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Research Article

Farmers' Perceptions of Rodents' Damage and Management Practices in Wenchi Highlands, Central Ethiopia

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Local perceptions about rodents and the damage they cause and management practices are the first step to design and implement rodent control programs. A study was conducted to obtain information about the perceptions and practices of farmers in Wenchi highlands on rodent damage and their management practices in the late-2020 and early 2021. Farmers ($n = 383$) from four highland villages of Wenchi district were randomly selected and interviewed using a semistructured questionnaire. Rodents were identified as major pests and perceived negatively among farmers. *Arvicanthis abyssinicus* (Rüppell), *Mastomys natalensis* (Smith), *Mastomys awashensis* (Lavrenchenko, Likhnova & Baskevich), *Hystrix cristata* L., and *Tachyoryctes splendens* (Rüppell) were the potential rodent pest species in the study area. There were significant variations in the type of damage ($\chi^2 = 112.698$, $df = 3$, $P < 0.05$) and crop type susceptibility to rodent pest attack ($\chi^2 = 143.26$, $df = 3$, $P < 0.05$). Crop damage (38.7%) and damage to human properties (27.9%) were the two dominant rodent-related problems in the area. Barley was the most susceptible crop to rodent attack (57.5%). The occurrence frequency of rodent pests and crop damage between the cropping stages also varied significantly. Most damage to barley crops (42.5%) occurred during the maturation stage. Farmers assessed rodent damage by observing damaged seeds, damaged stores, and rodent droppings in the storage and stem cuts of standing crops in the crop fields. The farmers stated that managing rodents in barley crop fields is practically impossible. In storage, farmers mainly use cats (53.73%) and trapping (22.64%) to control rodents. Detailed on-field rodent damage assessment and community education for rodent management are recommended.

1. Introduction

Rodents have played an important part in human history as a food source [1], model animals for research, and good indicators of environmental quality [2]. They are also a threat to food production and human property and are a public health risk [3]. Consequently, rodents are considered as the most serious vertebrate pests worldwide [4, 5]. However, only <10% of rodent species are major pest species, and even fewer cause problems in broader areas [6, 7].

Rodent pests remarkably affect the global crop production and livelihoods of farmers because their cost to agriculture is enormous [8, 9]. They cause large economic losses in agricultural crops, mainly root crops and cereals in the field, and consume and contaminate stored grains [10–12]. Rodents consume foodstuffs, cause physical damage to packaging and storage materials, and contaminate products with hair, urine, and feces [13–15]. They are responsible for damaging food volumes that could feed about 280 million people in a year [16]. Rodent hair or droppings in food may create great problems for exporting countries up to the rejection of the entire load [15].

Rodent damage significantly affects the food security and income of smallholder farmers in developing countries [13, 15, 17]. The damage can be severe and diverse, and shows temporal and spatial variations [18] because it is directly associated with rodent abundance, diversity, feeding habits, and reproductive patterns [19]. Crop losses also vary between crops, cropping stages, and storage types [19]. Annual losses due to rodents in several countries are economically unacceptable [10]. Such country-level damage can have a major effect on the economy of any country and all available consumers [18].

Rodents are one of the major problems in Eastern Africa, and have been the number one crop pests [20–22]. Ethiopia also experiences constant rodent pest problems on different agricultural crops [20–23]. Bekele et al. [23] have recorded the highest rodent crop damage (26%) in central Ethiopia. A more recent report has revealed that Ethiopia is the third country in stored grain losses after Egypt and Tanzania [22].

It is economically beneficial to control the rodent populations to reduce rodent-linked losses [13, 24]. This is influenced by the farmer's knowledge of variables affecting crop damage, the level of crop susceptibility, the rodent pest population during the most susceptible crop stage, and how much they are prepared to control the pests [20]. Local perceptions about rodents and the damage they cause are vital as a first step to design and implement rodent control or educational programs [3, 25]. Studies have been carried out on this subject in northern and southern Ethiopia [10, 26, 27], but still there is no documented information from Wenchi highlands. Thus, the purpose of this survey was to assess the knowledge, attitudes, and practices (KAP) of smallholder farmers on rodent damage and management in Wenchi highlands.

2. Methods

2.1. Study Area Description. The study was conducted in the central highlands of Ethiopia, Wenchi district of southwest Shewa Zone, Oromia. It is located at 37°50′0″E latitude and 8°55′0″N longitude between Ambo and Waliso towns, 155 km away from the capital, Addis Ababa (Figure 1). The altitude of the area ranges between 2,810 and 3,386 m above sea level [29]. Its highest elevation is at Mount Wenchi (3,386 m asl). The area is characterized by a highland subhumid climate with an average annual rainfall of 1400 to 1420 mm [30, 31]. The area receives unimodal rainfall with longer rainy periods stretching from May to September. The peak rainfall occurs in July and August. The cold-dry season is distinguished between October and January [31, 32]. The temperature varies from 14 to 26°C during the day and falls below 10°C at night [32].

Lake Wenchi is among the few remaining fairly pristine high-mountain crater lakes in the central highlands [31, 32]. It is one of the popular tourist attractions and interesting ecotourism destinations in this area. As a result, the Oromia Tourism Commission has recognized it as the best national tourism destination area in the region. The area also owns a 15th-century monastery and a hilly highland area covered with natural forests, mineral waters, and hot springs [30, 33].

The main livelihood in the area is mixed agriculture (crop cultivation and livestock rearing), small and micro-enterprises, and income-generating activities from ecotourism [28, 30]. The average land holding size for a single household is 0.5 hectares, and the major crops grown in the area are enset (*Ensete ventricosum*), barley (*Hordeum vulgare*), wheat (*Triticum* species), and potato (*Solanum tuberosum*) [30]. Like other highland farmers of the country, farming and harvest are performed by traditional technology [10].

2.2. Farmer Surveys. A total of four relatively accessible highland villages of Wenchi district were purposively selected in reference to Lake Wenchi and Haro town–Azar Qeransa (860), Haro Wenchi (856), Waldo Telfami (783), and Cabo Sansalati (681). These villages were also located either in or adjacent to the area where the ongoing rodent ecology research project is being conducted by the same group of researchers. For ethical compliance, the study participants were informed of the objective of the study, and their consent for participation was sought before commencing the study. They were also clarified that their names will not be mentioned and the responses are only used for this study. The questionnaires were administered to household farmers randomly selected from lists obtained from the administration bureau of the respective villages. Household samples were computed using the estimation formula for a single proportion, $n = Z^2 P(1-P)/d^2$, where n is calculated sample size, Z is critical value (1.96) at a 95% confidence level, P is an expected proportion (50%), and d is precision or margin of error which is fixed at 5% [34]. Hence, the questionnaires were administered to a total of 383 (329 males and 54 females) household heads that were randomly selected from the study villages.

Moreover, the calculated sample size was proportionally assigned to each of the four villages using the formula, $nh = N(n)/\sum N$ [35], where, nh is the number of sample households to be selected from each village, N is the total number of households in each village, n is the calculated total sample size to be selected from all the study villages, and $\sum N$ is the sum total of households in the selected villages. As a result, 104, 103, 94, and 82 households were randomly selected by lottery method for data collection from Azar Qeransa, Haro Wenchi, Waldo Telfami, and Cabo Sansalati village, respectively.

A semistructured questionnaire was extracted from published studies with similar objectives [10, 26, 36, 37] and modified to the situation of the area. It was designed not to be too troublesome and long for farmers while enabling the collection of relevant information [38]. Both open- and closed-ended questions were prepared in English and administered in a local language, Afan Oromo. Each interview was conducted by one of the researchers and his field assistant for approximately 30 minutes in December 2020 and February 2021.

The questionnaire was composed of three parts. In the first part, demographic profiles, such as age and level of education of the respondents, were collected. The second section contained questions that gathered information about agricultural practices, rodent pests, and farmers' knowledge of rodent damage and their perceptions in the respective villages. In the third section, rodent management practices data were obtained.

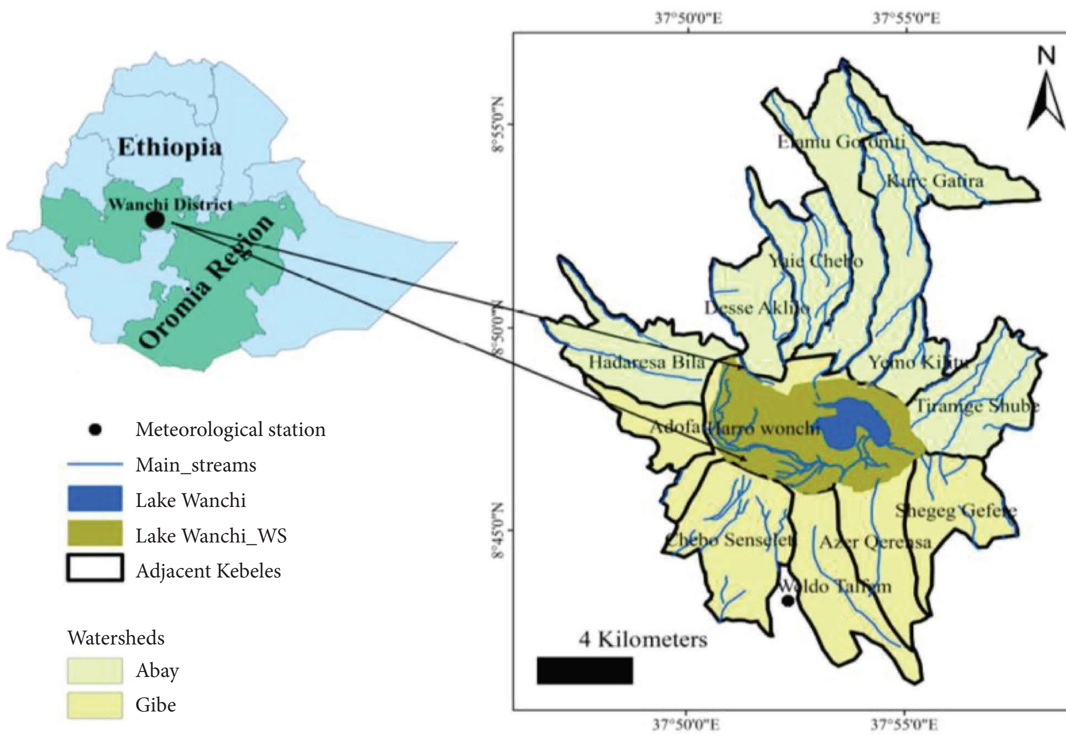

Figure 1: Map of the study area (adopted from [28]).

2.3. Data Analysis. The collected data were coded, cleaned, and summarized using a Microsoft Excel spreadsheet. Quantitative data were analyzed with appropriate statistical methods such as mean, percentage, and Chi-square test using SPSS version 20 (SPSS, Inc. USA). Chi-square (χ^2) tests were used to verify possible associations between the socioeconomic profiles of the respondents and their responses to KAP questionnaires. The differences between the villages in farming practices and composition were also compared using Chi-square tests. Probability values were considered statistically significant when P value is $\leq$0.05.

3. Results

3.1. Sociodemographic Characteristics of Farmers. Out of the 383 study participants, 84.8%, $n = 329$ were males and 15.2%, $n = 54$ were females. The majority of the respondents (82.2%, $n = 315$) were between 20 and 50 years old. Nearly half (47.8%, $n = 161$) of the study participants were not registered for any formal education, while 36.9%, $n = 140$ attended primary education. The majority of the respondents (86.5%, $n = 332$) had from 5 to 10 family sizes, while the remaining had below 5 family members. The respondents have spent at least 5 years to more than 50 years in farming. Most of the respondents (78.2%, $n = 301$) had a farmland size below one to two hectares, while only 7.3%, $n = 27$ of them had more than three hectares. Most (84.8%, $n = 329$) of the respondents supported their livelihood through mixed farming practices. Only 15.2%, $n = 54$ of the respondents generated additional income through ecotourism (Table 1).

3.2. Rodent Pests and Crop Damage. Crop and livestock production (84.82%, $n = 325$) were the main sources of income for the smallholder farmers in Wenchi highlands. The major crop types grown in the study area were barley, wheat, enset, and potato. Barley and enset were the two chief crop types produced by these farmers. In addition to these two crops, wheat and potatoes were produced in lower and upland areas, respectively. There was an insignificant difference in the responses of farmers in the study villages to the major crops grown in the area ($\chi^2 = 4.725$, $df = 3$, $P > 0.05$).

Results from smallholder farmer's interviews and indirect observations such as porcupine quills and molehills revealed that rodents were the major crop pests in the area. Abyssinian grass rat (*Arvicanthis abyssinicus,* Rüppell), Multimammate mouse (*Mastomys natalensis*, Smith), Awash multimammate mouse (*M. awashensis,* Lavrenchenko, Likhnova & Baskevich), Porcupines (*Hystrix cristata* L.), and African root rat (*Tachyoryctes splendens,* Rüppell) were the five rodent pest species recorded from their occurrences in neighboring natural habitats, indirect evidence, and surrounding community reports. The first three pests were live and snap-trapped from the adjoining forest remnants, while the remaining two were documented through indirect evidence and reports from the surrounding community.

The current study showed that rodents were the most worrisome pest to smallholder farmers. These farmers also believed that rodents are useless and damaging creatures. The farmers cited crop damage, disturbance, food contamination, and damage to human properties as the most rodent-inflicted problems. Crop damage (38.7%, $n = 148$)

Table 1: Sociodemographic characteristics of the study participants.

Variables		No. of respondents	Percentage (%)
Sex	Male	329	84.8
	Female	54	15.2
Age in years	20–30	99	26.07
	31–40	134	34.93
	41–50	82	21.26
	>50	68	17.72
Educational status	Illiterate	183	47.84
	Primary education	140	36.96
	Secondary education	21	15.18
Family size	<5	113	29.62
	5–10	219	56.96
	>10	51	13.41
Farming years	<10	45	12.4
	10–20	88	22.78
	>20	250	64.81
Farmland size	<1 ha	211	54.43
	1-2 ha	90	23.79
	2.1–3 ha	55	14.43
	>3 ha	27	7.34
Economic activity	Ecotourism	54	15.18
	Mixed farming	329	84.82

and damage to human properties (27.9%, $n = 107$) were the two predominant rodent-related problems in the area (Table 2). There was a significant difference in the types of rodent damage in the study area ($\chi^2 = 112.698$, $df = 3$, $P < 0.05$).

Most of the respondents claimed the vulnerability of all crops grown in the area to rodent damage. However, barley (57.5%, $n = 220$) was reported as the most affected crop by rodents followed by root crops (Table 3). Mice and rats damage barley and wheat, while African root rats and porcupines damage enset and potatoes. There was a significant variation among the major crop types' susceptibility to rodent pest attacks ($\chi^2 = 143.26$, $df = 3$, $P < 0.05$).

The annual crop yield varied among the smallholder farmers in the study area in relation to their farmland size. Most of the farmers (54.5%, $n = 209$) obtain a very low amount of crop yield, which is less than 5 kg on average. Only a few farmers (21.7%, $n = 83$) harvest more than 15 kg average yields (Figure 2). There was a statistically significant difference in the annual crop yields among farmers ($\chi^2 = 214.451$, $df = 4$, $P < 0.05$).

The smallholder farmers also crudely estimated crop losses due to rodent pests. Most respondents (74.5%, $n = 285$) estimated an average of 1.5 kg of crops might be damaged by rodents in storage. However, they were unable to estimate crop damage in the crop fields in figures. The level of rodent crop damage in the area is generally high. Most of the respondents (87.4%, $n = 335$) associated high crop damage to rodent pests in the area. Only less than 10%, $n = 38$ of the farmers reported low crop damage by rodent pests (Figure 3). There was a statistically significant variation in the responses of farmers to the level of crop damage by rodents ($\chi^2 = 196.371$, $df = 2$, $P < 0.05$).

The majority of farmers (72.5%, $n = 278$) reported a seasonal variation of rodent-damaging behavior in the house and the crop field. House rodent infestation was higher during the wet season, but the damage was significantly higher during the dry season in the crop fields. Most farmers reported regular presence of rodent damage (in every cropping season/year) in their locality (Table 4). The responses of farmers to the occurrence frequency of rodent pests varied significantly ($\chi^2 = 193.826$, $df = 2$, $P < 0.05$).

Crop damage by rodent pests occurred during both postharvest and preharvest stages. Smallholder farmers identified rodent damage at different cropping stages starting from sowing to harvesting for different crop types. They have noted serious damage to barley (42.5%, $n = 163$) and enset (35%, $n = 134$) crops during maturity. These crops were also vulnerable to rodent damage during the vegetative and booting stages. Potatoes were highly damaged both during sowing and after their maturity (Figure 4). There was a significant difference in crop damage between the cropping stages ($\chi^2 = 110.82$, $df = 2$, $P < 0.05$).

Most smallholder farmers in the study area supervise their farms occasionally before harvest and rarely after harvesting. There was no significant variation in farm supervision practices among farmers ($\chi^2 = 1.691$, $df = 1$, $P > 0.05$). Farmers assess and detect the presence and damage of rodents in the storage and crop fields using different assessment mechanisms. Observation of damaged seeds (32%, $n = 123$), damaged stores (27%, $n = 103$), and rodent droppings (23%, $n = 88$) were the three most used methods to detect the damage or/and presence of rodents in the house. Stem cut of standing crops (73.5%, $n = 282$) was the most used assessment method of rodent damage in crop fields (Figure 5).

Table 2: Types of rodent damage in Wenchi highlands.

Villages	No. of households	Rodent damage (%)			
		Crops	Properties	Contamination	Disturbance
Haro Wenchi	103	40.2	23.8	19.4	16.4
Waldo Telfami	94	41	28.5	17.8	12.5
Cabo Sansalati	82	33.3	31.2	24.4	11.1
Azar Qeransa	104	40.6	28.1	18.5	12.5
Total	383	38.7	27.9	20	13.1

Table 3: Types of crops grown and their susceptibility to rodent attack.

Villages	No. of household	Damage due to rodent pests (%)			
		Barley	Enset	Potato	Wheat
Haro Wenchi	103	52.23	19.40	26.86	4.47
Cabo Sansalati	94	48.21	16.07	23.21	12.5
Waldo Telfami	82	51.11	33.33	26.66	11.11
Azar Qeransa	104	43.75	18.75	34.37	6.25
Total	383	57.5	13.5	23.0	6.0

Table 4: Frequency of rodent crop damage in Wenchi highlands.

Villages	No. of households	Frequency of crop damage (%)		
		Regular	Frequent	Occasional
Haro Wenchi	103	56.71	25.37	17.1
Waldo Telfami	94	41.07	26.78	32.14
Cabo Sansalati	82	44.44	24.44	33.33
Azar Qeransa	104	43.75	21.87	32.37
Total	383	47.5	25.0	28.0

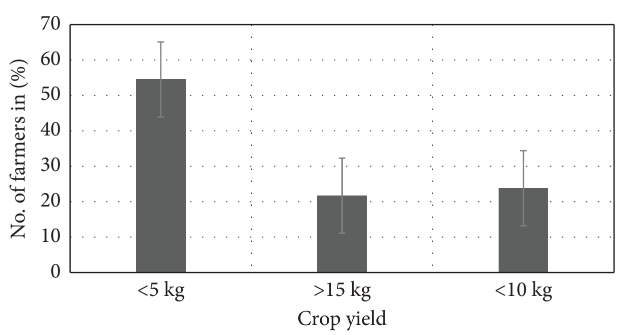

Figure 2: Average annual crop yields of the farmers in the study area.

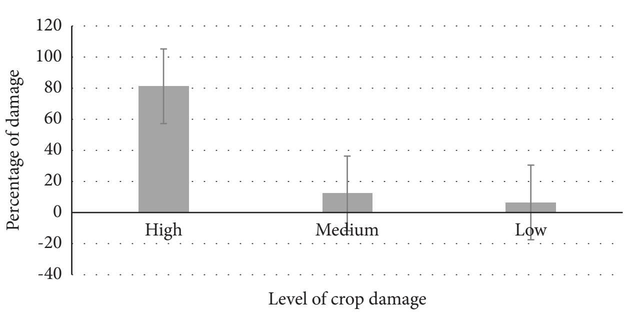

Figure 3: Level of crop damage by rodent pests in the study area.

3.3. Rodent Management. The smallholder farmers in the study area employ different management methods to control rodent damage in storage (Table 5). The farmers used domestic cats (53.73%, $n = 206$) followed by trapping (22.64%, $n = 87$) to contain rodent damage in storage. A significant variation was shown among the rodent pest-preventing mechanisms used by the respondents during storage ($\chi^2 = 89.63$, $df = 3$, $P < 0.05$). Trapping and hunting were employed to control rodent damage on enset and potatoes. However, none of the interviewed farmers have employed any management strategies in the barley crop fields. Farmers in the study area claimed that rodenticides were not safe, and rodents have developed an adaptation to avoid rodenticides and traps. Smallholder farmers in Cabo Sansalati and Azar Qeransa relatively used rodenticides more than other study villages.

4. Discussion

The smallholder farmers in Wenchi highlands rely on crop farming and rearing cattle for their livelihood. Only a few of them generated additional income from ecotourism. This is also documented by Shale et al. [30] and Angessa et al. [31]. Five rodent species are identified as major crop pests in the area. Similarly, different rodent pest species are reported from numerous localities of Ethiopia (Bekele et al. 2003; [10, 20, 26, 39]). The trapping of multimammate mouse, Awash multimammate mouse, and Abyssinian grass rat from areas close to farmlands by Legese and Bekele [40] supports the pest nature of these rodents. These rodents are widely distributed across the Ethiopian highlands, and in the farmlands and crop fields [41–44]. Porcupines and African root rats are the two rodent species that were observed based on indirect evidence, the encounter of porcupine quills, and molehills, respectively. Porcupine is a common rodent species in the uplands and scrubby habitats. The distribution of this species is probably impacted by the availability of food sources and concealing places. This is well proved by the farmers' appeals about the crop damages by this rodent (Kechinu Pers. comm., 2019).

African root rat is widely distributed in farming areas mainly after rainy seasons. It is a major rodent pest in high ground and farming areas (Mengesha *Pers. comm.*, 2020). Mole hills are observed only twice in forested areas. A rise in this rodent population shortly after the rainy season and its close association with farming areas suggests its reliance on plant products that mature shortly after the rainy season.

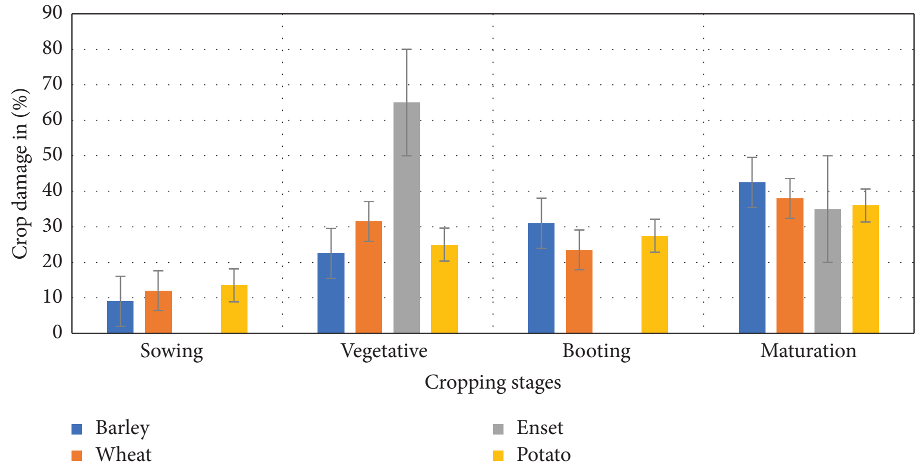

Figure 4: Rodent crop damage in different cropping stages in the study area.

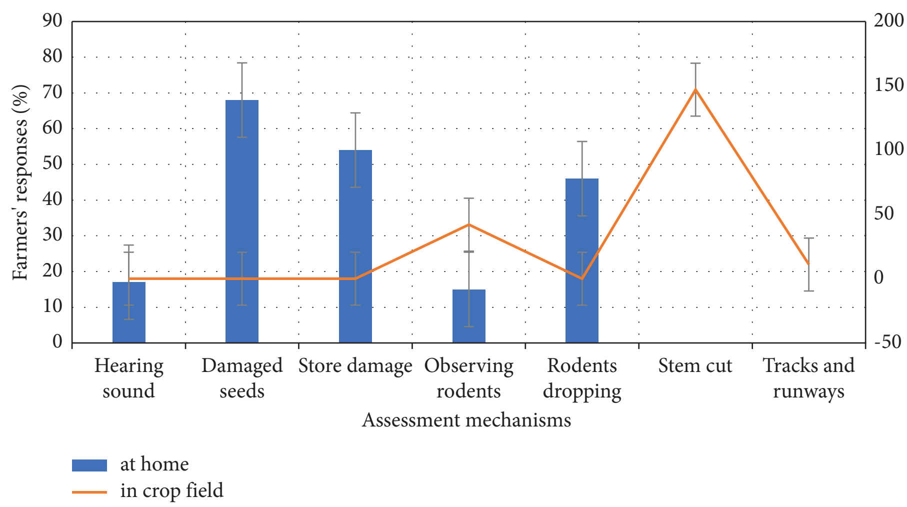

Figure 5: Smallholder farmer's assessment mechanisms of rodent damage in the house and crop fields.

Table 5: Rodent pest management techniques used in the study area during storage.

Villages	No. of households	Management strategies (%)			
		Cats	Trapping	Rodenticide	Hunting
Haro Wenchi	103	53.73	28.35	7.46	10.44
Waldo Telfami	94	37.5	28.57	12.5	21.42
Cabo Sansalati	82	40.0	22.22	28.89	8.89
Azar Qeransa	104	34.37	25.0	21.87	18.75
Total	383	43.0	22.0	16.0	14.5

Such behavior may be an adaptation to food availability and a way to avoid flooding from the rainy conditions of the area due to percolating rainy droplets to their nests and feeding tunnels.

The current study showed that rodents damage commonly grown crops, and are the most important pests in the area. This finding conforms to the worldwide problem associated with rodents [4, 5]. The smallholder farmers are well aware of rodent problems and expressed their frustration and anger towards these mammals. This result is consistent with earlier findings from Ethiopia [10, 20] and elsewhere in Eastern Africa and Southeast Asia [20, 45]. Furthermore, the farmers believe that rodents are useless but only damaging creatures. Such perception is common among sexes, age groups, and area inhabitants. This finding is also in agreement with the findings from northern Ethiopia [46] and India [47]. Local inhabitants were even viewing us as witchcraft when we were conducting field surveys. There were also occasions when individuals of different ages were harassing us verbally and intimidating us physically only because we made contact with rodents. This implies that there is a big knowledge gap about the biological and ecological values of these natural biotas, and a need for a community-wide education and training program on this matter.

In the present study, there was a significant difference in the types of rodent damage in the study area. A closely related finding is reported by Tomass et al. [26] and Panti-May et al. [3]. Crop damage and damage to properties are the two dominant impacts of rodents in the area. This is also in agreement with the finding of Panti-May et al. [3]. Like the report of Garba et al. [25] from Niger, there is also an apparent absence of knowledge about the potential role of rodents in public health issues.

Barley is the most affected crop by rodent pests followed by potatoes and enset. This finding supports the report from other Ethiopian highlands [10]. However, it goes against several reports from the lowlands of Ethiopia (Bekele et al. 2003); [20, 26], Kenya and Tanzania [20], where maize is the most susceptible crop to rodent attacks [48]. Rice is the most affected crop in Southeast Asia [45], the Philippines [37], Indonesia [47], and Central-eastern Tanzania [11]. This difference is associated with variations in climatic conditions, the type of crop grown, the wide distribution of these crops, and the inherent crop preferences of the present rodent pest species in these areas.

In the current study, smallholder farmers observed rodent damage to barley from the sowing to harvesting stages. Similar results are reported by Yonas et al. [10] and Wondifraw et al. [27] from northern Ethiopia. However, the damage is higher in the maturation stage, when the barley is near to harvesting. This is in agreement with the experimental finding of Wondifraw et al. [27] from south Gondar, and the general patterns of rodent damage in field crops [15, 19]. The finding, however, disagrees with a report from northern Ethiopia [10] and the Philippines [37], where damage is severe at the booting stages. This variation might be associated with the difference in the accessibility and vulnerability of the crop, forage selection, species richness, crop types, and abundance of rodent pests in the study areas.

The smallholder farmers reported a seasonal variation in rodent infestation of residential houses and crop fields. This is in congruent with the finding of Gebhardt et al. [18] who estimated rodent damage to selected crops in California. This supports the direct relationship between rodents' damage to rodent abundance, diversity, feeding habits, and reproductive patterns [19]. However, it disagrees with the report of Stuart et al. [37] that farmers considered significant rat damage during both the wet and dry seasons. This difference might be associated with the difference in geography, pest species, crop types, and climatic variations between the areas.

The smallholder farmers crudely estimated crop losses due to rodent pests. The estimation is in the same range of experimentally proved barley crop loss in south Gondar, which was $21.7\,\text{kg·ha}^{-1}$ [27]. However, it is lower than the reports from Tigray, where farmers experienced $100–500\,\text{kg·ha}^{-1}$ damage in crop fields [10], and southern Ethiopia, where 23.5% of average annual maize loss is associated with rodents [26]. This discrepancy might be due to the occasional supervision of crop fields by farmers, and the result confirms that rodent damage significantly affects the food security and income of smallholder farmers in developing countries [13, 15, 17]. It also suggests the need for an on-field rodent damage assessment to figure out the actual crop damage inflicted by rodents in the field.

In the present study, most farmers carried out farm supervision on rare occasions. The result disagrees with the report of Yonas et al. [10] from northern Ethiopia, Tigray, where farmers regularly supervise their farms. This might be due to the belief that farmers are powerless to control the damage caused by rodents in the field in the study area. In consistent with reports from Tigray [10] and Tanzania [11], rodent damage was assessed by observing damaged seeds, damaged stores and rodent droppings in the storage, and stem cuts of standing crop in crop fields.

Farmers in the study area employed several indoor and outdoor rodent pest management strategies. Similar findings are reported with similar practices by farmers [10, 11, 26]. Farmers used trapping and hunting to control rodent damage on enset and potatoes. These methods are well documented and the most practiced rodent control techniques in Ethiopia [20]. However, it is against the findings of Yonas et al. [10] in northern Ethiopia and Best et al. [49] in northwestern Taiwan, where farmers were reliant on rodenticides for rodent pest management. This difference might be due to the farmers' disregard of rodenticides by citing rodent adaptation and its side effects.

In the current study, none of the interviewed farmers employed any management strategies in the barley crop fields. This disagrees with the findings of Mulungu et al. [11] from Central-eastern Tanzania, Tomass et al. [26] from southern Ethiopia, and Yonas et al. [10] from northern Ethiopia, where most farmers used rodenticides in the crop fields. The farmers believed that managing rodents in barley crop fields are practically not possible. This is in total agreement with other studies conducted in Southeast Asia [50] and Vietnam [1]. In these areas, many farmers accepted that they have little control over the damage to crops caused by rodents. Asian farmers, for instance, plant two rows of grain for every 10 sown rows for rodents [50]. This might be due to the fact that rodents are minor and sporadic pests in the area and are often ignored by farmers. A similar scenario has been reported from Indonesia [47].

Another possible reason that leads the farmers to a level of acceptance of rodent crop damage could be the chronic and prolonged nature of rodent depredation. This is the most likely a rationalization for the current study area since it is experimentally supported, and Ethiopia experiences chronic rodent pest problems on different agricultural crops [22]. This situation is unbearable in Ethiopia because it is experienced by small farmholders and the country is also facing an ever-increasing population and stunning economic inflation. This finding, however, disagrees with the findings of Brown and Khamphoukeo [45] where farmers managed damage inflicted by rodents in the crop fields.

The smallholder farmers in the study area claimed that rodents have developed an adaptation to avoid rodenticides and traps. However, these claims are unsubstantiated, and rodenticide avoidance of rodents could be associated with the quality of baiting foods. It is well documented that the use of poor baiting food has low rodent attraction potential to the rodenticide and leads to the point where rodents avoid consumption (Hill, 2008). Using high-quality and palatable baits can easily reduce such problems. The second and most likely problem in the area could be the dose level of rodenticide preparation. This problem can be easily solved by balancing the amount of rodenticide and baiting food that is efficient and effective in attracting rodents. However, if rodents really developed rodenticide avoidance behavior, the only possible solution could be the use of other forms of rodenticides and rodent management strategies.

The claim of farmers about rodent trapping adaptation disagrees with the finding of Brown and Khamphoukeo [45] where trapping rodents are the most effective and important rodent control strategy. In fact, rodents are not easy to trap and may show trapping avoidance. This problem is largely associated with the ability of rodents to sense human smells in the traps and inappropriate trapping procedures—setting the trap defectively, using inadequate and low-quality baiting food, and placing traps closely (Hill, 2008). This suggests the need for a community-wide education and training program to trap-related problems and possible solutions.

The smallholder farmers in the study area used domestic cats as a natural enemy to control rodent pests in storage facilities. Owning local cats in a residential house is a widely employed biological rodent control method in different parts of Ethiopia [10, 26, 46] and in southwestern Zimbabwe [51]. This practice is well documented and has a major suppressive effect on the local rat population (Hill, 2008). The effectiveness of this rodent management strategy in the area contravenes other findings in other parts of Ethiopia [39, 46], where rodenticides are the best rodent management strategy, and in Southeast Asia [45], where trapping rodents are the most effective rodent control strategy. The possible explanation for this state of affairs could be due to the cost-effectiveness of this method and the differences in familiarity and availability of other rodent control measures between these areas. Such favor in the study area might be associated with farmers' rodenticide and trapping adaptation claims, and the fear of the side effects of rodenticides. Kasso [39] has argued that the use of domestic cats to control rodent pests is not equally effective in all areas because cats may avoid catching and consuming rodents. Little is known about the use of field sanitation in rodent pest management among farmers.

5. Conclusion and Recommendations

Rodents cause considerable damage to agricultural crops and properties of smallholder farmers of Wenchi highlands. The farmers perceived rodents as a pest to their crops and caused a nuisance to them. They declined to manage rodent damage in the crop fields. Owning cats, rodent trapping and using rodenticides were employed as indoor management strategies. Outdoor rodent management activities were scarce. The outcomes of this study suggest that rodent pests are a threat to food security in the area. Conducting on-field damage assessment and community-level education programs are critical to estimate the actual damage rodents inflict in the field and to awaken farmers for rodent management.

Data Availability

The data used to support the findings of the study are available upon request from the corresponding author.

Disclosure

This manuscript was submitted as a preprint in the link "https://www.biorxiv.org/content/10.1101/2022.12.06.519363v1.full.pdf."

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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