

Research Article

Storage Insect Pests and Their Effects on Cereal and Pulse Crops in Southern Ethiopia: A Review

Daniel Abebe Geletu^{1,*} , Firew Meka Mentso² 

¹Department of Plant Science, Jinka University, Jinka, Ethiopia

²Department of Physics, Jinka University, Jinka, Ethiopia

Abstract

Storage insect pests are important causes of post-harvest losses in cereal and pulse crops in Southern Ethiopia. Smallholder farmers commonly store harvested grain for several months using traditional storage structures and locally available materials, which may favor insect infestation and population development. This review synthesizes available evidence on major storage insect pests affecting cereal and pulse crops in Southern Ethiopia, their occurrence, damage, and effects on grain quantity, quality, food security, and farmers' livelihoods. Literature was compiled from scientific databases and other relevant sources, with emphasis on studies conducted in Southern Ethiopia and Ethiopia. Important pests of stored cereals include maize weevil (*Sitophilus zeamais*), rice weevil (*Sitophilus oryzae*), lesser grain borer (*Rhyzopertha dominica*), larger grain borer (*Prostephanus truncatus*), and Angoumois grain moth (*Sitotroga cerealella*), while pulse crops are particularly vulnerable to bruchids such as *Acanthoscelides obtectus* and *Callosobruchus* spp. Infestation causes grain weight loss, kernel damage, reduced germination, contamination, nutritional deterioration, and reduced market value. Pest occurrence and damage are influenced by crop type, grain moisture, temperature, storage duration, storage structure, hygiene, and initial infestation. Management options include improved storage, sanitation, hermetic storage, botanical materials, inert dusts, and appropriate insecticides. Integrated storage pest management and farmer participation are essential for reducing post-harvest losses and improving food security in Southern Ethiopia

Keywords

Cereal Crops, Pulse Crops, Storage Insect Pests, Grain Loss, Food Security, Post-Harvest Loss

1. Introduction

Cereal and pulse crops are important components of the food system and rural economy of Ethiopia. Maize, sorghum, wheat, barley, teff, common bean, chickpea, field pea, and faba bean provide food, income, livestock feed, and raw materials for different household and commercial activities. For many smallholder farmers, harvested grain is stored for several months to ensure household food supply, obtain better

market prices, and maintain seed for the following cropping season. However, a considerable proportion of grain can be lost after harvest because of inadequate drying, poor handling, unsuitable storage structures, rodents, microorganisms, and particularly insect pests [1, 2].

Storage insect pests are among the most important biologi-

*Correspondence: Daniel Abebe Geletu (danifaya91@gmail.com)

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cal factors responsible for quantitative and qualitative deterioration of stored cereals and pulses. They cause direct losses by feeding on grain, reducing its weight, and damaging kernels, as well as indirect losses through contamination with insect fragments, feces, exuviae, and other residues. Infestation can also reduce grain germination, nutritional value, market quality, and consumer acceptability [2, 3]. A review of post-harvest insect pests in Ethiopia reported substantial storage losses associated with insect infestation, with reported losses varying considerably among crops and storage conditions. Maize, sorghum, and chickpea have been particularly affected, demonstrating the importance of storage pest management for food availability and household income [2].

Several insect species are associated with stored cereal grains in Ethiopia. The maize weevil (*Sitophilus zeamais*), rice weevil (*S. oryzae*), lesser grain borer (*Rhyzopertha dominica*), Angoumois grain moth (*Sitotroga cerealella*), red flour beetle (*Tribolium castaneum*), and larger grain borer (*Prostephanus truncatus*) are among the important pests reported from stored cereals [2, 4]. The occurrence and importance of these pests vary according to crop, agroecology, grain moisture, storage duration, storage structure, and local management practices. In particular, the maize weevil is widely recognized as a major pest of stored maize in Ethiopia, while the recent detection of *P. truncatus* in southern Ethiopia indicates the need for continued monitoring of emerging storage pest problems [4, 5].

Pulse crops are also highly vulnerable to storage insect pests, particularly bruchids. Species such as *Callosobruchus chinensis*, *Callosobruchus maculatus*, and *Acanthoscelides obtectus* can cause serious damage to stored pulse grains. Infestation may begin in the field and continue or increase during storage. In heavily infested grain, feeding by larvae creates characteristic holes, reduces seed weight and germination, and can make grain unsuitable for consumption or planting [2, 6]. Chickpea, common bean, field pea, and other pulses therefore require effective protection during storage.

The problem is particularly important in Southern Ethiopia, where farmers use a wide range of traditional storage practices, including sacks, *gotera*, *gombisa*, household stores, and other locally constructed structures. A study conducted in southwestern Ethiopia on maize, sorghum, wheat, and faba bean demonstrated considerable quantitative and qualitative losses associated with insect infestation and reported deterioration of nutritional quality during storage [3]. Similarly, surveys in areas of southern Ethiopia have documented diverse insect communities in stored maize and substantial grain damage and weight loss under farmer storage conditions [7]. These findings indicate that storage pest problems are not uniform and may differ among agroecological zones, crops, storage systems, and farming communities.

The consequences of storage insect infestation extend beyond physical grain loss. Reduction in the quantity and quality of stored food can shorten the period during which households can depend on their own grain reserves, reduce income from

grain sales, increase expenditure on replacement food, and reduce the availability of quality seed for the next production season. Consequently, post-harvest losses caused by storage pests can contribute directly or indirectly to household food insecurity and economic vulnerability [1, 2]. In addition, excessive dependence on inappropriate chemical insecticides may create risks to human health, the environment, and stored-product quality, emphasizing the need for safer and more sustainable management approaches.

Different approaches have been investigated for managing storage insect pests in Ethiopia, including improved storage structures, hermetic storage, sanitation, proper drying, resistant varieties, botanical materials, biological control, and appropriate use of registered insecticides [2, 8]. Recent studies have shown that hermetic storage technologies can substantially reduce insect infestation and maintain grain quality compared with some traditional storage methods [8]. Nevertheless, adoption of improved technologies remains limited in many farming communities because of cost, availability, knowledge, accessibility, and differences in local storage practices.

Although numerous studies have examined individual storage pests, crops, or storage technologies in Ethiopia, information specifically addressing the overall effects of storage insect pests on cereal and pulse crops in Southern Ethiopia remains scattered. Evidence from different zones and districts is often reported separately, making it difficult to obtain a comprehensive understanding of pest occurrence, crop susceptibility, magnitude of grain loss, quality deterioration, economic importance, and management practices. Synthesizing the available information is important for identifying major knowledge gaps and developing practical integrated storage pest management strategies suited to the conditions of Southern Ethiopia. Therefore, this review was to assess the effects of storage insect pests on cereal and pulse crops in Southern Ethiopia.

2. Review Methods

Structured literature search was conducted to collect published and relevant information on storage insect pests affecting cereal and pulse crops in Southern Ethiopia. Literature was searched using scientific databases and search engines, including Google Scholar, PubMed, ScienceDirect, and other relevant agricultural and scientific databases. The search focused on studies published on storage insect pests, post-harvest losses, grain damage, grain quality deterioration, food security, farmer storage practices, and management of stored cereal and pulse crops. The main search terms included combinations of "storage insect pests," "stored grain pests," "cereal storage pests," "pulse storage pests," "post-harvest loss," "maize weevil," "larger grain borer," "bruchids," "maize," "sorghum," "wheat," "barley," "common bean," "haricot bean," "chickpea," "faba bean," "field pea," "Southern Ethiopia," and "Ethiopia." Priority was given to studies conducted in Southern Ethiopia and other parts of Ethiopia, while relevant studies

from East Africa and other regions were considered where local information was limited. Peer-reviewed journal articles, review papers, research reports, postgraduate theses, conference proceedings, and other credible scientific publications were considered. Studies were selected based on their relevance to the objectives of the review, particularly information on pest occurrence, distribution, crop damage, quantitative and qualitative grain losses, storage practices, and management options. Duplicate records and publications with insufficient relevance to stored cereal and pulse crops were excluded. Information obtained from the selected literature was organized according to crop type, major insect pest species, geographical area, storage system, type and magnitude of damage, effects on grain quality and food security, and management practices. The available evidence was then critically compared and synthesized to identify major storage pest problems, differences among crops and locations, existing management practices, research gaps, and priorities for integrated

storage pest management in Southern Ethiopia.

3. Review Result

3.1. Major Storage Insect Pests

Storage insect pests differ among cereal and pulse crops according to the physical characteristics of the grain, storage conditions, and the ability of individual pest species to infest and reproduce in stored commodities. In Southern Ethiopia, maize and other cereals are particularly vulnerable to weevils, borers, grain moths, and secondary beetles, whereas pulse crops are commonly attacked by bruchids. The major insect pests reported or considered important in stored cereal and pulse crops, together with their principal forms of damage, are summarized in [Table 1](#).

Table 1. Major storage insect pests associated with cereal and pulse crops.

Crop group	Crop	Major storage insect pests	Major type of damage	Reference
Cereals	Maize	<i>Sitophilus zeamais</i> , <i>Prostephanus truncatus</i> , <i>Sitotroga cerealella</i>	Kernel damage, weight loss and reduced germination	[9, 10]
Cereals	Sorghum	<i>S. zeamais</i> , <i>S. cerealella</i> , <i>Rhyzopertha dominica</i>	Grain damage and weight loss	[9, 10]
Cereals	Wheat	<i>S. oryzae</i> , <i>R. dominica</i> , <i>Tribolium castaneum</i>	Feeding damage and quality deterioration	[9, 10]
Pulses	Common bean	<i>Acanthoscelides obtectus</i> , <i>Zabrotes subfasciatus</i>	Exit holes, weight loss and reduced viability	[9, 11]
Pulses	Chickpea	<i>Callosobruchus chinensis</i> , <i>C. maculatus</i>	Internal feeding and weight loss	[9, 11]
Pulses	Field pea	<i>Callosobruchus</i> spp.	Seed damage and reduced germination	[9, 11]

3.2. Occurrence and Importance

The occurrence and importance of storage insect pests vary considerably according to crop, agroecological conditions, storage duration, grain moisture, and storage practices. Some pests are widely distributed and frequently associated with stored cereals, while others have a more specific association with particular crops. In Ethiopia, *Sitophilus zeamais* is an important pest of stored maize, while *Rhyzopertha dominica* and *Sitotroga cerealella* are also associated with stored cereal grains. Pulse crops are particularly susceptible to bruchid infestation. The principal storage pests and their relative importance are presented in [Table 2](#).

3.3. Major Types of Damage

The damage caused by storage insect pests extends beyond

direct grain consumption. Infestation may result in weight loss, reduced nutritional quality, decreased seed germination, contamination with insect fragments and faeces, and deterioration of grain appearance and market value. Primary pests damage intact grains, whereas secondary pests mainly attack broken or previously damaged kernels. In addition, insect activity may increase grain temperature and moisture in localized areas, creating conditions that favour further deterioration. The major types of damage associated with storage insect pests are summarized in [Table 3](#).

3.4. Factors Influencing Occurrence and Development

The occurrence and development of storage insect pests are influenced by several interacting factors, including crop type, grain moisture content, storage duration, temperature, storage

structure, and grain handling practices. These factors determine the suitability of the storage environment for insect survival, reproduction, and population growth. In addition, poor storage hygiene, initial infestation, and inadequate pest management may increase the risk of grain damage and quality

deterioration. Understanding these factors is essential for developing effective and practical storage pest management strategies under farmer storage conditions. The major factors influencing the occurrence and development of storage insect pests are presented in Table 4.

Table 2. Occurrence and importance of major storage insect pests.

No.	Insect pest	Common name	Major host crops	Occurrence and relative importance	Reference
1	<i>Sitophilus zeamais</i>	Maize weevil	Maize	Widely associated with stored maize and an important primary pest that damages whole grains.	[9, 10]
2	<i>Sitophilus oryzae</i>	Rice weevil	Maize, sorghum, rice, and other cereals	A widespread storage pest of cereals that contributes to grain weight loss and quality deterioration.	[9, 10]
3	<i>Rhyzopertha dominica</i>	Lesser grain borer	Maize, sorghum, wheat, and other cereals	An important primary pest of stored cereals that damages grains and reduces quality and market value.	[9, 10]
4	<i>Sitotroga cerealella</i>	Angoumois grain moth	Maize, wheat, sorghum, and other cereals	A major pest of stored cereal grains, particularly whole maize; larval feeding causes internal grain damage.	[9, 10]
5	<i>Prostephanus truncatus</i>	Larger grain borer	Maize	A serious pest of stored maize in parts of Africa, capable of causing severe grain damage during prolonged storage.	[9, 11]
6	<i>Tribolium castaneum</i>	Red flour beetle	Maize, sorghum, wheat, and processed cereal products	A common secondary pest that feeds on broken grains and flour, causing contamination and reduced quality.	[9, 10]
7	<i>Callosobruchus maculatus</i>	Cowpea bruchid	Cowpea and other stored pulses	A major bruchid pest of pulses; larvae develop inside seeds and cause weight loss and reduced germination.	[9, 11]
8	<i>Acanthoscelides obtectus</i>	Bean weevil	Common bean and other stored beans	An important pest of stored beans that reduces seed weight, germination, and marketability.	[11]
9	<i>Zabrotes subfasciatus</i>	Mexican bean weevil	Common bean	A bruchid pest of stored beans that causes internal seed damage and storage losses.	

Table 3. Major types of damage caused by storage insect pests.

No.	Type of damage	Description	Major consequences
1	Quantitative loss	Direct consumption of grain by larvae and adults, together with loss of grain material during feeding.	Reduced grain weight and lower food availability.
2	Grain perforation and breakage	Feeding damage creates holes, cracks, and broken kernels.	Increased susceptibility to secondary infestation and reduced grain quality.
3	Nutritional deterioration	Insects consume grain nutrients, particularly carbohydrates, proteins, and fats.	Reduced nutritional value of stored food.
4	Loss of seed viability	Feeding damages the embryo and other essential seed tissues.	Reduced germination and poor planting-material quality.
5	Contamination	Grain becomes contaminated with insect bodies, faeces, exuviae, and other residues.	Reduced hygiene, acceptability, and market value.
6	Quality deterioration	Infestation may cause discolouration, unpleasant odour, and changes in grain appearance.	Lower consumer acceptance and reduced selling price.

No.	Type of damage	Description	Major consequences
7	Increased moisture and heating	Insect respiration and movement may contribute to localized heating and moisture accumulation.	Favourable conditions for further insect development and grain deterioration.
8	Economic loss	Storage damage reduces the quantity and quality of grain available for consumption or sale.	Reduced household income and increased food insecurity.

Table 4. Factors influencing the occurrence and development of storage insect pests.

No.	Factor	Description	Effect on storage insect pests	Reference
1	Crop type	Cereals and pulses differ in their physical and chemical characteristics and susceptibility to insect attack.	Determines the pest species that can establish and the level of damage that may occur.	[9, 11, 13]
2	Grain moisture content	Moisture content affects insect survival, development, and reproduction.	High moisture can favour insect development and accelerate grain deterioration.	[10, 13, 14]
3	Storage temperature	Temperature influences insect metabolism, development rate, and reproduction.	Suitable temperatures can increase insect population growth and shorten developmental periods.	[9, 13, 15]
4	Storage duration	Grain stored for longer periods is exposed to pests for a greater length of time.	Longer storage generally increases cumulative infestation and grain damage.	[10, 14, 16]
5	Storage structure	Farmers use different systems, including sacks, gotera, underground pits, and other traditional structures.	Poorly protected structures allow pest entry and population development.	[13, 15, 17]
6	Initial infestation	Grain may already contain eggs, larvae, pupae, or adults before being placed in storage.	Initial infestation can lead to rapid pest population increase during storage.	[9, 10, 16]
7	Grain condition	Broken, cracked, or damaged grains are more vulnerable to secondary pests.	Increases infestation and facilitates secondary pest development.	[9, 13]
8	Storage hygiene	Grain residues and previously infested material can remain in storage facilities.	Poor sanitation provides shelter and food for surviving insect populations.	[13, 17]
9	Relative humidity	Humidity affects grain moisture and the survival and development of storage insects.	Favourable humidity can enhance pest development and grain deterioration.	[9, 13, 15]
10	Geographical and agroecological conditions	Temperature, altitude, rainfall, and local environmental conditions vary among areas.	Influence pest distribution, abundance, and seasonal occurrence.	[9, 13, 14]
11	Harvesting and drying practices	Inadequate drying before storage may leave grain with unsuitable moisture levels.	Poor post-harvest handling increases susceptibility to insect infestation and deterioration.	[10, 13]
12	Pest management practices	Farmers may use botanicals, synthetic insecticides, sanitation, improved storage, or combinations of methods.	Appropriate management reduces pest populations and limits grain losses.	[16, 20, 21]

4. Conclusion

Recent studies in Ethiopia have demonstrated that traditional storage structures may provide inadequate protection against insect infestation, while storage duration, grain moisture, temperature, storage hygiene, and initial infestation can

strongly influence the severity of losses [2, 6, 9, 20, 21]. The detection of *P. truncatus* in stored maize in Ethiopia further emphasizes the need for continuous monitoring of storage pests and the development of locally appropriate management strategies [4].

Several management approaches have been investigated,

including improved storage structures, hermetic storage, physical sanitation, inert dusts, synthetic insecticides, and botanical materials [7, 10-14, 20, 21]. Botanical products have received increasing attention because many locally available plants contain compounds with insecticidal, repellent, anti-feedant, ovicidal, and growth-inhibitory properties [16-19]. Ethiopian studies have demonstrated the potential of plant materials such as *Eucalyptus globulus*, *Chenopodium ambrosioides*, and other locally available botanicals for reducing storage insect infestation and grain damage [11-14, 20]. However, the effectiveness of botanicals may vary with plant species, plant part, preparation method, application rate, storage environment, pest species, and duration of protection [10-14, 16-20].

Therefore, further on-farm evaluation of locally available botanical powders under farmers' actual storage conditions is necessary to identify effective, affordable, safe, and practical alternatives for managing storage insect pests and reducing post-harvest losses in Southern Ethiopia.

5. Future Directions

Future research on storage insect pests in Ethiopia should move beyond documenting pest occurrence and grain losses toward the development and validation of practical, locally adapted, and sustainable management technologies. Greater attention should be given to on-farm evaluation of indigenous botanical materials, particularly locally available leaves, seeds, and fruits, under farmers' actual storage conditions. Studies should determine effective application rates, combinations of botanicals, duration of protection, effects on grain quality and seed viability, and their safety for farmers and consumers [10-20]. Comparative evaluation of botanicals with registered synthetic insecticides and improved storage technologies would provide useful evidence for integrated pest management.

Future studies should also assess storage pests across different agro ecological zones and farmer storage systems, including sacks, gotera, clay pots, and improved or hermetic storage structures. Regular monitoring of emerging and invasive pests, including *Prostephanus truncatus*, is important for understanding changes in pest distribution and developing timely management strategies [4, 7, 9, 21].

Abbreviations

IPM	Integrated Pest Management
PHL	Post-harvest Loss

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Author Contributions

Daniel Abebe Geletu: Conceptualization, Data curation, Methodology, Investigation, Visualization, writing – original draft, Writing – review & editing

Firew Meka Mentso: Conceptualization, Data curation, Methodology, Writing – review & editing

Conflicts of Interest

The authors declare no conflict of interest.

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