quantity harvested	
	d. Insect and rodent attacks	
	e. Theft	
	f. Not applicable	

56. Do you undertake activities with the intention of reducing your harvesting and post-harvest losses?
    a. Yes
    b. No

57. If yes, what method/technology do you use?
    a. Early harvesting when the maize is dried in the field
    b. Avoid harvesting during wet periods
    c. Moving the maize to a safe place before rains set in
    d. Transporting the maize in bags
    e. Drying the early-harvested un-dried maize in a commercial dryer to avoid fungal growth

f. Sun drying maize before storage to avoid fungal growth
g. Cleaning maize before storage
h. Control storage insects with pesticides
i. Protecting stored maize from rodents etc.
j. Protecting stored maize from thieves
k. Other (please specify) ……

58. Are you planning to invest in new storage?
    a. Yes
    b. No

59. If YES, what type of storage do you want to invest in?
    a. Earthen Pot
    b. Basket
    c. Open weave jute sack (cocoa sack)
    d. Normal sack
    e. Insecticide impregnated sack
    f. PICS or triple sack
    g. Other hermetic grain sack
    h. Metal silo
    i. Metal drum
    j. Plastic silo / Poly tank
    k. Mud silo
    l. Home crib
    m. Other (please specify) ……

Technical and training assistance

60. What types of technical assistance or support do you receive?
    a. Extension services / Technology transfer
    b. Material benefits (Supply of seed, fertilizer, inputs construction materials)
    c. Funding
    d. Coaching
    e. Supply of Credit
    f. Market Access
    g. Access to storage facility/infrastructure
    h. Not applicable

61. How often is the technical assistance provided?
    a. Regular
    b. Irregular
    c. A special one off package
    d. Not applicable

62. How often is the financial assistance provided?

e. Regular
f. Irregular
g. A special one off package
h. Not applicable

63. Have you received any training in harvesting and post-harvest management?
    a. Yes
    b. No

64. If YES, from whom did you receive the training?
    a. ADVANCE
    b. MoFA extension agents
    c. A local project extension service
    d. Lead farmer

65. Have you received any training in the use of grain storage chemicals?
    a. Yes
    b. No

66. If YES, from whom did you receive the training?
    a. ADVANCE
    b. MoFA extension agents
    c. A local project extension service
    d. Lead farmer

Processing of maize

67. Do you process part of maize into other product(s)?
    a. Yes
    b. No

68. If yes which product(s) do you process your maize into?
    a. Whole Maize flour
    b. Corn dough
    c. Roasted Corn meal (Tom Brown)
    d. Ekuegbemi/Oblayo etc.

69. What quantity of your maize goes into processing?
    a. About 5%
    b. About 10%
    c. Less than 5%
    d. Above 10%

Transport to the market

70. Do you transport your maize to markets outside the production area for sales?
    a. Yes
    b. No

71. Who are the major transporters in/out of your market
    a. Self / household member
    b. Transporter/businessman,
    c. Lead farmer
    d. Cooperative

72. What type of transport do you use to get to your market(s) or client(s)?
    a. Individual hired vehicle/truck
    b. In opened donkey cart
    c. In opened truck/ motor king etc.
    d. Group hired vehicle to market centres and covered.
    e. Private passenger vehicle with mixed load

73. How is the maize transported to the market?
    a. In jute sacks (used)
    b. Jute sacks (new)
    c. Synthetic (fertilizer) sacks (used)
    d. Synthetic (fertilizer) sacks (new)
    e. Others (please specify) ……..

74. Estimate PHH loss incurred arising from transporting of maize to market?
    a. 2 – 5%
    b. 5 - 10%
    c. 10 – 15%
    d. Above 15%

75. What are the types of losses observed from transportation to market?
    a. Biodegradation – bacteria, fungal, pest/insect infestation on account of poor drying, high temperature, poor ventilation and high humidity?
    b. Mechanical – mechanical damage (broken/cracked, rains, cracked grains and pitted grains from insect and other pest damages).
    c. Physiological – rot, discoloration, fungi contamination
    d. Physical spillage of grain from burst sacks from rough loading/handling

Marketing of Maize

76. Who buys your surpluses?
    a. Market women / Retailer
    b. Aggregator / Warehousing agent
    c. Lead farmer
    d. Processor

e. Consumer
f. Others (please specify) ……..

Profile and capability of the farmer

77. Do you have any formal training in agriculture production?
    a. Yes
    b. No.

78. If YES, what is your educational level in agriculture?
    a. No schooling
    b. JSS / JHS
    c. SSS / SHS
    d. Form 4 leaver
    e. Polytechnic education
    f. University education
    g. Hands-on short courses
    h. MOFA/institutional farmer training

79. Have you benefited from any support or intervention from ADVANCE in maize production?
    a. Yes
    b. No

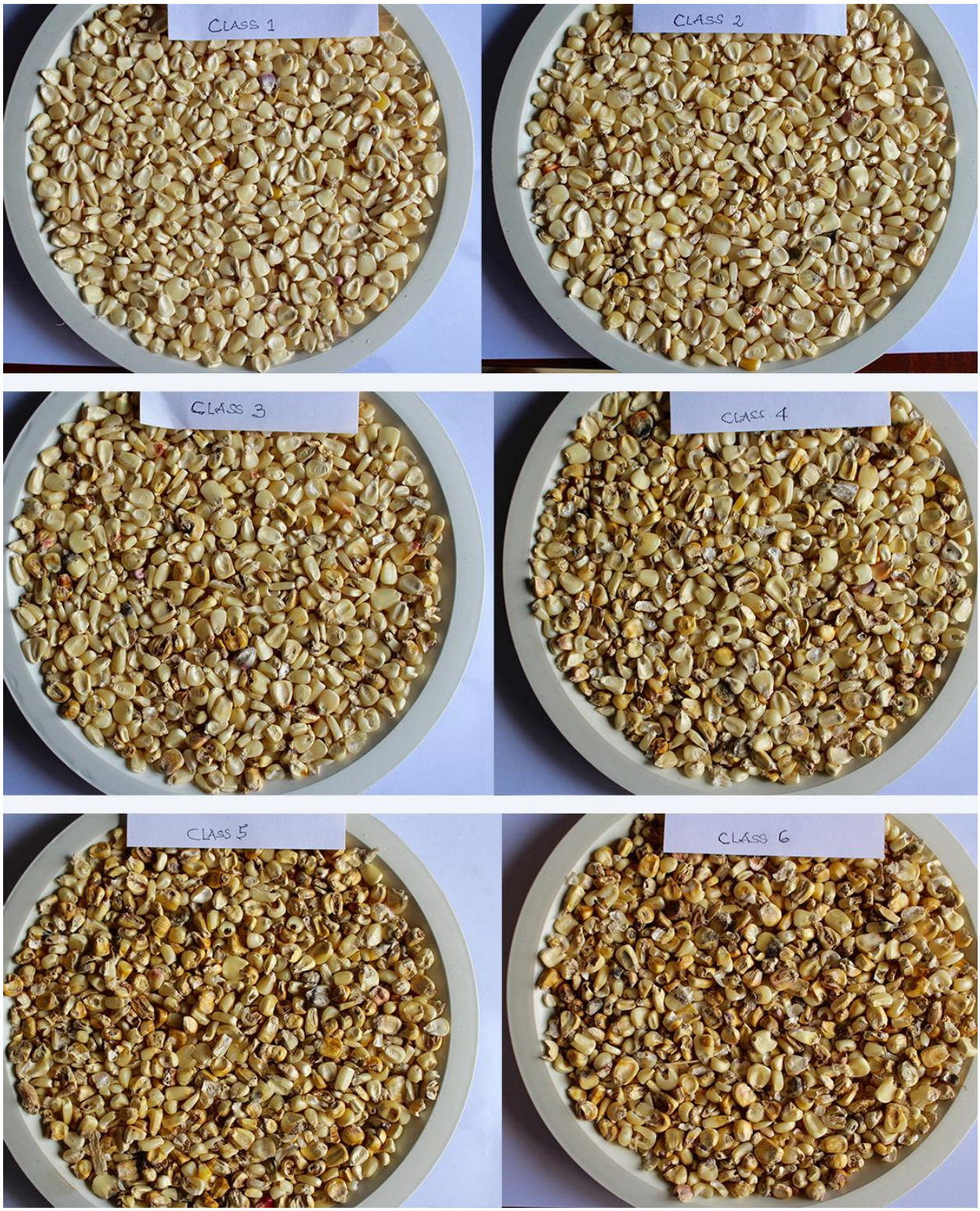
80. What type of assistance have you received from ADVANCE in maize production?
    a. Credit/financial
    b. Extension services
    c. Inputs – fertilizer, agro-chemicals, improved seed variety,
    d. Training in agronomic and cultural practices
    e. Marketing information and market linkages
    f. Grain Storage/warehousing facilities
    g. Tools/equipment for production etc. which types?

81. Using the visual scale aid the farmer in grading the sampled maize. What is the visual scale score
    a. Class 1
    b. Class 2
    c. Class 3
    d. Class 4
    e. Class 5
    f. Class 6

82. What is the average moisture content of sampled maize? ……..

83. Overall comments? ……

Annex 4 – Visual Scale Pictures



Annex 4a - VISUAL SCALE SHOWING INDIVIDUAL QUALITY CLASSES OF MAIZE


CLASS 2


CLASS 3

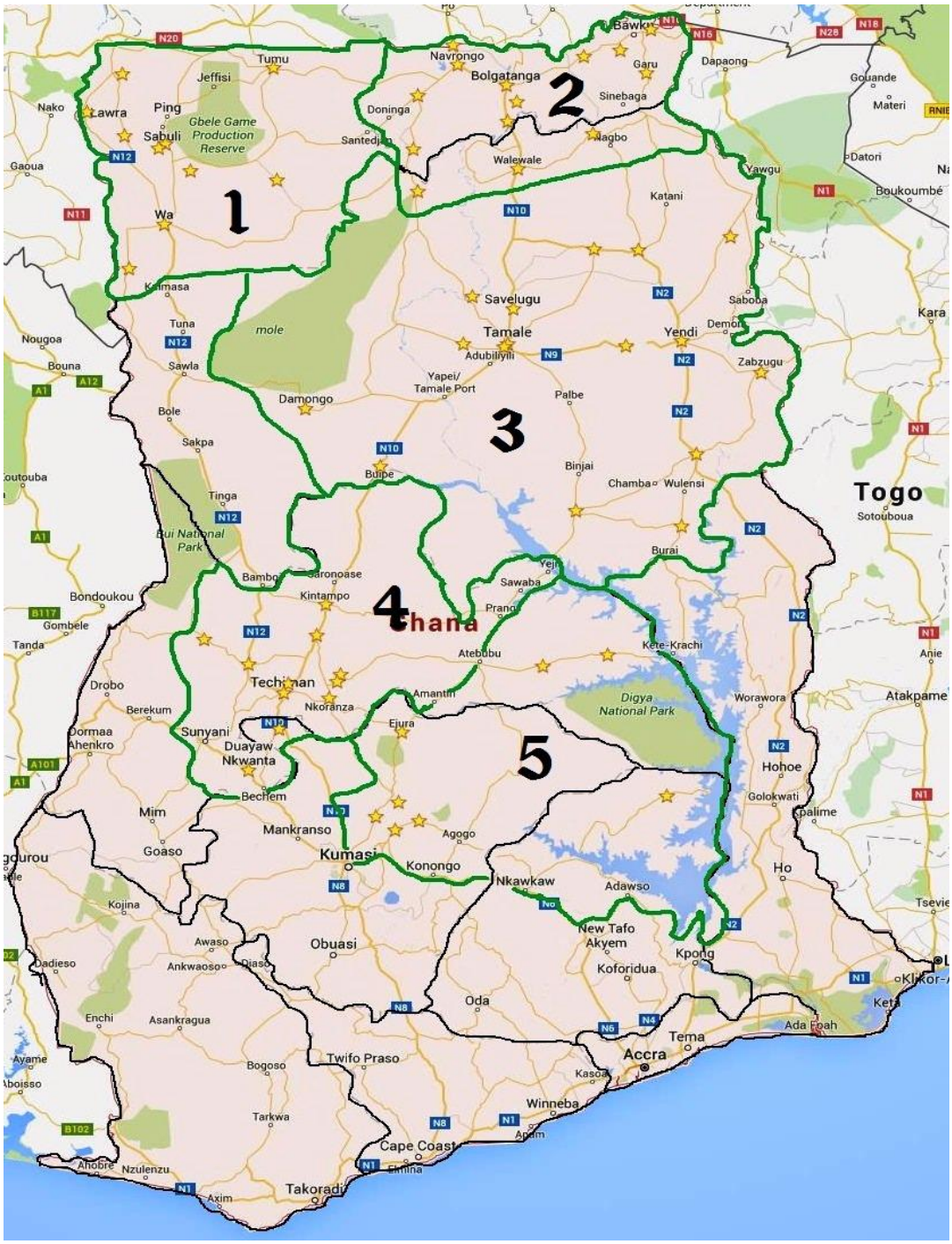

CLASS 4


CLASS 5


CLASS 6

Annex 5 - CLUSTERED RESPONDENTS AND MAPPED LOCATIONS

District Capitals and Proven Ag Solutions Station Points for Post Harvest Survey



Numbers denote Delineated Zones

Annex 6 - Respondents split according to Outgrower Business (OB), Districts and Regions

Region	District	Capital	OB	Respondents	Total Respondents	Comments
UPPER WEST	WA MUNICIPAL	WA	ABUDU SALIA	1	1	**11 Districts** **113 Respondents**
	WA WEST	WECHIAU	NGMENSOMBO LAMBOORE CO-OP FARMERS AND MARKETTING UNION	6	6	
	WA EAST	FUNSI	IDDRISU MUSAH	1	4	
			MASHOOD DORI	3		
	SAWLA/TUNA/KALBA	SAWLA	JOHN MULNYE	3	3	
	SISSALA EAST	TUMU	BATONG ASAMIRU IBRAHIM	1	21	
			ISSAH BAWOURON AHMED	16		
			JAMES BAWA	2		
			KASSIM BAWULE	1		
			YAHAYA TAHIRU-MORO	1		
	SISSALA WEST	GWOLU	FULERA ADAMU	2	18	
			ISSIFU YOMMIE	3		
			JOHN DIMAH	2		
			KANKANI NIIRA	1		
			KARIM SULEMANI-BASUFA	5		
			KUOHARITUO CO-OP FARMERS AND MARKETTING UNION	**2**		
			TAHIRU MEKE	1		
			YAHAYA SEIDU	2		
	DAFIAMA-BUSSIE-	ISSAH	ABDULAI ANTIKO	1	10	
			AUGUSTINE	3		

Region	District	Capital	OB	Respondents	Total Respondents	Comments
	ISSAH		AMBOTIMAH SANDOW			
			FELIX BAZING	**1**		
			EMMANUEL YOBOR	5		
	JIRAPA	JIRAPA	AHAA EMMANUEL	18	21	
			JIRAPA FARMERS NETWORK	**3**		
	KALEO-NADOWLI	NADOWLI	GRACE BOMANSAAN	2	18	
			GREGORY LANKONO	13		
			JONAH NGMAWU	3		
	LAMBUSSIE-KARNI	LAMBUSSIE	KARNI-DAMPUO	3	3	
	LAWRA	LAWRA	BIRIFOH	8	8	
NORTHERN	EAST MAMPRUSI	GAMBAGA	ALHAJI ABDULAI ABDUL RAHMAN	2	12	**14 Districts** **103 Respondents**
			BEN AWUNI ASATANGA	3		
			MAHAMOUD BABA	1		
			SHAIBU BUGRI	2		
			SULEMANA IBRAHIM	1		
			YAKUBU APURI	3		
	WEST MAMPRUSI	WALEWALE	ABU SALAM FUSIENI	2	11	
			AMOS BAGNARIGU	2		
			FARANAYA ABC	4		
			ISSAH NANTOGMA	1		
			MAHAMA TIA YAKUBU	1		
			WUNGU DARIBIO FARMERS ASSOCIATION	1		
	MAMPRUGU	YAGABA	TISUNGTABA	1	6	

Region	District	Capital	OB	Respondents	Total Respondents	Comments
	MAOGDURI		FARMER GROUP			
			TILAMIN-NGBAI	1		
			NABILA BUNTERA	1		
			SAHAD NAWURUKU	1		
			ISSAHAKU JIBRIEL	1		
			SUMNI VELLA	1		
UPPER EAST	BAWKU WEST	ZEBILLA	ALHAJI MBILLA ASAKI	3	19	
			AWINTOMA AKANDE	1		
			CHIEF MOSES ABAARE APPIAH	8		
			SULEMANA MUSAH	4		
			SULLEY AWONNI AGHOLISI	3		
	BINDURI	BINDURI	ISSAH SEIDU	1	1	
	GARU TEMPANE	GARU	ALHAJI IMORO AZURE	3	5	
			LETICIA APAM	1		
			MARY ANABIGA	1		
	BOLGA MUNICIPAL	BOLGA	IDDRISU AKOLBIRE	1	2	
			AKUKUBILLA AYAMGA	1		
	BUILSA NORTH	SANDEMA	AHMED BOGOBIRI	3	14	
			CHIEF THOMAS ALUA PAREKURI	1		
			DONATUS ABAG-DEM	1		
			ENOCH AKISIBA	3		
			MAXWELL AKANDEM	3		
			NAB ASIUK AKANFEBANYUETA	1		

Region	District	Capital	OB	Respondents	Total Respondents	Comments
			SAMUEL ABIAYEGA	2		
	BUILSA SOUTH	FUMBISI	AKAPATA ISAAC	6	7	
			STEPHEN ALAMPONG	1		
	KASSENA NANKANA MUNICIPAL	NAVRONGO	BONIA WOMEN YOUTH ASSOCIATION	1	11	
			CHIEF JAMES ADAWINA	6		
			CLEMENT KANSAKE	1		
			RICHARD AKOKA	3		
	KASSENA NANKANA WEST	PAGA	ALHAJI MUMUNI ATIPAGA	1	10	
			BADUNU FARMERS ASSOCIATION	1		
			EDWARD YARAH	1		
			ENOCH AKISIBA	5		
			LINUS NONTERA	1		
			PE JOSEPH BANAPEH AFAGACHIE II	1		
	NABDAM	NABDAM	VITUS YELZAALEM	1	1	
	PUSIGA	PUSIGA	ABDUL RAHMAN MOHAMMED	3	3	
	TALENSI	TONGO	SULLEY ADONGO	1	1	
NORTHERN	CENTRAL GONJA	BUIPE	ABDULAI TAKORO	1	1	**16 Districts**
	TAMALE METROPOLITAN	TAMALE	SULBILA IDDRISU	3	4	**102 Respondents**
			TAMIMU ABDULAI	1		
	SAVELUGU NANTON	SAVELUGU	DR CECELIA AMOAH	7	8	
			RICE GROWERS	1		

Region	District	Capital	OB	Respondents	Total Respondents	Comments
			ASSOCIATION			
	KUMBUNGU	KUMBUGU	ABDUL RAHAMAN DAHAMANI	2	12	
			ABDUL RAHMAN TAKORO	2		
			BERISUNG FARMERS ASSOCIATION	1		
			GRACE ABENA BOWU	2		
			SAAKA ALHASSAN WUNITRA	3		
			WFP NGANWUNI FARMER ORGANIZATION	1		
			WUNPINI FARMERS ASSOCIATION	1		
	SANARIGU	BUKPAMO	WFP SORUGU TUNG-TEEYA ASSOCIATION	1	2	
			SUGLO KONBO FARMERS ASSOCIATION	1		
	TOLON	TOLON	GOLINGA COPERATIVE UNION	1	11	
			HON UMAR ABDUL RAZAK	5		
			KHALID ABUBAKARI	1		
			KOBILIMAHILI FARMERS ASSOCIATION	2		
			TIBOM YEM YOUTH ASSOCIATION	1		

Region	District	Capital	OB	Respondents	Total Respondents	Comments
			WUMPINI FARMERS ASSOCIATION	1		
	WEST GONJA	DAMONGO	AMOS SEIDU	8	8	
	GUSHEGU	GUSHEGU	ABUKARI DOKURUGU	1	16	
			ABUKARI FUSEINI	3		
			ALHASSAN SEIDU	7		
			HON UMAR ABDUL RAZAK	2		
			IDDRISU TIA	**1**		
			IMORO AHAMED TIJANI	1		
			MUHIB HUSSEIN	1		
	MION	SANG	SULBILA IDDRISU	1	1	
	KARAGA	KARAGA	ALABANI IBRAHIM	2	6	
			MUHIB HUSSEIN	1		
			IDDRISU SALIFU	1		
			CHIEF ALHASSAN ABDULAI	1		
			HON UMAR ABDUL RAZAK	1		
	SABOBA	SABOBA	MICHAEL ASUNTANI BABA	1	1	
	YENDI MUNICIPAL	YENDI	ANZANSI FARMERS GROUP	1	12	
			KIMOBANS FARMERS GROUP	2		
			NTRIN FARMERS GROUP	1		
			PETER WAJAH	1		
			SUBAN NABEGMADO	4		
			YAMBA YELIMANGLI	1		
			ZIBLIM OSMAN	2		

Region	District	Capital	OB	Respondents	Total Respondents	Comments
	EAST GONJA	SALAGA	PATRICK SALIFU	1	3	
			AWA-EKAMAPE	1		
			SALAGA FBO	1		
	KPANDAI	KPANDAI	GRACE ABENA BOWU	3	3	
	NANUMBA NORTH	BIMBILLA	ABDUL RAHMAN AWAL	2	13	
			ABUKARI TINDANA	5		
			ALHASSAN IBRAHIM	5		
			IDDRISU ABDUL-KARIM	1		
	ZABZUGU	ZABZUGU	ALHAJI ABDUL-AZIZ MUKAILA	1	1	
BRONG AHAFO	KINTAMPO SOUTH	JEMA	ADAM SEIDU	5	27	**11 Districts** **173 Respondents**
			AGNES FOKUOH	1		
			AMISARE ASUA BAFFOUR	3		
			JOSEPH ADDAI	6		
			KOJO MATU	7		
			KWADWO FOSU	5		
	KINTAMPO NORTH	KINTAMPO	CHIRANDA RICE FARMERS ASSOCIATION	1	2	
			POAMBA FARMERS GROUP	1		
	NKORANZA NORTH	BUSUNYA	SAMUEL OPOKU AGYEMAN	1	8	
			JOSEPH ADDAI	7		
	NKORANZA SOUTH	NKORANZA	AFENA YORKE	3	31	
			SAMUEL OPOKU AGYEMAN	28		
	SUNYANI WEST	ODUMASE	BAFFOUR KUSI	8	35	
			EVANS FOSU	3		
			GEORGE YEBOAH	6		

Region	District	Capital	OB	Respondents	Total Respondents	Comments
			JOHNSON KYERE	8		
			YAW YEBOAH	10		
	TANO NORTH	DUAYAW NKWANTA	ALHAJI HALIDU ACHIDAGO	2	14	
			CATHECHIST	2		
			DAVID AGYENIM BOATENG	5		
			ISSIAH NAWURI	1		
			JULIANA BOAKYEWAA	4		
	TECHIMAN SOUTH	TECHIMAN	AFENA YORKE	6	12	
			OBIRI YEBOAH	3		
			SHAIBU MUMUNI	3		
	TECHIMAN NORTH	TUOBODOM	AFENA YORKE	8	27	
			AMISARE ASUA BAFFOUR	8		
			JOSEPH ADDAI	9		
			OBIRI YEBOAH	2		
	WENCHI	WENCHI	JOSEPH AMANSIA-TWUM	2	2	
	TAIN	NSAWKAW	PETER OKRAH	10	10	
ASHANTI	OFFINSO NORTH	AKOMADAN	KWABENA DOUDO	5	5	
BRONG AHAFO	SENE WEST	KWAME DANSO	GRACE OWUSU	7	7	**7 Districts** **148 Respondents**
	SENE EAST	KAJEDI	RUEBEN KUMAH	2	2	
ASHANTI	EJURA SEKYEREDUMASI	EJURA	IBRAHIM ABDUL-RAHMAN	5	73	
			MOHAMMED ISSIFU PANGABU	19		
			PAUL DUUT YENUMAH	31		
			PRINCE OWUSU-DANSO	18		

Region	District	Capital	OB	Respondents	Total Respondents	Comments
	SEKYERE AFRAM PLAINS	KUMAWU	MICHAEL OPOKU	2	2	
	SEKYERE CENTRAL	NSUTA	DAVID YANFUL	14	38	
	SEKYERE SOUTH	AGONA	EBENEZER AMANKWAH	22		
			GODWIN ODURO	2		
EASTERN	KWAHU APRAM PLAINS SOUTH	DONKOR KROM	BUKARI ISSIFU	12	26	
			DANIEL KOFI OSEI	**6**		
			DANIEL OSEI ASOMANING	**4**		
			KOFI TANGBE	4		

Annex 7 - Enumerators Selected for the Study

No	Name	Zone	Region(s)	Supervisor
1	Dong Abu Aaron	1	Upper West	Josh Glover Tay
2	Grace Dawuri	1	Upper West	
3	Dzidzienyo Edem	2	Upper East and Northern	
4	Simon Chanagia	2	Upper East and Northern	
5	Mumuni Abdul Baaki	3	Northern	
6	Alhassan Anwar Sadat	3	Northern	
7	Kingsley Baffoe	4	Brong Ahafo and Ashanti	Isadore Nii Attoh Armah
8	Mario Nii Ayi Armah	4	Brong Ahafo and Ashanti	
9	Felix-Ham K. Nugor	4	Brong Ahafo and Ashanti	
10	Nash Ansu	5	Ashanti, Eastern and Brong Ahafo	
11	Dawyne Richards	5	Ashanti, Eastern and Brong Ahafo	

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Annex 9 - Picture Gallery