Predation and theft: the standing threats of the scavenging chicken production system

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Abstract

Indigenous Village Chickens (IVCs) obtain most of their feed from a scavenging feed resource base. Free roaming makes IVCs express their instincts at will, which could enhance their welfare. Free-ranging has also endowed IVCs with excellent explorative behavior. However, predators might have also co-evolved, which necessitates special interference from smallholder farmers to reduce the adverse impact of predators. This study identified the main predators of IVCs and the evading strategies adopted by smallholder farmers. This cross-sectional study involved a general interview with 119 smallholder farmers. The prevalence of enset, *Ensete ventricosum* (Welw.) Cheesman, around the farmer's backyard can impose a significant threat because it shelters terrestrial predators. Smallholder farmers evade predators through patrolling, guarding dogs, fencing, confinement, and, in rare cases, killing. An unplanned conversation made with an informant revealed that men with some clerical ability but no priesthood title incantate on whole grains of black wheat. When the chicken is fed this grain, reportedly, the aerial predator becomes weak and cannot catch the chicken. The agroecological zone has a statistically significant impact on the proportions of predators encountered and the types of evading strategies adopted by smallholder farmers. This association entails the need for developing agroecology-based predator-evading methods. Predators' evading methods, however, need to be refined further to reduce the recurrent losses of chickens. The threats associated with predators' challenges must be thoroughly investigated to advance their evading strategies. Another problem that leads to the significant loss of family poultry is theft. In addition to the strategies used to avoid predators, which may also apply to controlling theft, the legal system must be well-organized to punish such misdeeds.

Introduction

Indigenous Village Chickens (IVCs) are left free to scavenge,[1] refresh themselves, and mix and socialize with free-ranging sibling family flocks. Subsequently, IVCs have unlimited access to the open air environment.[2] The scavenging production system provides excellent enrichment, a vital resource that enhances the welfare of IVCs, improves the quality of eggs and meat, and creates ample opportunity for IVCs to deliver ecosystem services.[3] This unrestrained interaction with the local ecosystem makes the IVCs develop excellent explorative behavior and predator-evading abilities.[4] For example, in response to predators' challenges, IVCs roost high on perches or any sort of raised object,[5] in trees in the wild,[6] and in those trees that are found in farmers' backyards,[7] especially at night, to escape predators. However, the predators

may have also co-evolved to get access to prey. This co-evolution calls for the notion that anthropogenic interference is indispensable to rescue IVCs from the adverse impact of predators.

Predators are among the main environmental challenges that can cause a significant loss in the family flock,[1,8] especially chicks.[3,7] Unlike their wild cousins, *i.e.*, the morphologically cryptic junglefowl,[9] IVCs display tremendously magnificent plumage colors and morphological structures such as combs, wattles, legs, and beaks, especially the cocks.[10] These vivid morphological structures, however, could expose IVCs to predator sightings and attacks. Nevertheless, these traits of the show are highly sought after in the ritual practice of the traditional community and are eye-catching to sightings.[3,10] Conspicuous morphological structures are important ingredients in the process of sexual selection.[11] IVCs might not be as active as junglefowl in exploring their environment and evading predators. These adaptive behaviors might have been weakened to some extent by domestication-instigated breeding and management practices.[12]

A real threat to scavenging chickens is the dense vegetation cover around the farmer's backyard, which could serve as a hide-away for predators.[13-15] This is also a good recipe for theft-instigated chicken loss, which is exacerbated further due to inadequate housing, fencing, care, and offensive behavior.[16] To lessen the negative effects of predators and theft, vegetation cover management, especially in the backyards of small-scale farmers, is important. Small-scale farmers must adopt locally feasible evasion strategies to reduce the adverse impacts of predators and theft. This study identified the main predators of IVCs in the study sites, and the evading strategies adopted by smallholder farmers. It also proposed alternative methods of predators' evasion to circumvent one of the most important challenges of village chicken production systems.

Materials and Methods

Study sites

The study site Wolaita Zone is located in southern Ethiopia. Wolaita is conventionally divided into two agroecological zones: highland, more than 1,500 meters above sea level (MASL) and lowland (less than 1500 MASL). A significant proportion of the agriculturally important region of Wolaita falls under the moisture-reliable enset-based highland agroecology. However, a considerable part of the lowland region is moisture-stressed. Most of the human population lives in the highland region. Besides the study conducted in Wolaita, the case of lost and found hen was studied in Adama city, which is located in the central Rift Valley of Ethiopia. Moreover, a knowledgeable respondent who is living in Adama City reported the case of scrambling predators using the act of incantation.

Methodologies

The main data was collected in 2007 and additional information about the case study of theft and the act of incantation that enables to evade predators recorded in 2022. In the highland region, three rural villages were selected, and 59 small-scale farmers were interviewed. Similarly, three villages were selected from the lowland region, and 60 farmers were interviewed. The interview questions were open-ended and administered using a trained enumerator. The contents of the interview are the main types of predators encountered in the respective vicinities of the respondents and the types of predators' evading strategies adopted by small-scale farmers. This study also discusses a unique incident in which a chicken owner was the victim of theft and the act of incantation that is used to evade predators.

Statistical analysis

The statistical analysis of the strength of the relationship between dependent and independent variables was performed using IBM SPSS Statistics 23[17] and R.[18] Specifically, the χ^2 test and Cramer's V were used to quantify the relationships among the studied variables. Data summary statistics were produced using SPSS, and graphical presentations were made using Excel.

Results

Reported predators

The reported predators live in terrestrial and aerial habitats. The terrestrial predators include two families of carnivores, the Felidae and the Canidae, and an omnivore family, the Muridae. The Felidae family includes wildcats (*Felis silvestris*) and genets (*Genetta genetta*), whereas the Canidae family includes wolves (*Canis lupus*). The Muridae family includes rats (*Rattus norvegicus*). The only reported carnivorous bird that preys on IVCs is the hawk (*Buteo buteo*). Figure 1 shows the frequency counts and the corresponding percentages of the commonly encountered terrestrial and aerial (flying) predators of IVCs (multiple responses exist) for the entire dataset. The data shows that most of the reported predators were terrestrial mammals (72.4%, χ-square=20.07, df=1, p-value=7.464e-06). The frequency count of the reported predator types shows statistically significant differences (χ-square=93.865, df=4, p-value<2.2e-16). Agroecology has a statistically significant impact on the proportion of reported predator types (Pearson χ-square=18.974, df=8, p=0.009). Cramer's V also shows a statistically significant association between the percentage of reported predator types and agroecological zones (V=0.223 and p=0.009).

Predators-associated loss of chickens

The Independent Samples T-test analysis shows a statistically trivial difference in the average percentage of birds killed by predators in the highland and lowland regions (T-test=0.581, df=114, p=0.653, 95% CI: -7.982, -4.363). Accordingly, a year ahead of the

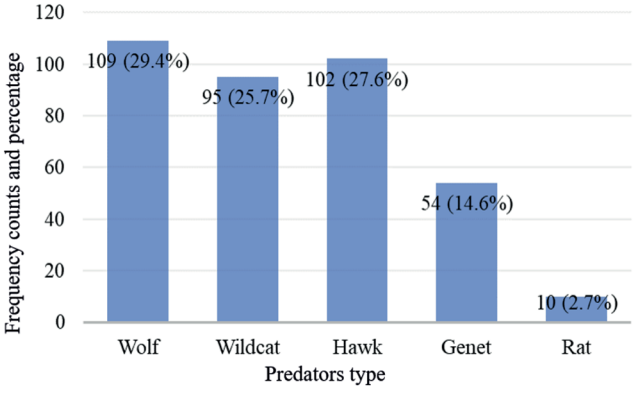

Figure 1. Reported frequency counts and the corresponding percentages of predators of indigenous village chickens.

study period (2006), the percentage of killed chickens per studied household in the highlands ranged from 0 to 56% with a mean and standard deviation of 27.36±17.055% and a standard error of the mean of 2.279%, whereas these statistics were in the range of 1 to 60% with a mean and standard deviation of 29.17±16.498% and a standard error of the mean of 2.13% in the lowland region.

Predators evading methods

Small-scale farmers adopted various strategies to evade terrestrial and aerial (flying) predators. These strategies are summarized in Figure 2, and their percentages show statistically significant differences (χ-square=156.67, df=4, p-value<2.2e-16). However, farmers reported that controlling rats is a daunting task. Regardless of this, some of the farmers who have been involved in informal discussions reported that domestic cats can be used to scare off and kill rats, and rats can also be poisoned or trapped. The reported evading strategies show that complete avoidance of predators is impractical.

Dogs were more frequently used to scare off predators in the lowlands (31.9%) than in the highlands (7.0%) (χ-square=15.114, df=1, p-value=0.0001012). Conversely, confinement as an evading strategy was frequently adopted in the highland region (17.4%) compared to the lowland region (3.3%) (χ-square=8, df=1, p-value=0.004678). The percentages of the reported evading strategies vary between agroecological zones (χ-square=27.737, df=5, p=0.000). Cramer's V analysis also corroborates the relationship between agroecology and the percentages of the reported predators' evading methods (V=0.396, p=0.000). To evade aerial predators such as hawks, farmers usually use guard dogs and confinement. Farmers have relatively more methods to evade terrestrial predators than their aerial counterparts.

An informal conversation revealed that men in central parts of Ethiopia who have some clerical ability but have lost their priesthood title for some reason incantate on black whole-grain wheat. When the chicken eats this grain, the aerial predator that would normally take the chicken away becomes frail and is unable to catch it. However, an in-depth investigation of the efficacy of this ritual (magical) practice is required.

The case of a prolific hen experiencing theft

Figure 3 depicts a hen that mysteriously vanished on November 11, 2022, and, surprisingly, returned on December 15, 2022 in Adama City, central Rift Valley of Ethiopia. After displaying a brief period of broody character for one or two days, the hen, which is typical of the local type, continued to lay eggs. The owner was concerned that the hen might have been held hostage for more than a month by a thief who was aware of the bird's high egg production. Fortunately, the owner suspected that the bird was able to escape the hostage by accident and return home. The hen could have been slaughtered after it was stolen if the thief had not been aware of how well it laid eggs.

Discussion

The absence of well-secured night enclosures, an ideal niche for the survival of predators, suboptimal care, and inadequate follow-up by small-scale farmers expose IVCs to predators' attacks and losses associated with theft. In line with our findings, the predators' challenge is a persistent threat to IVC production.[19] Disease outbreaks may occur sporadically, but predators' problems are a persistent constraint, which makes them tedious for small-scale farmers to take care of. Small-scale farmers are not specialized in IVC production; consequently, they may not provide consistent and adequate care for a few of the birds they are raising. The limitation of suboptimal management, however, can be partly circumvented by the agile and self-reliant nature of IVCs.[20] Predators, which are virtually wild animals as it has been found in this study, may have evolved at a faster rate than IVCs, especially in traits of adaptive importance.[21] Nevertheless, IVCs are managed under the mild impact of human-driven selection pressure,[22] and this production system enables them to develop excellent explorative behavior. The adaptive behaviors developed in the wild might be significantly canceled out due to the adverse impact of domestication phenotypes. IVCs may also show diminished "fight-or-flight" responses attributable to domestication syndrome.[23] Domestication might have also enhanced the vulnerability of livestock species, such as chickens, to predation by favoring

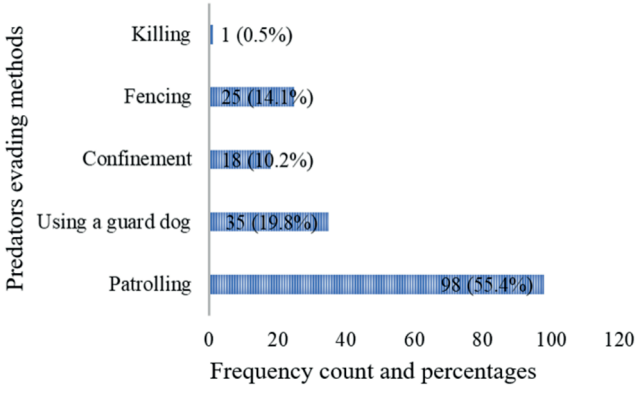

Figure 2. Frequency counts and the corresponding percentages of predator-evading methods implemented by small-scale farmers.

Figure 3. A hen that was stolen but surprisingly returned home after one month.

the development of maladaptive behaviors.[22] In line with the work of Lindholm *et al*.[24] on free-ranging Rowan Ranger broiler chickens in Sweden, IVCs do not refrain from scavenging, although they have recurrently encountered predator challenges. However, the memorizing capacity of chickens must be proven through investigation.

Predators have a proclivity towards the human landscape[25] because it enables them to scavenge on carcasses and kitchen meat scraps discarded on the street side. This intimacy between wild animals and humans enables predators to audit the abundance and species richness of domestic animals – potential sources of prey. However, in agreement with our findings, predators' impacts could vary among agro-ecologies, *i.e.*, based on the abundance and species richness of predators, variation in topography-induced landscape, forest, and vegetation cover, and disparity in human density.[26] Enset, *Ensete ventricosum* (Welw.) Cheesman, also known as false banana, is a common food crop grown in the backyards of farmers in southern and southwestern Ethiopia, *i.e.*, including the study sites.[27] Because it creates a niche environment in which predators can thrive, it poses a significant threat to the scavenging chicken production system, regardless of its significance as a staple food.

In line with predators' avoidance strategies adopted by the respondents, to evade predators, the night enclosure should have to be vermin-proof. The night enclosure and perch must be off the ground to discourage predators from hiding under them. Providing wide-open spaces around enclosures is advantageous because most predators are reluctant to pass through such open spaces.[7,28] The respondents reported that live fences established using thorny bushes efficiently block the entrance of predators to farmers' compounds. Supplementing with adequate amount of feed and water in the farmer's backyard makes IVCs not wander far to scavenge, which reduces the odds of encountering predators. Farmers have not included domestic dogs and cats in the list of predators, which is good because this reduces the resources allotted for the control of predators.

The type and degree of the prevailing threat determine predator evasion strategies adopted by farmers and predators' avoidance behavior developed by the victim IVCs. IVCs trained themselves (*a.k.a.* "learned behavior" or "trained phenotype") on how to escape predators because of the challenges they have encountered. Small-scale farmers reinvent and refine their evading strategies by assessing the type and degree of emerging threats.[29] However, farmers practice the common types of predator-evading methods adopted in rural settings. Shotguns and traps that lead to the death of predators could be illegal. Therefore, clearing predators' hiding places and constructing well-secured night enclosures need to be encouraged. Preventing daytime predators is more difficult than preventing nighttime predators because IVCs are free to roam during the day and can be easily attacked by hiding predators.[13] Overhead cover can be used to protect the chickens from aerial predators. Intertwined, dry branches of trees or shrubs and live fences can provide overhead cover against aerial predators. The common types of predator-evading strategies that can be used by small-scale farmers are summarized in Figure 4. This shows that there are opportunities to improve predator-evading methods.

In Ethiopia, the practice of incantation is common. Incantation is performed in rhyming words or scripts to produce magical solutions and is spoken in a clerical language called "Geez," which is an ancient Ethiopian Semitic language. In Ethiopia, according to traditional believes, men known as "*Debtera*" engage in illicit magic and have some clerical experience. *Debteras*, for instance, use an incan-

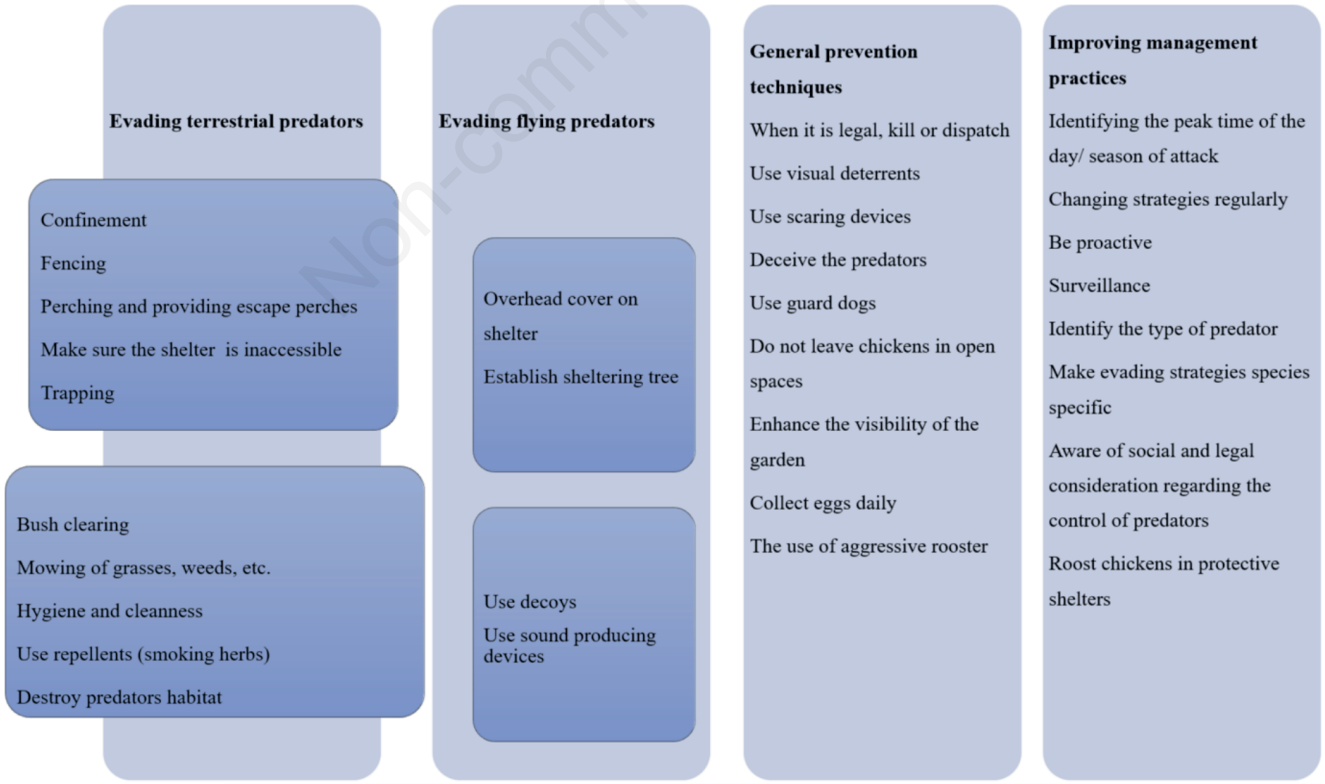

Figure 4. Proposed enhanced predator-evading methods.

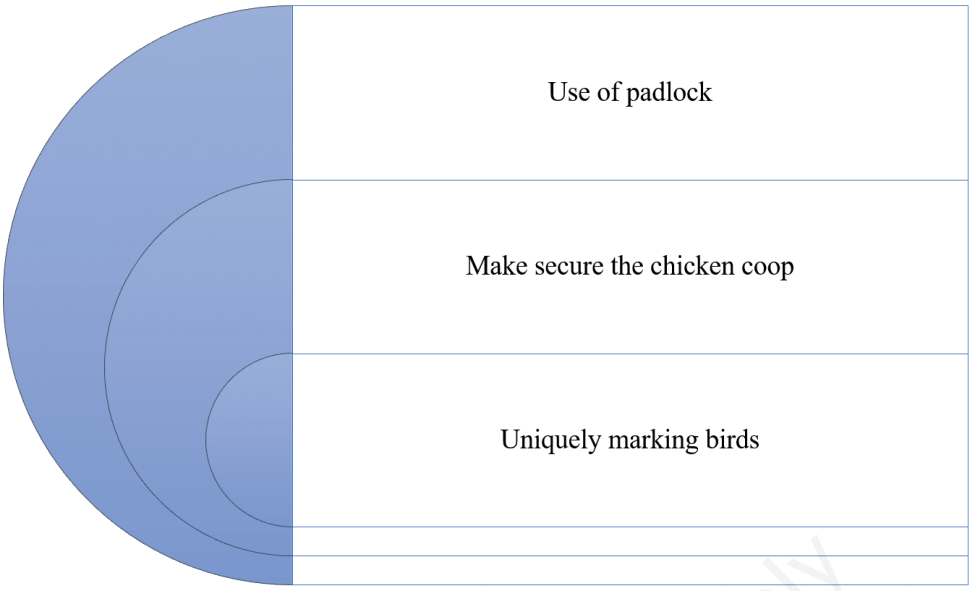

Figure 5. Proposed plausible theft evading methods.

tation to protect the lost donkey from a night-time hyena attack. Even though the hyena tries to bite the donkey, its teeth become weak, and it can only wet the donkey with its saliva. However, after receiving the incantation, the donkey's owners must refrain from searching for the lost donkey because, if they do, the incantation will be void and the lost donkey will be killed by a hyena. Despite this, the chicken case that this study describes is quite intriguing and could be the subject of further investigation.

Regardless of this, we need to gain insight into the key role of predators in maintaining the health of the ecosystem.[25] Increasing the size of the family flock makes farmers invest more in evading strategies, which in turn reduces the overhead cost of predator control. The effect of theft might not be distinguished from the loss associated with predators' killing; therefore, a thorough investigation needs to be carried out to get a clue on the remains of killed birds and signs of mauled birds. However, it might be difficult to distinguish the case of missing birds because it could be due to theft or predators.

According to Desta and Wakeyo[14] and Onono *et al.*,[16] one of the most significant production constraints that the extensive chicken production system of the Global South faces is theft. Therefore, the strategies adopted to avoid predators can be partly used to control theft, and additional methods are presented in Figure 5. Theft poses a significant threat, particularly to female-headed households, which frequently feel afraid to conduct night-time property patrols. Depending on the specifics of the chicken production system, the level of theft may vary. It could, for instance, become even more intense during the holidays, when there is a high demand for chickens.

Conclusions

Given the high risk of predators and theft challenges small-scale farmers face, evading strategies should be developed and perfected further. To reduce the devastating impact of predators and theft, studies dedicated to the control of predators and theft must be thoroughly conducted. While devising predator-evading strategies, the impact of agroecological zones must be considered. It is also vital to develop farmer-friendly predators and theft deterrence strategies. Studies on the challenges of predators and theft need to consider the variation in predator attack and theft among different classes of sex- and age-group chickens, the seasonal variation in predator and theft challenges, the part of the day the chickens are encountering frequent predator attacks and theft, and the drivers of these challenges.

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