The distribution, frequency of occurrence, and the status of stored faba bean insect pests in relation to food security in Farta District, North West Ethiopia

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ENTOMOLOGY | RESEARCH ARTICLE

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Wondale Endshaw¹ and Berhanu Hiruy¹*

Abstract: Faba bean is one of the principal foods and cash crops produced in Ethiopia. However, storage insect pests are causing its considerable loss, and farmers’ food insecurity. Consequently, a survey involving bean grains sampling from a total of 162 farmers stores were conducted between 4, September 2019–15, May 2020 in its six, major producing kebeles of Farta District. From each kebele, nine villages were selected at random and at each village, three randomly selected farmers’ stores using a nested design were used for grain sampling. The keys of storage pest books were used for insects identification collected from samples. A total of 1844 insects belonging to 10 species, within two families of order Coleoptera, and one family of order Psocoptera were identified. Acanthoscelides obtectus, Callosobruchus sp., Callosobruchus chinensis, Zabrotes subfasciatus, followed by Callosobruchus species and C. dimidatus were the densely distributed, and the most frequently occurring; thus, major pests. The major status of these pests was suggested to affect farmers’ food security in the study area. Consequently, the farmers’ traditional practices were ineffective for faba bean grains protection.

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PUBLIC INTEREST STATEMENT

Pulses are an important source vitamins, proteins, minerals, and fibers. They possess nearly two to three times more protein than cereals, and thus, constitute a good source of supplementary protein, while consumed along with cereals. They possess no cholesterol and a little fat content, and therefore, aid in obesity reduction. Pulses also contain active phytochemicals, which could aid in human health via anticarcinogenic actions and cholesterol reductions. They also help in maintaining soil structure, biodiversity, and organic matter, i.e. soil health improvement. Among pulses, faba beans are the foremost imperative crop that accounts for nearly one-third of the entire legumes production in Ethiopia, next to haricot beans, field beans, and chickpeas for the aforementioned values. Nevertheless, their production and yield have been critically threatened by field and storage pests. Designing management strategies for such destructive pests demands the determination of their status. Therefore, our present study has addressed this gap.
Therefore, planning stored faba bean pests’ management strategies in the study area, in particular and Ethiopia, in general is desirable.

**Subjects:** Agriculture & Environmental Sciences; Nutrition; Biology; Entomology

**Keywords:** Constance; insect pests; indigenous farmers’ practices; stored faba bean

1. **Introduction**

Cereals and pulses are the staple food crops for most of the Ethiopian population, in addition to aiding as sources of income at a domestic level and contributing to the earnings of the foreign currency. Recently, the attempt to ensure food security has been made merely by increasing crop productivity and production in the field. Paradoxically, a huge amount of losses occurs after crops are harvested at different stages, and before consumption, after a large investment of time, labor, and money in the production process (Mohammed & Tadesse, 2018). These post-harvest losses were reported to be in the range between 30 and 50% in Ethiopia (Tadesse & Regassa, 2013)

A recent report also indicated that more than one third of food is lost every year in the postharvest operations (Kumar & Kalita, 2017). Of these post-harvest losses, the maximum has been shown to be occurring in grain storage on the postharvest system nationally (Mohammed & Tadesse, 2018). Therefore, achievement of food security objective in Ethiopia needs to consider, not only increasing productivity and production of food grains, but also the reduction of their postharvest loss especially, in grain storage due to pests.

Legumes are produced by most of the small holder frames all over the sub-Saharan Africa as a source of food, feed, cash, or income as well as improvement of soil fertility. Diverse legume varieties that could adapt to the changing agro-ecological and sociocultural conditions have developed by farmers, and legumes have constituted an essential component of the smallholder farming systems across the country (Ruelle et al., 2019). They are the second most important crop next to cereals (E. Kebede, 2020), which are grown nationally mainly for the aforementioned importance’s (Neda, 2020).

Of legumes, faba beans have been indicated to be the most important food crop that accounts for nearly one third of entire legume production in Ethiopia, followed by haricot beans, field beans, and chickpeas (ITC [International Trade Centre], 2019; Neda, 2020). Of the 12.33% of land area and 9.69% production of pulses, the proportion of land covered by faba bean, haricot bean, and chickpea was 27.59, 18.72, and 14.56%, respectively. Regarding production, the proportions of faba bean, haricot bean, and chickpea were reported to be 31.19, 17.19, and 15.78%, respectively in 2016/17 (Central Statistical Agency [CSA], 2017; Mohammed & Tadesse, 2018). Ethiopia is currently the world's second largest producer of faba bean (Ruelle et al., 2019).

Faba bean was introduced to the northern parts of Ethiopia around the 16th century (Shimelis, 2005) and is among the oldest crops grown in the Amhara region for the aforementioned vital values. However, faba bean production and yield have been subjected to attack of various pest species, including insect pests, mites, and fungi (Tadesse, 2008). Of these pests, the most economically important ones have been reported to be insect pests (Dhalwal & Arora, 2001; Hiruy, 2018; Mesele et al., 2019). Consequently, every year, large quantities of stored faba beans have been destroyed due to insect pests, especially of the order Coleoptera in Ethiopia. Among the Coleopterans, the leading destructive pests have been bruchids; Callosobruchus maculatus (Fab.), C. chinensis (L.), Zabrotessubfasciatus (Boheman), and Acanthoscelides obtectus (Say) (Harberd, 2004; Mesele et al., 2019; Nchimbi-Msolla & Misangui, 2002; Schmale et al., 2002; Tadesse, 2008).

Worldwide losses of pulses and other grains due to pests after harvest are estimated to be 10% (Boxall et al., 2002; Sori, 2014). In eastern Africa, an estimated grain loss between 30% and 73% was reported (Mesele et al., 2019). In Ethiopia, Z. subfasciatus and A. obtectus were reported to cause average grain losses of 60% within 3–6 months of storage period (Getu et al., 2003). Losses
of both grain quantities (weight losses) and quality due to pests has been depriving the sub-Saharan Africa (SSA) farmers from benefits of their labors. Such losses of grains are not just as a loss of food, but as a loss of all the resources that spent in creating food, i.e. labor, land, water, fertilizer, and insecticide, among others. Accordingly, losses of food grains such as faba bean due to insect pests during storage has been reported to be one of the major threats to food security of people living in Ethiopia (Hiruy, 2018).

So far, to reduce the losses due to pests, farmers have been using different management measures, which range from synthetic insecticides to cultural control methods (G/selase & Getu, 2009). Nevertheless, there has been a heavy reliance on synthetic insecticides, which have been blamed for its adverse effects such as impact on public health, toxic residue in food, development of resistance on target pests, and pollution of local ecosystem. Lack of appropriate core during application may also expose pesticide sprayers and others for chemical damage. Pesticides may also harm non target organisms (A. A. Kebede, 2014; Alemu, 2008; Hiruy, 2018; Sori, 2014). This necessitated the search for more bio rational alternative insect pest management options such as the use of plant products, varietal resistance, cultural methods, and integrated pest management, among others (Hiruy, 2018; Sori, 2014).

Furthermore, one way of reducing loss of stored food grains such as faba bean by the pests and improvement of income and food security has been indicated to be recognition, promotion, and utilization of indigenous knowledge, skills, and practices of farmers that they developed in handling, processing, preservation, and storage of food grains (Kuyu & Bereka, 2020). Moreover, designing and implementation of effective insect pests intervention strategies has been reported to necessitate determination of the status insect pest, degree of losses that have happened, indigenous methods and pest management practices used by the farmers during storage of their grains, among others (Togola et al., 2013). Therefore, the current study was initiated with an objective of determining the distribution and frequency of occurrence of the stored faba bean insect pests in relatively different agro-climatic kebeles of the Farta District of South Gonder Zone of North West Ethiopia.

2. Materials and methods

2.1. Description of the study area

The study was conducted in Farta Woreda (district), which is located in south Gonder zone of the Amhara Regional State (ARS) of northern Ethiopia. Farta district lies between 11° 32' to 12° 03' latitude and 37° 31' to 38° 43' longitude (SPEDD (South Gondar Administrative Zone Planning and Economic Development), 2007; Beadgie & Zemedu, 2019). It is one of the 105 districts in the Amhara Regional state of Ethiopia, bordering Debre Tabor, the capital of South Gondar Zone. It is located at about 100 km northeast of Bahir Dar, capital city of the Amhara Region, Ethiopia. It is found within altitude range of 1920-4135 m above sea level. The district receives an average annual rain fall of 900–1099 mm and a mean ranges temperature of 9–25°C. The wet or raining season ranges from May to September. The districts major socio-economic problem is food insecurity (Fereke et al., 2014).

2.2. The study period and design

The study was conducted between from 4, September 2019–15, May 2020 in six, major faba bean producing kebeles (peasant associations) that had relatively different agro-climatic condition of the Farta woreda (district). The peasant associations were namely Abaregay (dega or high-land), Weybila-Selamko, Kanat, Eyesus (weyna dega or mid-altitude or midland), Buro-kantona, and Werkien (kolla or low-land).

From each peasant association (PA), nine villages were selected at random with the assistance of the Ministry of Agriculture (MOA) sub-kebele staff using a nested design as adopted by earlier researchers (Getu, 1993; Hiruy & Getu, 2018a, 2018b; Hiruy, 2018). At each village, three farmers'
were selected randomly. The peasant associations were selected purposefully based on abundance of faba bean production, while villages and representative farmers’ were selected randomly. Then, samples from any available storage facilities of each representative farmer were used for the study.

2.3. Stored faba bean insect pests status determination
One kg of faba bean grain was taken from a total of 162 stores selected randomly in the aforementioned manner (i.e. 6 PAs × 9 villages × 3 stores = 162 stores totally). Samples were taken from top, sides, center and bottom of the different storage structures using different sampling tools such as sampling spear and human hands after mixing them thoroughly. Each sample at each sampling date from different storage methods at each village of the sampling site was collected in sampling bag, labeled with necessary information and brought to insect science laboratory of Debre Tabor University for identification of insect pests (Hiruy, 2018). The sample grains were collected three times from representative farmer’s storages of each village in the middle of 3rd, 4th and 5th month’s storage period, beginning from December (the most common harvesting period of the survey site). This is because of the stored faba bean grains were more likely to be infested by insect pests in these storage periods than in the beginning, of the most commonly practiced (2–6 months) farmers’ storage period in the study area (Endshaw, 2020). Besides, in cases where samples were lacking on previously sampled farmers store, other stores of randomly selected farmers of the same village, holding the grains were used as a substitute.

Then each sample at each sampling date from different storage methods at each village of the sampling site was subsampled to come up with the standard of 100 g subsample for identification of pests. Sieves of a different size (mm) were used for separating the adult insects from the sub sample grains. All alive and dead insects from subsamples from different farmer’s traditional methods of each kebeles were collected and immediately preserved in 100 ml capacity bottles, and kept for further identification (Hiruy, 2018). The procedures, and keys of the books related to stored product insect pests, and other arthropods by different authors (FGISUS (Federal Grain Inspection Service of United states), 2015; Hagstrum et al., 2013; Hagstrum & Subramanyam, 2006, 2009; Rees, 2004, 2007) were used for identification purpose. Identification of pests was done using morphometric of adult insects such as antennae, wing pattern, size, legs, spines on different segments of legs, and the side thorax, among others, using keys, and morphological characters of the aforementioned books as tried to show at the Appendix.

Then after, insects were sorted according to their orders, families, and species, and counted for each sub sample grain different farmers’ traditional storage methods from each PA, in each case noting the number. The average of the total of species of insect pests collected from subsampled grains from all the farmers’ traditional storage methods over three sampling periods were used to determine the distribution and frequency of occurrence (the status) of insect pests (Bueno & Souza, 1991; Gognsha & Hiruy, 2020; Hiruy, 2018; Işıkber et al., 2016; Shiferaw, 2018; Wubetu & Hiruy, 2020) with slight modification.

2.4. Data analysis
The frequency of occurrence and distribution (the status) of the insect pests were determined as suggested by earlier researchers (Bueno & Souza, 1991; Gognsha & Hiruy, 2020; Hiruy, 2018; Işıkber et al., 2016; Shiferaw, 2018; Wubetu & Hiruy, 2020). Accordingly, abundance at each peasant association (the distribution) refers to the total number individuals of a species divided by the total number of samples (in this case the total weight (kilograms) of grain sampled) at each peasant association, and it is expressed by the following formula:

\[
\text{The abundance of species} = \frac{\text{Total number of individuals of species}}{\text{Total number of samples}}
\]
Constance (frequency) of occurrence expresses the percentage of species occurrence. It is obtained from the relationship between the number of samples containing the species and the total number of samples (in this case the total weight (kilograms) of grain sampled). This relationship is expressed by the following formula;

**Constance of species** = \((\text{number of samples in which the species occurred/Total number of samples}) \times 100\)

All the data that were collected from the sample grain survey was managed and analyzed using Microsoft excels software version 2010 and the Statistical Program for Social Sciences (SPSS) software version 2016, considering the aforementioned suggestion. Descriptive statistics (mean and percentage) were used for computing data on distribution and Constance (the status) of insect pests of stored faba bean. Appropriate statistical method, one way analysis of variance (ANOVA) was used for computing the distribution and frequency of occurrence (the status) of insect pests recorded from sampled stored faba bean grains of the study area. The number each species of insects identified from sample grains of each village of each peasant association was considered as an independent variable, while mean distribution, and mean % frequency of occurrence of the pests were considered as response variables. These numbers of each pest were subjected to one way analysis of variance to compute mean distribution, and mean % frequency of occurrence of the pests. Moreover, the status of each pest was determined using distribution, and frequency of occurrence of the pests as suggested by the aforementioned scholars. Significant differences between means were separated by Turkey’s honestly significant difference (THSD) test at 95% confidence interval level.

3. Results

3.1. The distribution stored faba bean insect pests in Farta District

The distribution and taxonomic position of stored faba bean insect pests recorded under farmer’s traditional storages of the study area are shown in Figure 1 and Table 1, respectively. Accordingly, a total of 1844 insects belonging to 10 species, within two families of order Coleoptera, and one family of order Psocoptera were identified and recorded in sample grains collected from the traditional storages of the study area.

![Figure 1. The distribution of insect pests stored faba bean at different peasant associations (PAs) with relatively different agro climate of the study area.](image-url)
All the ten insect pests (Acanthoscelides obtectus, Callosobruchus sp., Callosobruchus chinensis, Zabres subfasciatus, Callosobruchus maculatus, Bruchus sp., and Bruchidius sp.) recorded from stored faba bean were greatly ($p < 0.05$) distributed or disseminated at Buro-kantona and Werkien (kolla or low-land) peasant associations as they were occurring in a range between 2.5 and 32 individual species on average per 100 g of sample grain in the aforementioned peasant associations than in the rest of peasant associations, which were mid-altitude and highland (Figure 1).

All the aforementioned ten species were also ($p < 0.05$) heavily distributed at Weybila-Selamko, Kanat, Eyesus (weyna dega or mid-altitude) peasant associations. As they were appearing in a range between 0.9 and 28.8 individual species on average per 100 g of sample grain in the aforementioned midland peasant associations than their distribution at Abaregay (dega or highland) peasant association, in which they were occurring in a range between 0.6 and 12.3 individual species on average per 100 g of sample grain (Figure 1).
2. Summarized data of pests distribution

| Species                  | Abaregay (dega) | Weybila-Selamko (weyna dega) | Kanat (weyna dega) | Eyesus (weyna dega) | Buro-kantona (kolla) | Werkien (kolla) | Mean (in all PAs) |
|-------------------------|-----------------|------------------------------|--------------------|--------------------|----------------------|----------------|--------------------|
| A. obtectus             | 15.06           | 27.1                         | 28                 | 27                 | 31                   | 30             | 26.36              |
| Callosobruchus sp.      | 13.1            | 23                           | 24.2               | 24                 | 29.32                | 29             | 23.77              |
| C. chinensis            | 10              | 14.2                         | 15                 | 16.22              | 22.32                | 23             | 16.79              |
| C. maculatus            | 5               | 9.6                          | 10                 | 11                 | 20                   | 20.3           | 12.65              |
| Z. subfasciatus         | 6.23            | 14                           | 15.13              | 15                 | 21                   | 22             | 15.56              |
| Carpophilus sp.         | 2               | 6                            | 7.1                | 7                  | 9                    | 10             | 6.85               |
| C. dimidatus            | 1.2             | 5                            | 6                  | 6.1                | 9                    | 9              | 6.05               |
| Liposcelis sp.          | 1               | 1.32                         | 2                  | 2                  | 3                    | 4              | 2.22               |
| Bruchus sp.             | 0.77            | 1                            | 1.11               | 2                  | 3                    | 4              | 1.98               |
| Bruchidius sp.          | 0.6             | 1                            | 1                  | 1                  | 3                    | 3              | 1.6                |

Concerning pests distribution status, five species; Acanthoscelides obtectus, Callosobruchus sp., Callosobruchus chinensis, Zabrotes subfasciatus, and Callosobruchus muculatus, respectively were prominently distributed in all the six peasant association, as they were occurring in between 5 and 32 individual species on average per 100 g sample grain. These species were followed by Carpophilus sp. and C. dimidatus that were occurring in a range between 1.1 and 10 individual species on average per 100 g sample grain. However, Liposcelis sp. Bruchus sp., and Bruchidius sp. were lightly distributed species, as they were appearing in between 0.6 and 4.2 individual species on average per 100 g sample grain, as compared to the aforementioned seven insect pest species. The distribution of most pests of the stored fava bean recorded from farmers traditional storages of the study area was significantly different from each other (except for Bruchus sp., Bruchidius sp. and Liposcelis sp., and Carpophilus sp. and C. dimidatus as well as Callosobruchus chinensis and Zabrotes subfasciatus in some kebeles) at p < 0.05 using Turkey’s honestly significant difference (THSD) test (Figure 1).

3.2. The frequency of occurrence stored fava bean insect pests in Farta District

The frequency occurrence of pests of identified from stored fava bean from farmers storages followed similar trend of with that of the distribution pests in the study area (Figure 2). Accordingly, five species; Acanthoscelides obtectus, Callosobruchus sp., Callosobruchus chinensis, Zabrotes subfasciatus, and Callosobruchus muculatus, respectively were the most frequently occurring, as they appeared in a range between 92.59 and 67.90 mean percent of individual species per 100 g of sample grain of stored fava bean of the study area. Following these species, Carpophilus sp. and C. dimidatus were the next more frequently occurring species, as they occurred in 49.38 and 43.21 mean percent of individual species, respectively per 100 g sample of stored fava bean of the study area. However, Liposcelis sp. Bruchus sp. and Bruchidius sp. were the least frequently appearing, as they occurred in 24.69, 18.52, and 12.35 mean percent of individual species, respectively on 100 g sample of stored fava bean of the study area. The frequency of occurrence of all the pests of fava bean recorded from farmers traditional storages were significantly different from each other at p < 0.05 using Turkey’s honestly significant difference (THSD) test (Figure 2).
3.3. The status of stored faba bean insect pests in Farta District

Based on results under sub topics 3.1 and 3.2, Acanthoscelides obtectus, followed by Callosobruchus sp., Callosobruchus chinensis, Zabrotes subfasciatus, and Callosobruchus muculutus, respectively were found to be the densely distributed, and the most frequently occurring, and hence, major insect pest species of stored faba bean in the study area. Carpophilus sp. and C. dimidatus, respectively were the next heavily dispersed and the most frequently occurring, and thus, intermediate pests. Nonetheless, Liposcelis sp., Bruchus sp., and Bruchidius sp. were sparsely distributed, and the least frequently occurring, and thus, minor pests of stored faba bean in the study area (Figures 1 and 2, and Table 1).

Generally, the distribution and frequency of occurrence (the status) of the ten species of insect pests recorded from stored faba bean followed the order; Acanthoscelides obtectus > Callosobruchus sp. > Callosobruchus chinensis > Zabrotes subfasciatus > Callosobruchus muculutus > Carpophilus sp. > C. dimidatus > Liposcelis sp. > Bruchus sp. > Bruchidius sp.

4. Discussion

In the current survey, it was possible to notice that all the ten pests recorded were the most prominently distributed and frequently occurring in relatively low land kebeles. This result suggests their being more problematic in relatively low-land peasant associations (kantona and Werkien), followed by in mid-altitudes (Weybila-Selamko, Kanat and Eyesus) than in high-land (Abaregay) peasant association. This finding also implies the difference in the climate of the different peasant association had its own influence in pests’ propagation, distribution and frequency occurrences of stored faba bean. This in turn, suggests the presence need to consider the ecology and biology of pests, while designing their management strategies to achieve effective protection of stored grains and improve income and food insecurity poor farmers. In similar manner, it was also shown that tropical climatic conditions together with the use of inappropriate storage facilities and poor sanitation of grain storage in SSA also encourage insect pest attack (Talukder, 1995). Similarly, Manandhar et al. (2001) also indicated that high humidity coupled with high temperature allow insects and diseases to establish quickly. Chomchalow (2003) also indicted that the increased severity of the infestation of insects such as bruchids, weevils, and others to quality deterioration of durables (cereals, pulses, roots, and tubers) stored in warm and humid climates. It was also revealed that storage losses were highest in the moist transitional and moist mid-altitude agro-ecological zones of Kenya, and lowest in the dry-transitional zone (Ognakossan et al., 2016). It was also revealed that the insect infestation and densities was much higher in southern and south-eastern regions than central region where the environment was warm and humid in Turkey (İşikber et al., 2016).
Classification of pests of stored faba bean of the study area concerning the distribution and frequency of occurrence (the status) in the order; Acanthoscelides obtectus > Callosobruchus sp. > Callosobruchus chinesis > Zabrotes subfasciatus > Callosobruchus muculatus > Carpophilus sp. > C. dimidatus > Liposcelis sp. > Bruchus sp. > Bruchidius sp., in the present study, is accordingly of the reports of pervasive authors (FGISUS (Federal Grain Inspection Service of United states), 2015; Hagstrum et al., 2013; Hagstrum & Subramanyam, 2006, 2009; Rees, 2004, 2007), in which these pests in similar respective manner are indicted to be cosmopolitan pests of pulses. Furthermore, in accordance with the pest status determined in the current study, the major pests of legumes (beans, peas and cowpea among others) are reported to be bruchids, including the bean weevil, Acanthoscelides obtectus (Say), the cowpea weevils belonging to the genus Callosobruchus (C. maculatus (F.), C. chinesis (L.) and C. analis (F.) and C. phaseoli (Gyllenhal), the ground nut bruchids, Caryedon serratus (Olivier) and the Mexican bean weevil, Zabrotes subfasciatus (Boheman) (Athanassiou & Arthur, 2018). Average grain losses of 60% due to Z. subfasciatus and A. obtectus were also reported within 3–6 months of storage period in Ethiopia (Getu et al., 2003).

The greater distribution and frequency of occurrence (the major status) of Acanthoscelides obtectus, Callosobruchus sp., Callosobruchus chinesis, Zabrotes subfasciatus and Callosobruchus muculatus, followed by Carpophilus sp. and C. dimidatus, respectively of stored faba bean in the present study, also implies that the quantity, quality, resources, labor and food security of poor farmers was affected in the study site. Similarly, it was indicted that infestation caused by insects imposed several losses such as weight loss, viable value loss, commercial value loss, nutritional loss, health hazards, and storability loss (Banga et al., 2018). Banga et al. (2020) also revealed that insects are the major threat for causing the qualitative as well as quantitative losses in stored food grains such as cereals, legumes, and oilseeds during the storage. Mailafiya et al. (2014) also shown that grain losses of even 1% in various agro-ecological zones can deprive people of constant supply of quality food (adequate nourishment year round), and income generation, and their means of livelihood.

The aforementioned findings, i.e. the greater distribution and frequency of occurrence (the major status) of the aforementioned seven species; therefore, call for planning of management strategies. It also suggests the presence of need for improving of the existing farmers indigenous practices for effective protection of their grains from pests, and improving income and food insecurity problem. Accordingly, the major storage methods used to store faba bean in the study areas were reported to be Gota outdoor, polyethylene bags (sacs) in amalgamation with Gota in living house, and Gota in the living house. Except for outdoor ventilated Gota, which is made of riven bamboo stem, and mud plus straw plaster, traditionally in the survey site, the rest of the storages were indicated to favor pest proliferation. As they increase temperature within the grain mass, which in turn lead to mold development. This is because; these storage facilities were usually placed indoor (in living house), where foods, and other necessities for the family, were often prepared traditionally via firing wood several times per a day (Endshaw, 2020). Thus, improving the effectiveness farmers’ indigenous practices in an integrated fashion is very imperative. For example, integrating the outdoors ventilated Gota with the use of resistant varieties, and potent botanicals of the study area, as well as mixing faba bean with small grains like millet and teff could have paramount importance in stored faba bean protection. This might also reduce the cost that could be spent to purchase insecticide, and health and environmental risk, which could emonate from pesticide use for grains protection from pests. Similarly, it was also shown that upgrading indigenous knowledge of grain processing, preservation, and storage through incorporating into any policy of the program geared toward reduction of food insecurity, and could boost the people confidence and ability to be a part of the solutions (Kuyu & Bereka, 2020). It was also revealed that a little improvement in storage structures coupled with sound hygienic measures and other cultural practices can lead to significant reduction in storage loss of grains (Tadesse, 2003). It was also reported that improvements to the main storage structure used by the farmers and using locally available plant materials and cultural methods instead of chemicals could help to improve farmer’s food security (Utono, 2013). Indigenous knowledge and practices were also
reported to be simple to operate and accessible and could improve the food insecurity problem if they could be upgraded to faster and better practices (Kuyu & Bereka, 2020).

5. Conclusion
The present study confirmed the existences of conspicuous distribution, great frequency of occurrence, and severity of insect pests of stored faba bean in low-land peasant associations (kantona and Werkien), followed by mid-latitudes (Weyblia-Selamko, Kanat and Eyesus), which were relatively warm and humid than in high-land peasant association. Thus, any attempt that will be made in designing of management strategies of these pests need to consider the ecology and biology of the pests for effective control of them and protection of the grain.

In the current survey, out of ten species of the stored bean recorded from the study area, Acanthoscelides obtectus, Callosobruchus sp., Callosobruchus chinensis, Zabrotes subfasciatus, and Callosobruchus maculatus, followed by Carpophilus sp. and C. dimidatus were found to be the densely distributed, and the most frequently occurring, and thus, were major pests. Nevertheless, Liposcelis sp. Bruchus sp. and Bruchidius sp. were sparsely distributed and the least frequently occurring, and thus, minor pests of stored faba bean. Besides, the heavy distribution and great frequent occurrence (the major status) the aforementioned seven insect species was suggested to affect the quantity, quality, resources, and labor and food security of poor farmers in the study area.

Consequently, the traditional practices used by farmers were ineffective for acceptable protection of their stored faba bean grains from insect pests and the associated food insecurity. Therefore, planning effective management strategy against insect pests of stored faba bean in the study area is urgently needed to reduce loss of their grain by the pests, and the associated food insecurity problem. Furthermore, improving the existing farmers traditional practices should be immediately addressed by any concerned bodies.

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Authors’ contributions
The first author was accountable for planning the research proposal as well as searching literature reviews and writes up the paper. The second author also contributed to the approval of the research plan, preparation, and standardization of the manuscript. Both authors had equal responsibility for the preparation and approval of the final manuscript for publication.

Availability of data
Data is available within the article on its last pages.

Ethical statement
This study does not involve any human or animal testing.

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Appendix
Partial views of insect pests recorded from stored faba bean grains of farmer’s storages of the study area

*Liposcelis* sp.  *C. dimidatus*  *Callosobruchus* sp.  *Callosobruchus* sp.

*Callosobruchus chinensis*  *C. chinensis*  *C. chinensis*  *C. chinensis*

(Females, the former two; left and males with distinctive antennae, the latter two; right)

*Callosobruchus* sp.  *Zabrotes subfasciatus*  *Z. subfasciatus*

(*Z. subfasciatus* Adult; *globular* with long legs and antennae, elytra patterned and do not fully cover abdomen, spines at tip of tibia on hind leg)
*Callosobruchus maculatus*  *C. maculatus*  *C. maculatus*  *C. maculatus*

(Adult globular with long legs and antennae, elytra patterned)

*Acanthoscelides obtectus*  *Bruchus* sp.  *Bruchidius* sp.

(*A. obtectus* adult; Elytra patterned and do not fully cover abdomen; adult have long antennae, patterned elytra and exposed final segments of abdomen, spines on lower edge of femur of hind leg)

(*Bruchus* sp. adult; side of thorax with spine, larger relatively and *Bruchidius* sp. adult; head capsule narrow relative to width of pronotum, small relatively)
