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Survey on Storage Insect Pest, Methods of Storage and Management Measures on Sorghum Grain around Sub Zoba Hamelmalo, Eritrea

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Abstract: ***Survey was intended to study the storage insect pests in sorghum around the sub-zoba Hamelmalo. Though this crop is one of the most stable field crops in Eritrea, it is severely infested by many storage insect pests. Therefore, the survey was conducted to address the challenges with storage insect pests with the aim of identifying the storage insect pests of sorghum grains, storage methods of the subsistence farmers and its management practices used by the farmers. The survey was carried out in sub-zoba Hamelmalo by using open ended questionnaires. Five administrative villages were randomly selected and from each village eleven farmers were selected at random for interview and sample collections. Five hundred gram of sorghum grains were collected and checked for pest occurrence and emergence in the laboratory. Sitophilus oryzae, Sitotroga cerealella and Sitophilus granaries were recognized as major storage insect pests in the representative administrative villages. The study discovered that the weight losses due to the storage insect pests range from 0.089% to 1.82% in sub-zoba Hamelmalo. The interview showed farmers in the sub-zoba used different management practices including ash mixing with grain, sun drying, cleaning, plant materials and insecticides to protect the grain from storage insect pests. In addition to that it is indicated that the most of the growers of the sampled villages used polyethene (meshemae) and guffet (traditional storage material) to store their produce.***

Keywords: Storage insect pest, Sorghum, Seed damage, Seed germination, Storage methods, Management practices.

1. Introduction:

Sorghum (*Sorghum bicolar* L.) belongs to poaceae family. During 1998 total world production of sorghum grain was 61.7 million metric tons produced on 43.4 million hectare [1] and about 39 countries in six continents produced at least 100,000 metric tons of sorghum grain during the same year. Sorghum is used mainly as livestock feed in the western hemisphere while significant quantities are used for human food in Africa and Asia [2].

The most important insect pests of stored grain sorghum are beetles and moths. Most of these insects have short development period, high rate of reproduction and long lives, on top of it, larvae do the most of the damage. Insect that attack stored sorghum grain are either primary pests that attack whole kernel and develop inside the kernel or a secondary pest that feed primarily on cracked or broken kernel, grain dusts, moulds that growing on grain in storage. These insects consume and damage

grain directly or cause indirect damage by contamination with feaces, odors, webbing or dead insect. Indirect damage can be done by insect caused heating and moisture accumulation with subsequent molding and caking of grain.

Pest species include beetles and moths with stages of life cycle adapted for feeding on grains. Some insect pests such as the rice weevil (*Sitophilus oryzae* L.) develop and feed in seed kernels consuming the entire seed. While other species such as red flour beetle (*Tribolium castaneum* Herbst.) feed mainly on the germs thus reducing germination [3]. For cereals alone this is equivalent to storage losses of more than 100 million tons of grains [4]. According to [5], the annual stored grain loss due to insect pest is 130 million tons. One of the problems of storage in Eritrea is management of the store and continues sources of infestation of the new harvested grains in the same vicinity, which causes an easy migration or infestation of the new grain from the old grains.

In the western lowlands of Eritrea, *Wia* (a type of grain storage) remains open for a long period of until the rainy season so that it is easy to take out grains when needed. This makes it easy for pest infestation. Similarly, in the highlands of Eritrea farmers' keep their grain in *koffo* from one harvest to the next for storage or as food security and most of the times it remains open for a prolonged period. This helps the pests migrate from old grain to new one. In additional, the location of the store is near a fire place, which increase the temperature of the store and finally speeds up pest's population build up.

Farmers in Eritrea use different pest control methods; they use internationally banned chemicals like DDT, chemicals that leave residue, kerosene and some other traditional methods such as mixed cropping, ash, sand, pepper, smoke and extracts of plant materials. If moist seeds are stored without air moving through them, the grain became hot, respires more quickly, mold form rapidly, insects multiply faster and the grain can germinate (sprout) while in storage [6].

2. Materials and Methods

Survey on storage insect pests, storage methods and management practices on sorghum grain were conducted in sub-zoba Hamelmalo, Eritrea which is located about 15km from Keren towards the north of Eritrea. The survey site is situated at $15^{o}55'$, 12.92''N latitude and $38^{o}27'$, 46.9''E longitudes with an altitude of 1280 m above sea level. It receives an average annual rainfall of 459mm and has sandy loam soil with pH range of 6.0 to 7.0 and it has an average temperature of 24^{o}C [7].

Five administrative villages (*Bashery, Libana, Wazntet, Kubrebered* and *Hamelmalo)* from this sub-zoba Hamelmalo, (Fig. 1) were selected for this survey. From each village eleven farmers' stores were selected randomly for sampling and data collection. Open ended questionnaires were used to generate free flow of information about the storage insect pests, storage structures and management measures taken by the ordinary farmers. During the survey the gain sample, types of storage methods and the control practices used by the farmers were recorded. A sample of 500g grain was taken and checked in the laboratory for identification of the

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storage insect pest. The identified insect pests were categorized as major and minor based on their level of infestations.

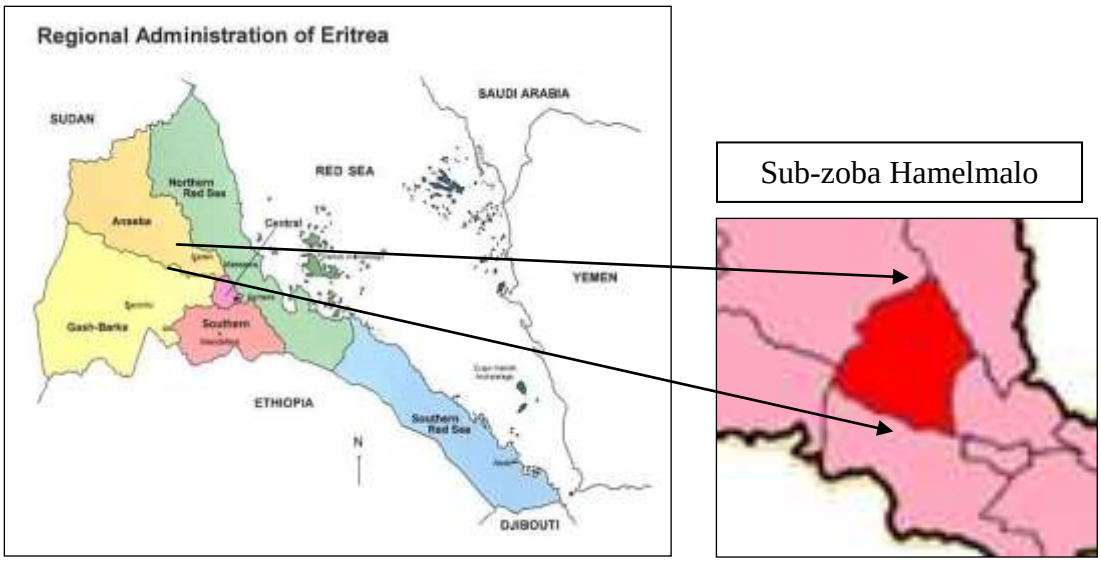

Figure 1. Sub-zoba Hamelmalo in Zoba Anseba of Eritrea.

From each collected samples 1000 seeds were taken at random and were counted as damaged and undamaged and weighed and calculated the loss percent of grain/seed weight. Samples of 50 and 100 seeds of damaged and undamaged were taken respectively and placed in Petri dishes, in a germination cabinet to determine the germination percentation of the sorghum grains/seeds. Viability loss assessment and germination percent were calculated in the laboratory.

$$\text{Germination percent (\%)} = \frac{\text{number of germinated seeds}}{\text{Total number of seeds}} \text{ X } 100$$

By using a gravimetric method [8] and [9] the percent loss of the sorghum grain/seed was calculated.

$$\text{\% loss in weight} = \frac{\text{UND-DNU}}{\text{U (ND+NU)}} \text{ X } 100$$

where: U= weight of undamaged grains

D=weight of damaged grains

ND=number of damaged grains

NU= number of undamaged grains

3. Results And Discussion

3.1 Identification of storage insect pests

The main storage pests in the study areas were identified and categorized as minor (*Tribolium spp)* and major (*Sitophilus granaries*, *Sitophilus oryzae* and *Sitotroga cerealella*) based on their level of infestation (Table 1). All the sampled sorghum seed/grains were damaged and affected both in quantity and quality as these insect pests feed inside the seed/grain kernels and consume the entire contents which are in agreement with [10] that biotic factors like insect pests, rodents and microorganisms are responsible for qualitative losses of stored grain. According to [3] the *Sitophilus oryzae* and *Tribolium castaneum* develop and feed inside the seed and on the germ (embryo). These storage insect pests cause damaged on the grain by

consuming the carbohydrates, vitamins and protein contents of the seed and it was reported that both beetles and moths larvae show a feeding preference for the germ region and resulted in germination failure or viability loss [11].

Table 1. Identified Storage Insect Pests of Sorghum and their Status in Sub-Zoba Hamelmalo

Storage Pests	Status	Administrative Villages				
Common and Scientific names		*Bashery*	*Libana*	*Wazntet*	*Kubrebered*	*Hamelmalo*
Granary weevil (*Sitophilus granaries*)	Major	√	√	√	√	√
Angoumois grain moth (*Sitotroga cerealella*)	Major	√	√	√	√	√
Rice weevil (*Sitophilus oryzae*)	Major	√	√	√	√	√
Confused flour beetle *(Tribolium confusum)*	Minor	√	√	√	√	√
Confused flour beetle *(Tribolium castaneum)*	Minor	√	√	√	√	√

√ indicates "identified pest".

3.2 Estimation of Damaged and Undamaged Seeds Weight

It is estimated from the Table 2, that the seeds collected from the five administrative villages showed a difference in their weight and ranges from 0.06g to 0.84g with a mean of 0.38 gram. The maximum damage (lowest seed/grain weight of undamaged) was recorded from *Wazntet* village (0.84g and 25.06g) for damaged and undamaged respectively where as the minimum damage was recorded from *Bashery* village (0.06g). It could be due to the long storage period of the sorghum grains in *Wazntet* as compared to other sampled areas. Similarly the undamaged seed weight varies from 25.06g to 44.72g with a mean of 38.54 grams where the maximum seed/grain weight (44.72g) and the minimum weight (25.06g) were obtained from Hamelmalo and *Wazntet* respectively.

3.3 Grain Weight Loss Percent in Store

During the study period the percentage weight loss of grain sorghum in the five administrative villages was determined and it showed that lower percent of grain/seed weight loss, ranging 0.09 to 1.82% (Table 2). The highest weight loss was recorded from *Wazntet* (1.82 %) as it was responded the seed/grains were stored for longer period and the lowest weight loss was registered from *Bashery* (0.09%). The result indicated that there was low storage insect pest infestation in the study area as a result the weight loss percent was very low as compared to the previous findings of [11] which was recorded above 20% weight loss in *Sitophilus* infested sorghum grains.

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Table 2. Mean Weight of Damaged and Undamaged Storage Seeds of Sorghum and Percentage of Weight Loss in Five Administrative Villages of Sub-Zoba Hamelmalo

Villages	Mean weight of seeds in gram		Weight loss
	Damaged	Undamaged	Percentage
Bashery	0.06	37.24	0.09
Libana	0.52	43.42	0.99
Wazntet	0.84	25.06	1.82
Hamelmalo	0.29	44.72	0.68
Kubrebered	0.18	42.47	0.33
Grand Mean	**0.38**	**38.54**	**0.782**

3.4 Germination percentage of damaged and undamaged sorghum seeds

During the study period there was a variation in the percent of germination of the damaged and undamaged seed (Figure 2). The highest germination percent of damaged seeds were recorded in *Hamelmalo* (39.2%) and lowest was recorded from *Wazntet* (9.5%) with mean of 25.1%. Similarly, the highest germination percent of undamaged seeds (93.3%) and the lowest (81%) were recorded from *Hamelmalo* and *Kubrebered* respectively with a mean of 85.2%. The maximum score of germination from *Hamelmalo* area was due to the short time storage of the sorghum grains/seeds and the grains were not heavily infested as compared to the rest of the surveyed villages. Generally heavily infested sorghum seeds may loss their viability due to the inside development and feeding habit of the larvae of the storage insect pests. These results in agree with [12] that during the storage period, a gradual reduction in germination percentage of maize grain occurred for *Gombisa* under intermediate agro-ecologies, while the percentage was, relatively less, in case of Sacks. Germination loss in *Gombisa* and Sacks as the period of storage increased might be due to fungal invasion [13].

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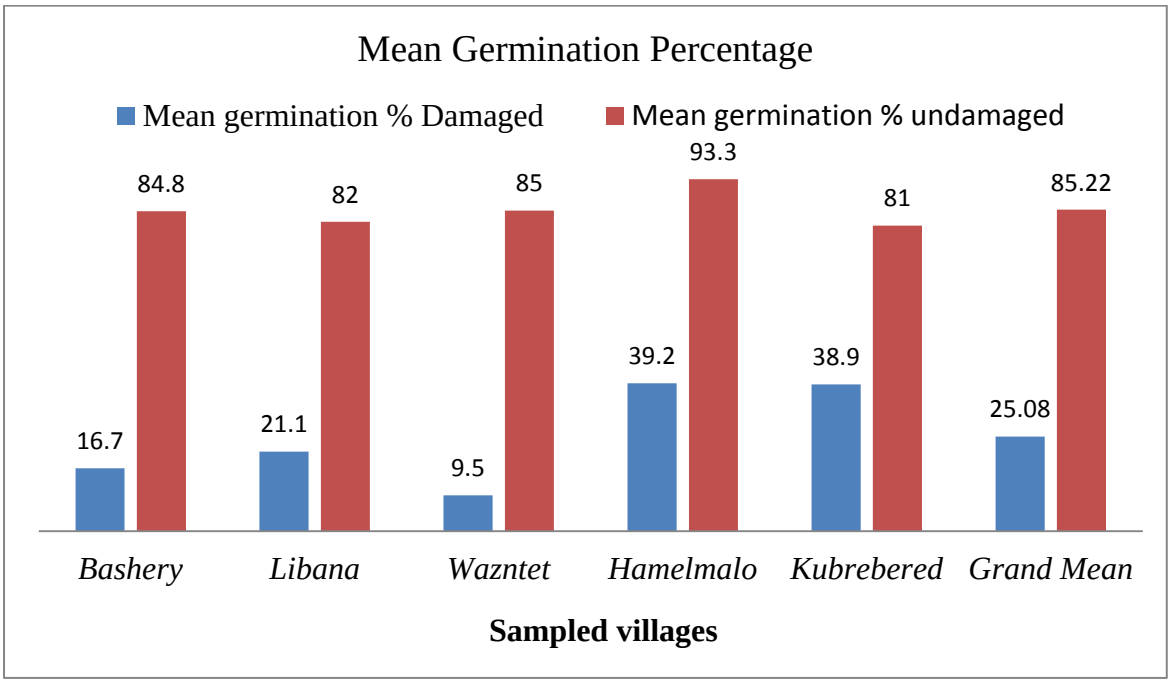

Figure 2. Germination percentage of damaged and undamaged seeds of sorghum in sub-zoba Hamelmalo

3.5 Storage methods

According to the interviewed farmers in the survey areas, it is studied that different grain storage materials include sack, polythene, underground pits and *guffet* (local grain storage made from leaves of coconut-*Coccus nucifera*), which can store about 5-10 quintals (Figure 3). Among the different storage materials the polythene bag (*meshemae*) followed by *guffet* was found the most popular grain storage materials. Polythene bag was the most preferred by farmers due to its easily availability and cheaper price. Sack is made from jute fiber in the country and is more liable to insect infestation; insect can easily get into it and cause grain damage. It is also similar to the investigation of [14] that as storage period proceeds the number of pests and their damage also increased. According to the farmers' the use of *guffet* was in a disappearing trend due to recurrent drought and less harvest in the last 10 years.

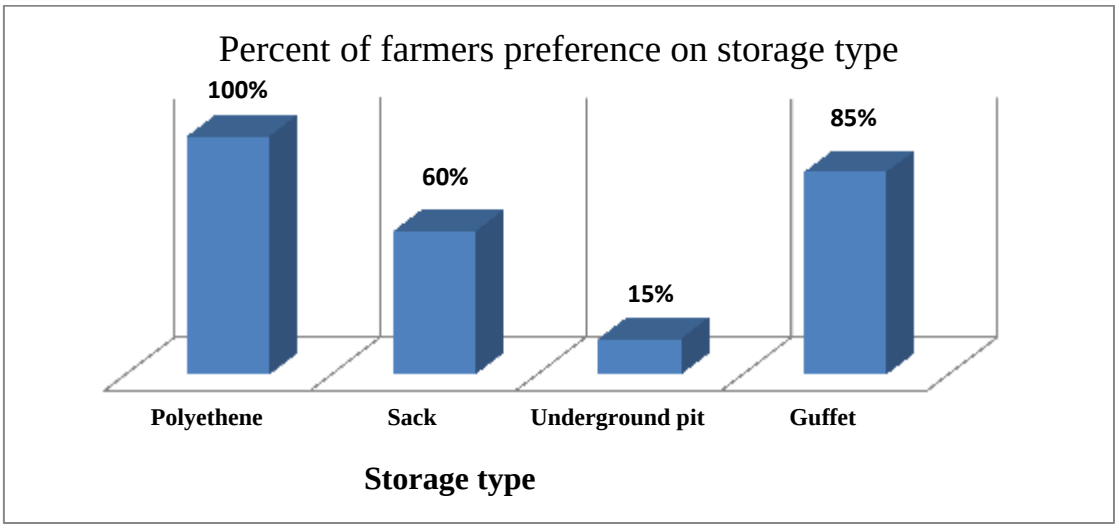

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Figure 3. Types of Grain Storage Methods and Farmers Preference

3.6 Control Management Practices Used By the Farmers in the Study Area

In the survey areas the farmers practice different types of storage insect pest control methods such as use of physical, chemical, cultural practices and use of bio-agents such as plant materials.

3.6.1 Physical Practices: Farmers practiced sun drying of grains to limit the moisture contents of the grains both under field and storage conditions so as to reduce re-infestation and to keep the moisture content of the grains to the level where storage insect pests cannot reproduce and survive. The response of the growers was matched to the earlier researcher's report, in tropics the unthreshed sorghum stalked in the field for drying so as to stop feeding ability of *Sitophilus* weevils by reducing the moisture content 9-5% [11].

3.6.2 Chemical Practices: Farmers, in the surveyed villages, used chemicals such as malathion 1% and DDT to protect their grains from storage pests. These chemicals were applied mainly for grains to be used as a seed for cultivation in the next season.

3.6. 3 Cultural Practices: Farmers, traditionally, used 'ash' for control of storage insect pests due to its effect on physical and physiological injuries to the insect pests. It is an inert dust that affects the respiratory system of the insect and kills them by suffocation. These results were in agreement with the investigation of [15] that 'ash' has the ability to hamper the development and cause desiccation due to the friction of the dust particles with the insect's cuticle. Furthermore, ash reduces the relative humidity of the store and increases the dryness of the grains. Some other farmers responded that the use of 'animal urine' for treating of grain from infestations caused by storage pests. As they believed that urine is acidic in nature, hence it affects the development of the insect in the grain.

3.6.4 Biological Method: The plant leaves of *Lantana camara*, *Datura stramoneum*, *Nicotina glauca* and Neem (*Azadiracta indica*) were used as protestants and its affect on the reduction of infestations of storage pest during storage. According to [11], neem leaves are minimize the storage pest and *Sitophilus spp* infestation when the usage of *Lantana camara*, *Datura* spp and *Eucalyptus* spp in Indian houses. It is also recorded as a successful biological control of pest to combat storage pests in different parts of the world.

Other recommendations

It is recommended that the farmers should get training on storage insect pests to recognize the pest early and control before it causes damage. The store should be well cleaned, ventilated and fumigated before and during storing a new produce. Growers should not use damaged grains for seeding as their germination percent is very low and they should avoid the use of insecticides that have residual effect as these chemicals are harmful to humans and animals. Extension workers should be available to advise the farmers in controlling the storage pests.

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