Farmers' and Traders' Perceptions on the Incidence and Management of Weevils in Maize (*Zea Mays*) Storage in the Tano South Municipality of the Ahafo Region of Ghana

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Abstract: **This paper assessed farmers' and traders' perception in the incidence and management of pests in maize *(Zea mays*) in in the Tano South municipality of the Ahafo region of Ghana.A sample size of 200 respondents consisting of 150 maize farmers and 50 maize traders, from six communities were used for the study. Semi-structured questionnaires and personal interviews were used in collecting information from the respondents. Data collected were analysed using Statistical Package for Social Scientist (SPSS version 19). Insects were the number one cause of maize spoilage at storage, mostly weevil infestations. *Sitophilus zeamis* and *S. oryza* were the commonly identified weevils in stored maize. Gain lost ranged from 1-5 100 kg bags per farmer anually. Control measures adopted by farmers and traders in managing weevil infestation in storage included the use of chemicals such as Actelic® EC, Baltelic® EC, Attack, Combat, Confidor, Fumigant, Karate and wood ash.**

Keywords: **Farmers, Traders, Perception, Weevil Incidence, Management, Maize**

I. INTRODUCTION

Cultivation of maize (*Zea mays* L.) has been going on in Ghana for generations. It became a vital staple crop in all regions of Ghana after its introduction in the late 16th century. Maize is Ghana's most frequently grown and consumed grain crop, and its production has been steadily expanding since 1965. (Morris, et al. 1999; FAO, 2008). In Ghana, rain-fed maize cultivation is primarily carried out by smallholder farmers with limited resources (SARI, 1996). Maize is grown all over the world and is a staple food for most people in different parts of the globe. There are no known poisons connected with the genus *Zea*, which includes maize (IFBC, 1990). Maize is a key source of calories in Ghana, and according to one assessment, it has practically supplanted sorghum and pearl millet as traditional staple crops in the country's northern regions (SRID-MoFA, 2011). Between 2007 and 2010, the average annual maize production was 1.5 million MT (Rondon&Ashitey, 2011), with an average yield of roughly 1.7 t/ha (SRID-MoFA, 2011). Maize accounts for more than half of Ghana's total cereal production, and annual yields have been reported to be increasing at a rate of 1.1 percent each year (IFPRI, 2014). Despite maize's various economic benefits in Ghana, the crop suffers from significant postharvest losses both in the field and in storage.

Food insecurity is mostly caused by pre-and post-harvest losses in Ghana and around the world. The phrase "postharvest loss" refers to food loss in the postharvest system that can be measured both quantitatively and qualitatively (Harris &Lindblad, 1978). From the moment of harvest, through agricultural processing, marketing, and meal preparation, to the consumer's final decision to eat or discard the food, this system is made up of interconnected activities. Pre-harvest, harvest, and/or post-harvest losses in grain quality are all possible. Insects, weeds, rusts, and lodging can cause pre-harvest losses, which occur before the harvesting process begins. Harvest losses occur throughout the harvesting process and are usually due to mechanical injury, shattering, and poor harvesting practices. Between the time of harvest and the time of human consumption, postharvest losses occur (Alhassan&Kumah, 2018). These losses include those that occur on the farm during threshing/shelling, winnowing, and drying, as well as losses that occur throughout the supply chain during transportation, storage, and processing (Harris &Lindblad, 1978). On the farm, significant losses happened during storage, whether the grain was being stored for consumption or the farmer was waiting for a selling opportunity or a price increase (Shepherd, 2007). In most developing countries, the postharvest loss is the leading cause of food insecurity, and it could lead to deforestation and, as a result, land degradation as more land is cleared for farmers to meet the growing demand of the growing population and to make up for the losses to be food secure. Food security exists when all people have physical, social, and economic access to enough, safe, and nutritious food to suit their dietary needs and food preferences to living an active and healthy life (FAO, 2010). A study of maize postharvest losses at various levels of the handling chain would aid in determining the scope and size of losses incurred by farmers, transporters, and dealers, as well as the variables that contribute to such losses. This would also demonstrate the whole economic loss from harvest to storage (Alhassan&Kumah, 2018). The goal of this study was to

determine how farmers and dealers in the Tano South Municipality of Ghana's Ahafo Region perceived the level of postharvest losses in maize before and during storage.

II. MATERIALS AND METHODS

The study was conducted at Tano South municipality of the Ahafo Region in Ghana in 2019. Two hundred (200) respondents making up of one hundred and fifty (150) farmers and fifty (50) traders were used for the study. A simple random sampling technique was used to select the respondents from six communities with the support and guidance of an Agriculture Extension Officer (AEO). The communities were chosen based on the level of maize cultivation and market activities. The communities included Bechem, Mansin, Derma, Ankaase, Techimantia and Tweapiase. Thirty (30) farmers each were selected from Bechem, Derma and Techimantia while twenty (20) farmers each were chosen from Mansin, Ankaase and Tweapiase. Farmer associations in the various communities were contacted for the choice of the farmers for the study. Nine (9) traders each were selected from Derma and Techimantia while eight (8) traders each were selected from Bechem, Mansin, Ankaase and Tweapiase for the work. There are maize trader associations in the municipality and members of these associations were used for the study. The simple random sampling gave every member of the population the probability of being selected to represent the population thereby making it trustworthy, unbiased and a fair cross-section representation.

Data Collection

A semi-structured questionnaire which employed both open and close-ended questions was designed and used for the farmers and traders selected from the six communities. There were 52 questions in the farmers' questionnaire and 43 questions for the traders' questionnaire. The questionssought views of the respondents on storage conditions of maize and their associated problems in the municipality. The questionnaire for farmers covered demographic characteristics, farm characteristics, harvesting and handling and pest management in maze. The traders' questionnaire also looked at demographic characteristics of traders, market characteristics, storage practices by traders, occurrence of storage pests and control of weevils in storage.

Respondents who were literate were given the questionnaires to answer. They were guided the researchers to enable them answer the questionnaire items without any difficulty. They responded by ticking (√) the right responses in the case of the close-ended items and to state their views in the open-ended items.

To the respondents who could not read and write, the researchers read out and explained the questionnaire items to them for them to make their choices in the close-ended items and to state their views in the case of the open ended questions.

Data Analysis

The data collected were analyzed using Statistical Package for Social Scientist (SPSS version 19). The results were presented in tables and graphs. Values were presented in percentages.

III. RESULTS

Demographic Characteristics of Respondents

In relation to the gender of farmers, 82.6% of the farmers interviewed were males while 17.4% were females. This indicates that males dominate in the production of maize (Figure 1). Majority of the maize farmers, were single males (82.6 %),aged between 31-50 years (65.1 %) (Figure 2), who had only basic education (62.0%) and had farm sizes ranging from 1 to 5 acres (53.3 %), (Tables 1 and 2)

The gender of the traders is presented in (Figure 1). Most of the traders were females (64%) with 36 % being males. This indicates that females dominated in the marketing of maize. Majority (66 %) of the traders were between the ages of 31-50 years (Figure 2). Majority (52. %) of the traders were married and 60 % of them had basic education as their highest academic qualification (Tables 1 and 2)

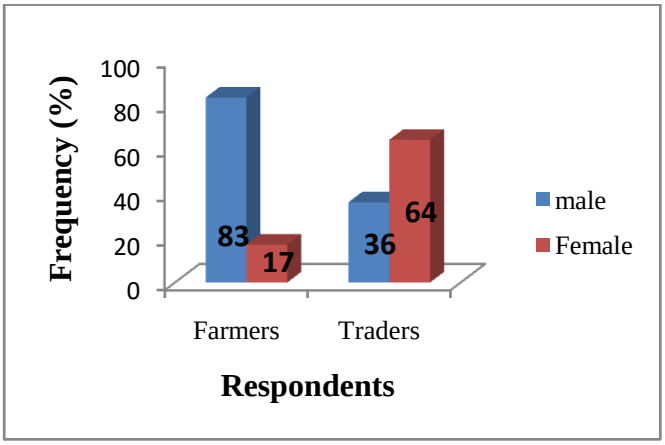

Figure 1: Gender of Respondents

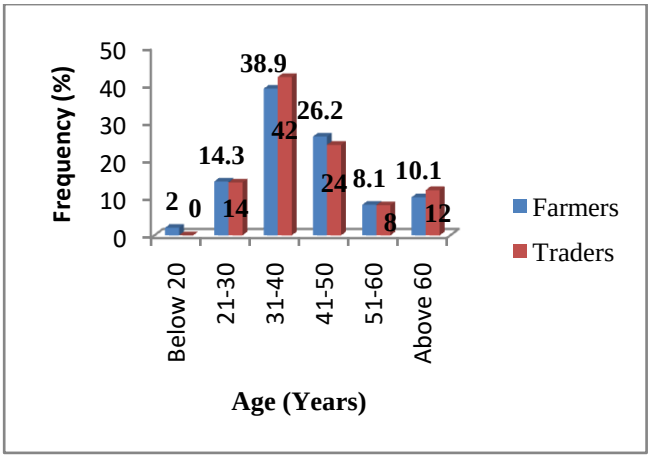

Figure 2: Ages of Respondents

Table 1: Marriage status of Respondents

Marriage Status	Percentage (%)	
	Farmers	Traders
Married	8.0	52.0
Single	80.7	12.0
Divorced	7.3	28.0
Widowed	4.0	8.0
Total	100	100

Table 2: Educational Level of respondents

Education Level	Percentage (%)	
	Farmers	Traders
No Formal Education	32.7	38.0
Basic (Primary-JHS)	62.0	60.0
Secondary	3.5	2.0
Tertiary	2.0	0.0
Total	100	100

Farm Characteristics

Acreage of land under maize cultivation

The farmers surveyed had small areas for maize cultivation. From the survey (Table 3), 53.3% of the respondents (Farmers) interviewed indicated that they cultivated between 1-5 acres of land, 30.7% cultivated between 6-10 acres of land, 6.0% cultivated between 16-20 acres with 5.3% cultivated more than 20 acres of land. Only 0.7% of the respondents were found to cultivate between 11-15 acres of land.

Table 3: Acreage of land under maize production

Farm size	Frequency	Percentage (%)
1-5 acres	80	53.3
6-10 acres	46	30.7
11-15 acres	1	0.7
16-20 acres	9	6.0
More than 20 acres	8	5.3
No response	6	4
Total	150	100

Variety of maize cultivated

There are several maize varieties released and cultivated by farmers in Ghana. In the Tano South Municipality, the common varieties of maize cultivated included, 'Obatampa'(53%) and 'Aburopa' (40.7%),(Figure 3).

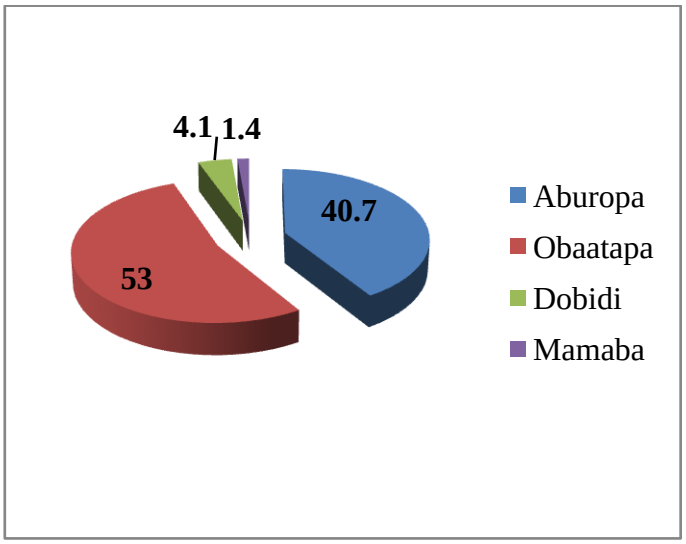

Figure 3: Variety of maize cultivatedby farmers in the Tano South Municipality

Varietal susceptibility to storage pests

The study also looked at susceptibility of maize varieties cultivated by the farmers to storage pest attack (Figure 4). It was revealedthat 'Obaatanpa'was most susceptible to pest attack (85.1%), followed by the Aburopa, 13.5%, then Dobidi and Mamaba maize varieties.

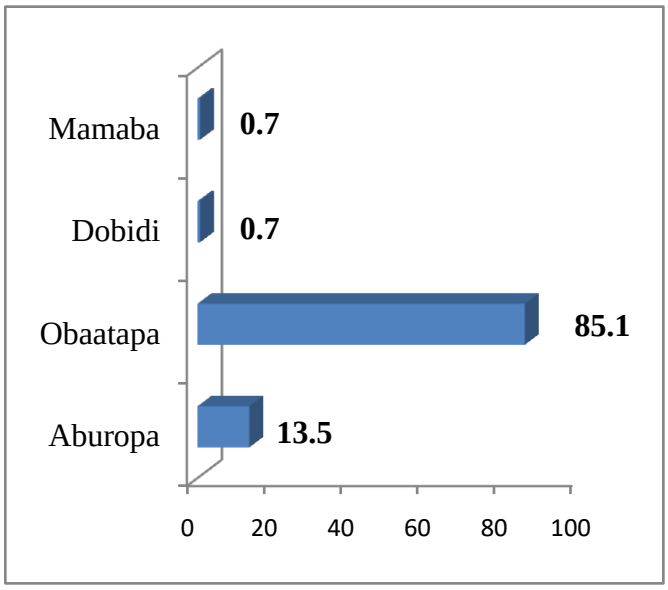

Figure 4: Varietal susceptibility to storage pests

Market Characteristics

Figure 5, depicts the number of years the respondents (Traders) had been trading in maize. Majority of the traders(58.3%) had been in the maize business for 6-10 years and buys 10-30 bags (30 %) of maize per market trip (Table 4).

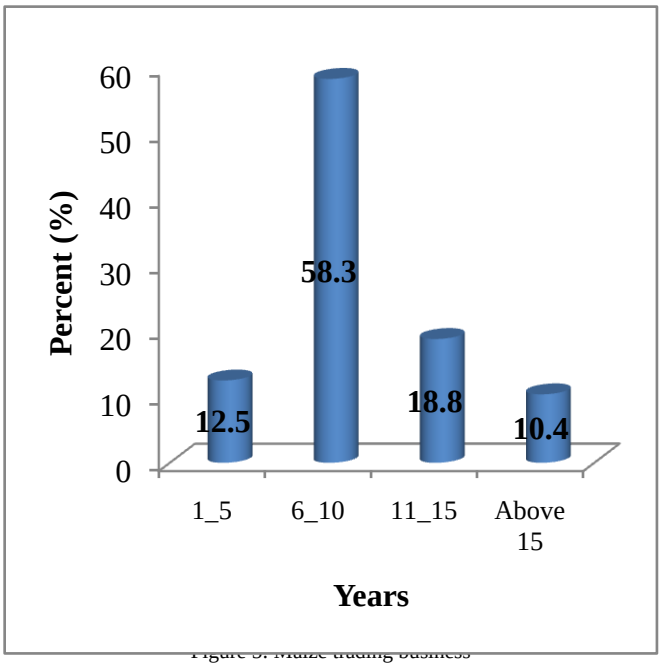

Figure 5: Maize trading business

Table 4: Quantity of grains bought per Market trip

	Frequency	Percentage (%)
Less than 10 bags	13	26.0
10 -20 bags	15	30.0
21-30 bags	6	12.0
31-40 bags	5	10.0
41-50 bags	4	8.0
Above 50 bags	7	14.0
Total	50	100.0

Harvesting and Handling Practices

Storage of maize after harvesting

Almost all the farmers (96.8 %) indicated that they stored their grains.Most of the respondents (57.3 %) indicated that they de-husk the cob before storing. Others stored the cob in the husk (35.3%) and some shelled the maize before storing (7.4%), (Table 5, Figure 7).80.7% of the farmers indicated that they stored the grains between 1-6 months whereas 11.3% of the farmers stored the grains for 7 months and above (Table 6. Figure 7).

Table 5: Form in which the maize grains were stored

Form of storage	Frequency	Percentage (%)
Husked	53	35.3
De-husked	86	52.0
Shelled	11	7.4
Total	150	100.0

Table 6: Duration of maize grain storage after harvesting

Storage duration	Frequency	Percentage (%)
1-6 months	121	80.7
7 months and above	17	11.3
No response	12	8.0
Total	150	100.0

Farmers and maize traders in the Tano South Municipality stored maize in so many ways. The common storage facilities identified were Cribs, Depot/Warehouse and Converted Bedrooms. 22.9 %) of maize traders used cribs, 2.1 % used depots/warehousesand 75 %stored their maize in ordinary/ empty bedrooms.Majority (82 %) of the farmers stored their maize in cribs (Figures 6). It was also identified that farmers and traders packaged their grains in nylon woven sacks (86.7%), jute sacks (8.0%) and in baskets (1.3%), (Figure 7). The duration of maize storage before selling, ranged from 2 weeks to a few months.

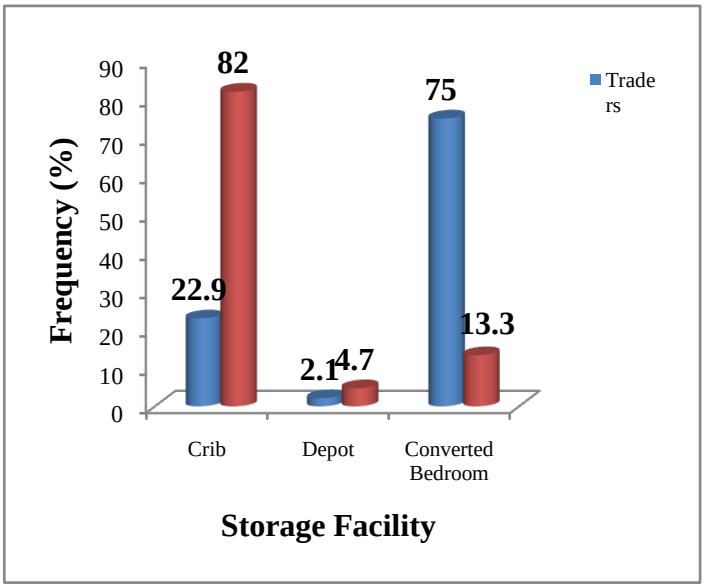

Figure 6: Type of storage Facilities used by the farmers and traders in the Tano South Municipality

Figure 7: Storage of Maize in the Tano Municipality; A) Unhusked maize stored on Barn at Mansin; B) Unhusked maize stored in a Crib at Derma; C) Unhusked maize stored in the kitchen at Tweapiase; D) Husked maize stored in a Shed at Bechem; E) Husked maize stored on the floor of an empty bedroom at Techimantia; F) Shelled maize stored in Nylon bag at Derma; G) Shelled maize(grains) stored in an empty bedroom at Bechem

Practices carried out on maize before storage

Drying, shelling, winnowing and disinfection were identified as some of the practices farmers and traders carry out on the maize before storage. According to the respondents, drying was mostly by sun dry. Most of the farmers used shelling machines (66%) in shelling their maize (Table 7).

Table 7: Method used by farmers to shell maize

Method	Frequency	Percentage (%)
Machine	99	66.0
Manual	47	31.3
No response	4	2.7
Total	150	100.0

Pests Management in Maize

Incidence of pests attack in maize storage

Here, the researchers sought to find out the perception of farmers and traders on incidence of pest and their attack on maize. According to the respondents, majority of maize spoilage was due to insect attack (82 %), fungal attack (5.0 %) and other infections (13.0 %), (Table 8). According to the respondents, the insect attack on the maize was mainly attributed to weevils. Fungal attack resulted in moldiness of the stored grains. On the other infection or attack on the maize, the respondents made mention of rodents such as mice andgrass cutteras well as termites.

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Table 8: Farmers and Traders responses on Pest attack on maize

Response	Frequency	Percentage (%)
Other pest attack	26	13
Insect attack	164	82.0
Fungal attack	10	5.0
Total	200	100.0

Maize weevils and their effect on stored grains

Majority (72 %) of the respondents (Farmers and Traders) believe that infestations begin in the field. The degree of damage from the weevils on maize was said to be very severe (88 %), (Figure 8).

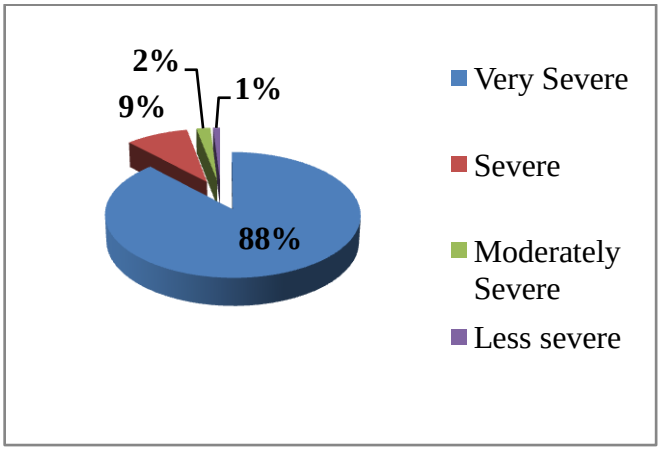

Figure 8: Degree of damage by weevils on maize

Control of maize weevils in storage

It was identified that farmers and traders controlled weevil using insecticide (68 %), intermittent sun drying (20 %), use of plant extracts (10 %) and release to market (2 %). Insecticides such as Atellic, Baltelic are mostly in controlling the weevils. The respondents also revealed that they use other chemicals such as "Akwadaa nyame" powder, Attack, Combat, Confidor, Dusting, fumigant, Karate and Wood ash in controlling weevil infestation in maize storage.

When they were asked whether the chemicals /insecticides were effective and available on the market all the respondents indicated that the chemicals/insecticides used in controlling the weevils were very effective and available on the market. They indicated that they mostly obtained these chemicals from the agro chemical sellers, agricultural institutions and research stations.

On the application of the insecticides, only 22 % of them said they used the prescriptions given to them by the chemical sellers. The rest of them said they used their own measurements in applying the insecticides, as they believe that most of the times the prescribed doses were less effective in controlling the weevils.

IV. DISCUSSION

Demographic Characteristics of Farmers

The study conducted revealed that males dominated the maize production compared to females. Most of the farmers were aged between 31 to 50 years which represent the economic active working class of the country. It can therefore be inferred that the farmers in Tano South municipality were still in their youthful ages and could work for longer periods of time barring any unforeseen circumstances. This is good for the municipality and the country as a whole. This is in line with the national cry for the youth employment in agriculture, to increase food production and reduce poverty. Majority of the farmers were not married with only a few either married or divorced. A high proportion of the farmers had basic education with a small percentage attaining either secondary or tertiary level but also, a relatively high proportion had no formal education. The current results are in line with the report from the agricultural production survey for the northern regions of Ghana for the year 2014, which showed that 90 % of farmers in the northern regions were males and the 10 % being females (Amanor- Boaduet al.,2015). Haruna et al. (2018) reported that majority of farmer involved in cowpea cultivation in the Upper East region of Ghana were males between 21 and 50 years with every little or no formal education. English is important for individuals' longterm economic wellbeing because it is Ghana's official language (Amanor-Boaduet al.,2015). While significant effort is being made by the government to enhance formal education in the country, over 90 % of the farmers in the Tano South municipality, either had no formal education, or very little education (Primary education).

They could therefore not speak or write in English. This could affect their production as they cannot read simple instructions on chemicals, fertilizers and other inputs. Manuals from training workshops cannot be easily used by farmers because of illiteracy. Amanor-Boadu and his colleagues (Amanor-Boadu et al.,2015), reported that only 12.5% of 526 farmers in the northern regions of Ghana could read and write in English.

The agriculture sector in the Tano South municipality is dominated by illiteracy. There is very little involvement of the elites in agriculture in the municipality. This could be a very serious challenge to agricultural production in the municipality and Ghana at large. However, adult literacy evening community classes for farmers could improve the current situation significantly.

On the part of the traders, most of them were females indicating the female dominance in the trade. The traders were aged between 31 and 50 years. This means that the traders fell within the working class of the population. Most of them were married with a few divorced. Most of the traders had basic education which meant that they could read and write. The income levels of the traders fell within the middle income bracket (Ghana Statistical Report 2008).

Farm Characteristics

The study revealed that majority of the farmers cultivated between 1-5 acres (0.4-2 ha) and 6-10 acres (2.4-4 ha) of land. Ghana Grains Development Project (1991) estimated that most maize fields range from 1ha to 2ha as was seen in the study. Again, MOFA (2010) reported that about 90% of farm holdings in Ghana were less than 2ha in size although there were large farms and plantations for specific crops. The average yearly maize production was reported to be 1.5 million MT between MY 2007 and 2010 (Rondon and Ashitey, 2011) with an average yield of about 1.7 t/ha (SRID-MoFA, 2011).Obatanpa was the most cultivated maize variety and more prone to pest attack than the local variety and the two hybrids; Dobidi and Mamaba which were less susceptible to pest attack. Farmer preference despite its susceptibility to pest attack could be attributed to the fact that the Obatanpa variety had a larger market and price making it the most demanded. According to CRI (1996) Obatanpa has superior quality protein (about 10%) and higher levels of tryptophan and lysine and is resistant to major maize diseases such as maize streak virus, rust (*Puccinia polysora*), blight (*Helminthosporium maydis*), Fusarium ear rot and *Aspergillus flavus* (Asiedu et al. 2002). Also Sallah et al. (1997) and Twumasi-Afriyie *et al*. (1992) reported that Obatanpa was high yielding comparable to the popular normal maize varieties similar to improved intermediate and late maturing normal maize varieties.

On production, the average number of bags obtained per cropping season per farmer, ranged between 1-10 bags, with a few producing between 11-30 bags. Production reaching 100 bags constituted a small fraction of the farmers.

Postharvest handling and Practices in Maize by Farmers

Quality cannot be compromised in the agricultural production chain, and post-harvest handling of produce is a critical factor in determining standards and quality. Post-harvest handling involves the management of produce before processing which involves drying, storage, protection against pests, and moisture regulation. This step importantly requires quality control processes, a key in competitive products marketing (Darfour & Rosentrater, 2018)

The majority of the farmers stored their maize after harvesting and the cobs were usually stored whole or de-husked with only a small fraction shelling before storage. de Lucia and Assennato (1994) indicated that dry maize could be stored in husked, unhusked or shelled on the farm, in the residence, at a collection centres, or in silos by individuals or storage agencies. Hayma (2003), said that maize can be stored as husked or unhusked maize cob or as shelled grains when well dried because after storage almost no further drying occurs. Storage usually ranged between 1-6 months with few farmers storing more than 6 months. This practice of the farmers storing their grains gives them a bargaining power since the farmers will be in a better position to sell their grains during the lean season where maize is scarce and the prices are good. Thus, it guarantees the farmer better price for his labour. FAO (2012) reported that farmers mostly stored much of their maize in anticipation of higher prices in the lean season and indicated that farmers are able to hold over 70% of their produce on the in-farm storage system.

Before the harvested grains are stored, practices such as drying the grains before storing was not done by most of the farmers. This was due to the fact that harvesting of cobs was usually done when the entire crop is dried on the field. This cut down the cost of harvesting since the farmer could harvest the entire field without looking out for fresh cobs. However, Darfour & Rosentrater, (2018) stressed that proper drying, cleaning of grains and treatment of grains are necessary for meaningful storage programme.

It was obvious from the study that mechanical shelling of the cobs was mostly employed by the farmers in the district since it was fast and saved time compared to the manual system where there is the beating of the cobs in a sack to liberate the grains and the cost involved in hiring extra hands in the shelling process. Winnowing was not done by most of the farmers especially those who used the mechanical system of shelling since the machine separates the chaffs from the grains

Disinfection of storage room were mostly done, chemicals such as Actelic, Attack, Combat, Confidor and Karate were commonly used in controlling storage pests. Few of the farmers employed traditional methods such as the use of salt, wood ash in storing the maize grain against insect pests.

De-husked maize was more susceptible to weevil attack than husked and shelled maize. Storing shelled maize would help reduced losses due to weevil attack. The nylon woven sacks were mostly used in the packaging of the grains.According to Baributsa and Ignacio (2020) nylon/hermetic bags preserves grain without the use of insecticides, keeping grains in good quality from several months to at least two years. A small percentage also used the jute sacks. The use of the nylon woven sacks by the farmers could be attributed to the fact that these materials were readily available on the market and very cheap compared to the jute sacks which were mostly expensive and normally used in cocoa bean packaging. Post-harvest losses could therefore be reduced through the use of appropriate packaging materials.

The method of storage used by the farmers included the crib system which was normally used for storing husked cobs whereas the converted bedroom system was used for storing shelled maize and bagged grains. MOFA (2008) reported that farmers stored their grains in a converted room or in a purpose built crib as their storage facility. As such it may be argued from the farmers' perspectives that, post-harvest losses due to weevil infestation, is higher when maize is stored in crib.

Storage of Maize by Traders

The availability of storage facilities for storing the purchased maize was very crucial in the maize business. The study showed that majority of the traders had a storage facility for

storing the purchased grains. Rooms and depots/warehouses were normally used as a storage space for the grains. Most of the traders stored the grains for 2 weeks before selling while few others stored for more than a month to improve pricing. Moreover, FAO (2011) statistics revealed that traders rather buy and sell quickly the grains, earning a moderate profit on each transaction. They also believed that traders disposed of stocks as quickly as possible, in order to minimize losses associated with pest infestation and to avoid the extra expense of pest control. In situations where the grains were well dried, the traders did not dry but where the grains were not well dried, they employed sun drying before storing the maize grains. Besides, Lindblad and Druben (1976) reported that maize was mostly dried by sunshine or hot-air current especially in wet regions where humidity is high. Drying was either on-platform (Hodges, 2001) or on-ground (World Bank, 2011).

Darfour and Rosentrater (2018) reported that farmers in the northern Ghana used mud silos, constructed with mud and roofed with grass straws, for maize storage.

Farmers management of Pest in Maize

When the perception of the farmers and traders on incidence of weevils in storage was assessed, it was observed that majority of them experienced some form of spoilage in storage and the most serious was attributed to insect attack mostly maize weevils. Vowotoret al. (2005) in their work indicated that the most dominant insect pests of stored maize in West Africa were mainly the large grain borer (LGB) *Prostephanustruncatus* (Horn) and the maize weevils *Sitophilus zeamais* (Motschulky). This accounted for the enormity at which grains were destroyed in storage. Fungal attack was rated serious and normally resulted in mouldiness of the stored grains, thus reducing the quality of the grains. Furthermore, Betiet al. (1995) reported that weevil attack sometimes predisposes the stored grains to fungal colonization, hence the seriousness recorded in the present study. Other pests attack was moderately serious and included mice, grasscutters and sometimes termites depending on the material used in constructing the cribs. Indeed, Gwinneret al. (1996) reported rodents as one of the major pests of stored grain. Pitt and Hocking (1996) in their studies concluded that fungi and insect were the most important storage pests of maize.

The main source of the weevils in storage, according to the farmers was from the field and the stored room especially where disinfection was not properly done. *Sitophiluszeamais* and *S. oryza* were the two major weevils identified to cause serious damage to the stored grains. Ofosu (1990) reported that the maize weevil, *S. zeamais*was the most important primary pest of stored maize in Ghana.

On the average, losses as high as 1-12 50kg bags were recorded, per farmer. Tefera (2012) reported that poor post-harvest management led to between 14 % and 36 % loss of maize grains.APHILIS (2014) reported that about 15% to 20 % of maize grains harvested in Ghana were lost annually to *S. zeamais*. This according to the writers affects farmers' income and food security; the quality and quantity of stored grains and finally the market value of the grains. Dartey (1998) pointed to the fact that for most peasant farmers' loss of their maize during storage means food shortage and subsequent famine. Similar results are recorded in other African countries.In, Ethiopian, 20-30 % of stored maize is lost to S. zeamais infestation, while 100% damage has been found in maize stored for 6 to 8 months in the Bako Region of the country (Demissie et al., 2008a). Mulungu et al., (2007) also found about 18% of shelled maize in store were weevil damaged in Tanzania, while Demissie et al., (2008b) found levels of 11-59% weevil infestation in husk-covered maize stored at Bako, Ethiopia, after one month of storage.Udoh et al., (2000) reported fungi, insects and rodent attacks in maize storage in Nigeria.

Control methods employed by the farmers included the use of chemicals such as Actelic, Baltelic, Attack, Combat, Confidor, Fumigant, Karate among others in controlling storage pests. This is because; the chemicals were effective and readily available on the market. Most of the farmers detained the treated grains for more than 1 month before selling. This practice enables the chemical to breakdown before the grains were consumed. Danilo (2003) recommended the use of Actelic® EC 25 at the recommended dosage as being safe to human health.

Tomlin (2009) reported that both synthetic and botanical insecticides were applied to the grains to kill insect pests and this was the commonest and the most effective method of controlling insect pests. They however, cautioned that over reliance and improper usage of the chemicals had led to rapid build-up of resistance to these pests to many of the insecticide. Other strategies employed in controlling the storage pest included shelling the maize and selling off to potential traders and also storing for a short period to break the cycle of the weevils.

Trader's management of Pests in Maize

Stored maize can be attacked by 20 different species of insect pests including the maize weevil, *Sitophilus zeamais* (Mots.) (Coleoptera: *Curculionidae*), and the larger grain borer (LGB), *Prostephanustruncatus* (Horn) (Coleoptera: *Bostrichidae*).

The traders indicated that the presence of storage pests was a major concern and that weevils, mice and sometimes mites were the most common storage pests identified. ARDC (2001) reported that among the major pests of stored maize, insects, rodents and mites have been the major constraint to grain storage because of the damage caused to grains resulting in grain weight loss, reduction in nutritional value and seed viability as they feed on the kernels. Again, *Sitophiluszeamais* and *S. oryza*were the major weevils identified in storage. Owusu-Akyaw (1991) also reported that about 20% of maize and cowpea produced annually are lost to *S. zeamais*

On the severity of weevil damage in storage, most of the traders indicated that the weevils caused moderate damage to the grains. The quantity of maize grains damaged to weevil activities was within the range 1-6 50kg bags of stored maize. Darfour and Rosentrater (2018) reported that in Ghana, an estimated 5 - 75% of maize is destroyed during storageThese losses increase cost of produce and thereby reducing consumers' purchasing power, divert income out of farmers' and traders' pockets, and hinder food availability (Opit, 2014). Losses of maize during storage to the traders mean loss of revenue(FAOSTAT/FAO Statistical Division, 2012).Boxall (2001) also reported that losses of stored grains have several negative impact at the farmers and other users, including deterioration in the nutritional qualities of a maize grain, reduce food availability for families, resultants need to purchase food product at high price during lean seasons, financial and profitability losses, disruption of the planned family food supply and reducing local maize processing industry.

It has been reported that 90% worldwide postharvest losses are due to insects, and mite infestation; and therefore the need to control them (Vachanth et al., 2010). The strategies employed by the traders in controlling weevils in storage included releasing the grains early to the market, sun drying to extend the storage life and the application of chemicals such as Atelic, Baltelic, D.D.T. and other fumigant in controlling the weevils. Further, FAO (2012) reports on pesticides residues in foods indicated that the use of Dichloro Diphenyl Trichlorethane (D.D.T) for storage can be harmful since it has residual effect of 0.09 mg/kg on the produce treated with the D.D.T.The use of DDT even though banned in all agricultural activities is still being used by maize traders and this present situation poses a health threat to almost all maize consumers.

On the use of chemicals in controlling storage pest, the traders indicated that the chemicals were effective in controlling the pests and also available on the market and could be obtained from the agro-chemical sellers and the agricultural institutions. Most of the traders detained the treated grains for 3 weeks before selling by which time; the chemical would have broken down. Obeng-Ofori, (2007 and 2011) reported that, control of the weevils is largely dependent on the use of synthetic insecticides.

Some recommended chemicals used are Actelic 1%, Malathion 2%, Malathion 2%, Etrimfos 1%, Gardona 3.25%, and Methacrifos 2% (Danilo, 2003). The development of resistant insects strains, and health hazards to grain handlers could broadly be attributed to widespread and overdose use of synthetic chemicals (Zettler and Cuprus, 1990; White, 1995; Obeng-Ofori et al., 1998). Annual cereal grain losses could be up to 50% even with the heavy chemical usage although the average losses stand at roughly 20% (Obeng-Ofori, 2011). Misuse of insecticides by farmers is predominant and health and environmental problems are inevitable (Baributsa et al., 2010).The major draw backs in the use of insecticides are that they do not protect against grain re-infestations, they are extremely poisonous and could result in death if not well-handled (Danilo, 2003).

V. CONCLUSION

The study confirmed that maize farmers and traders in the Tano South municipality experienced the presence of storage pests. The major storage pest was weevils. Damage caused by weevils on stored maize grain was very severe, resulting in the loss of 1-5 bags of stored grain. The major sources of weevil infestation in the stored maize were from storage. The method used in storing the grains determined the final quality of the grains. *Sitophiluszeamais* and *S. oryza* were the two major species of weevils identified to cause damage to stored maize. Farmers and traders in the Tano south municipality used insecticides in the control of weevils, such asActelic, Baltelic, Attack, Combat, Confidor, Fumigant, Karate.

DATA AVAILABILITY

The data used to support the findings of this study can be accessed from the corresponding author upon request.

DISCLOSURE

The authors take full responsibility for any error.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest regarding the publication of this paper.

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