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Research Article

PERCEPTIONS AND PRACTICES: FARMER RESPONSES TO WILDLIFE CROP RAIDING NEAR MONT SANGBÉ NATIONAL PARK, WESTERN CÔTE D'IVOIRE

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ABSTRACT

In tropical regions, human-wildlife conflicts are escalating, particularly in the vicinity of protected areas, where animal incursions cause considerable damage to crops. The Mont Sangbé National Park (MSNP) in Côte d'Ivoire exemplifies this issue. Farmers' protection strategies under these pressures remain inadequately documented, both in terms of their diversity and the influencing factors governing their adoption. A survey was conducted between February and April 2022 involving 120 households across three villages near the MSNP. The data collected comprised crop species, identified crop raiders, protection methods employed, and perceptions of damage. The analysis integrated descriptive statistics, χ^2 tests to evaluate associations between variables, and logistic regression to model the impact of damage perception on the adoption of control measures. Of the 1,085 devastation cases recorded, 61.8% of households had not implemented any protective measures. The prevalent active strategies were guarding (16.7%) and trapping (11.8%). The analysis revealed a strong correlation between protection methods and the types of crops or crop raiders, as well as a significant influence on damage perception. Specifically, only households that perceived losses as "catastrophic" significantly adopted control measures (OR = 5.3; $p = 0.029$). This study highlights a pronounced strategic inertia in response to wildlife crop raiders. However, it also reveals a refined adaptability among producers, based on the economic value of crops and the ecology of the crop raiders. It emphasizes the necessity of incorporating local knowledge and farmers' perceptions in devising integrated management strategies that are better aligned with the realities of tropical agriculture.

Keywords: Crop protection strategies, Crop Raiding, Human-wildlife conflict, Perception of damage.

INTRODUCTION

In various tropical regions, the interactions between agricultural systems and wildlife are leading to increasing conflicts, specifically manifesting as wildlife-induced crop damage (Digun-Aweto *et al.,* 2004). These phenomena, widely recognized as human-wildlife conflicts, are particularly prevalent in areas adjacent to protected zones, where agricultural endeavors coexist with diverse and occasionally invasive biodiversity forms (Larson *et al.,* 2016; Woodroffe *et al.,* 2005). This situation is further intensified by habitat fragmentation, the expansion of agricultural boundaries, and the depletion of natural resources, compelling wildlife to venture beyond protected areas in search of sustenance. Mont Sangbé National Park (MSNP), situated within the forest-savannah transition zone of western Côte d'Ivoire, serves as a case study of the ongoing tension between conservation initiatives and the interests of local communities. Designated as a protected area since 1976, the park spans 95,000 hectares and supports a diverse array of wildlife, including several protected species such as duikers, arboreal primates, and burrowing rodents (Lauginie, 2007). However, this biodiversity also engenders disputes with local populations, predominantly due to wildlife incursions into agricultural

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territories, resulting in considerable economic losses for rural households (Koffi *et al.,* 2024).

In this context, the defensive strategies employed by agricultural producers are essential for bolstering the resilience of agricultural systems. However, there is a paucity of comprehensive documentation pertaining to these strategies, especially in relation to their diversity, ecological appropriateness, and the factors that determine their adoption. Gaining an in-depth understanding of farmers' responses to wildlife crop raiders is crucial for devising more effective integrated management systems tailored to specific local conditions.

This research aims to address the existing gap by evaluating wildlife crop raider control practices in three villages located on the periphery of the MSNP. Utilizing a household survey, the researcher examines the interrelations among crop types, crop raider species, protection strategies implemented, and damage perceptions. By applying statistical tools and explanatory models, this study provides a comprehensive understanding of farmers' responses to wildlife pressures, analyzed through an agroecological perspective.

MATERIALS AND METHODS

Study site

The collection of data occurred from February to April 2022 across three villages situated in proximity to the Mount Sangbé National Park (MSNP) (Figure 1). The MSNP has maintained its status as a classified forest since 1945 and was formally recognized as a national park on February 19, 1976. It experienced a phase of development between 1995 and 2001, facilitated by financial support from the European Commission and the Republic of Côte d'Ivoire, amounting to three million euros. Located in the Man region, the park sits in a forest-savannah transition zone in the western part of the country. The MSNP is confined to the Biankouma-Touba-Sifie triangle and is traversed from west to east by the Bafing River, a tributary of the Sassandra River. This contributes to a hydrographic network that sustains the extensive Ivorian plateau. As part of Côte d'Ivoire's natural and forest heritage, the MSNP covers an area of 95,000 hectares, making it the fourth largest park in the country, following Comoé, Tai, and Marahoué parks. Notably, 40% of its area is situated in mountainous regions: the Sangbé Mountain massif, which represents the last eastern bend of the Guinean Ridge, reaches a height of 1,052 meters. A wildlife census conducted in 2000 identified 69 species of mammals, 12 species of reptiles, and 60 species of birds (MEEF, 2000). The local populations living around the park are situated in what is known as the "MSNP peripheral zone." This area extends over 200,000 hectares within a radius of 20 to 40 kilometers around the park and is home to four ethnic groups: the Yacouba, the Toura, the Mahou, and the Worodougou. The economy in this region is characterized by cash crops such as cocoa (*Theobroma cacao* L.), coffee (*Coffea canephora* Pierre ex A. Froehner), and cashew nuts (*Anacardium occidentale* L.), alongside a traditional subsistence economy that includes the cultivation of rice (*Oryza sativa* L.), cassava (*Manihot esculenta* Crantz), yam (*Dioscorea sp.*), okra (*Abelmoschus esculentus* L.), potatoes (*Ipomoea batatas* L.), chili peppers (*Capsicum sp.*), and eggplant (*Solanum melongena* L.). The MSNP operates in an integrative manner (Gueneau and Jacobee 2005), serving as a nature reserve open to both visitors and researchers. However, resource exploitation is prohibited for local populations. As compensation, these communities benefit from special subsidies aimed at developing the park's peripheral zone, as well as job opportunities created through its tourism development.

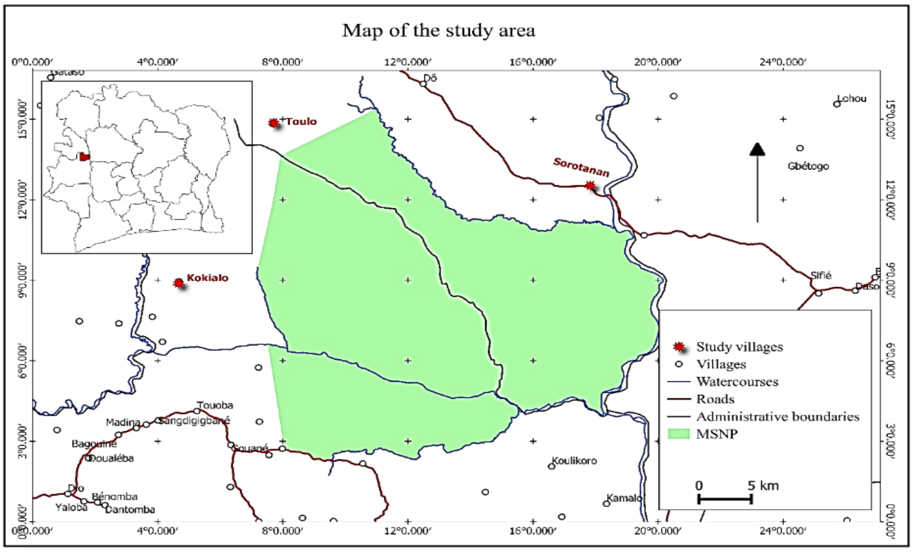

Figure 1. Location of the study area.

Data collection

A random selection of 40 households was made from each village, resulting in a total of 120 households. Three interviewers were assigned to each village, accompanied by three local translators fluent in both the local languages and French. During the interviews, participants had the option to communicate in either French or their native language. If both the household head and their spouse were present, the interview was conducted with both individuals; otherwise, it proceeded with a single participant. Throughout the survey process, interviewers documented the animals causing damage to the crops, the methods employed for controlling these wild animals, and the participants' perceptions regarding the extent of the damage. OIPR ecologists assisted with the surveys by helping to identify the wild animal species that were crop raiders of crops. Interviewees also provided the names of crop-raiding animal species in either French or their native language. The identification of these crop-damaging species was verified using morphological description guides authored by Hilary Fry and Keith (2020), Kingdon *et al.,* (2024; 2013) Kingdon and Happold (2024) and Urban *et al.,* (2020). These resources enabled a scientific verification of the species responsible for the damage.

Data analysis

To examine crop raiders protection strategies, a comprehensive methodological framework was applied, integrating descriptive analyses, statistical cross-referencing, and modeling techniques. Initially, a horizontal bar graph was employed to depict the frequency of various crop protection methods, facilitating the identification of the strategies most commonly employed by producers. Subsequently, the associations between protection methods and three explanatory variables—crop species, crop raider species, and damage perception—were analyzed through cross-analyses. In each case, the data were filtered to eliminate instances where the farmer took no action against crop-raiding animals, thereby focusing the analysis on active methods. Cross-tabulations were generated and subjected to a χ^2 independence test to assess the significance of the observed associations (Momeni *et al.,* 2018). The results were visualized using stacked bar charts, which aided in interpreting method preferences within the agricultural, ecological, and perceptual contexts. Finally, to further understand how damage perception affects the adoption of control measures, a logistic regression (binomial model) was implemented, with the variable "adopt" (1 = active method, 0 = no action) as the response. Odds ratios (OR) and their confidence intervals were calculated, and predictions were derived from simulated data to estimate the likelihood of adopting control methods based on perceived severity levels. This integrated approach provides a clearer comprehension of the factors influencing grower behavior regarding crop raiders (Ghosh, 2020; Statology, 2022). The statistical method was implemented with the R Software Version 4.4.2.

RESULTS AND DISCUSSION

The study documented 1,085 occurrences of field raiding among the 120 households included in our survey sample. The most prevalent response to damage caused by crop raiders was inaction, with 60.5% of households indicating that no remedial measures were implemented to address the issue (Figure 2). The second most commonly utilized strategy was field surveillance, which was adopted by 24.2% of farmers and primarily involved human monitoring to avert animal intrusions onto their lands. Trapping and capturing techniques were implemented by 6.9% of farmers as a focused approach to controlling crop raider activity; however, this method requires a certain level of expertise. Additional strategies included the use of scarecrows (2.9%), traditional hunting practices (2.6%), fencing (1.2%), as well as the employment of weeding (1.1%) and noise deterrents (0.7%).

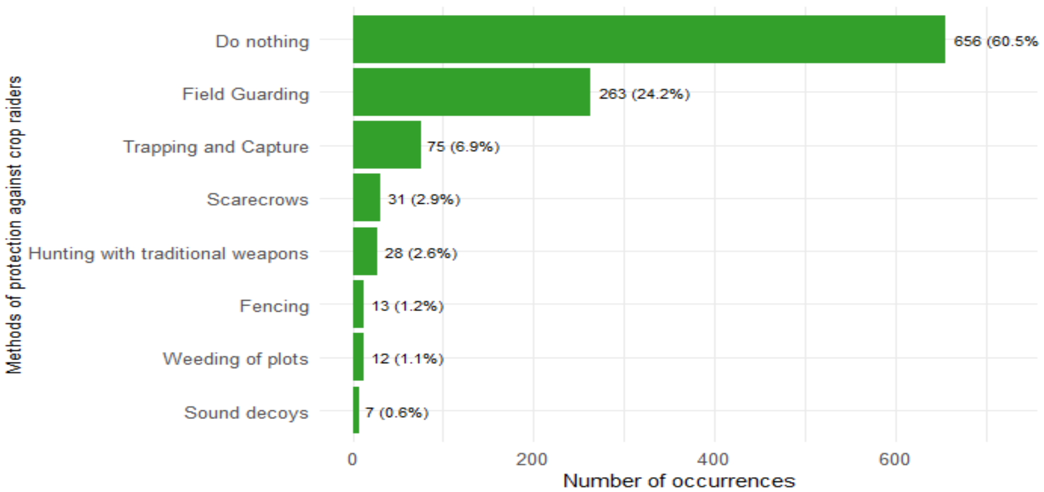

Figure 2. Response Against Crop Raiding.

The agronomic study reveals a significant diversity of species within the evaluated agricultural systems, comprising a total of 15 cultivated species distributed across 10 distinct botanical families. The findings highlight a varied distribution of protection methods specifically adapted to the species under cultivation (Figure 3). The cashew emerges as a crop of strategic importance, utilizing a substantial combination of guarding (21 instances) and trapping (29 instances), emphasizing its considerable economic value and vulnerability to numerous crop raiders. In contrast, rice is predominantly safeguarded through guarding (155 instances), while also benefiting from additional methods, including trapping, hunting, and the deployment of scarecrows and auditory deterrents, indicating pressure from a diversity of species, especially avian and primate crop raiders. Certain food crops, such as potatoes, sesame (*Sesamum indicum* L.), and okra, often demonstrate simpler or less diverse protection strategies, which may sometimes be largely confined to guarding alone. Cassava displays a balanced protection profile, employing guarding and trapping techniques equally (14 instances each), reflecting the subterranean nature of its crop raiders, which are often targeted with specific countermeasures. Statistical analysis employing the χ^2 test ($\chi^2 = 114.53$; ddl = 54; $p = 3.038 \times 10^{-6}$) corroborates that the selection of protection methods is distinctly correlated with crop type rather than occurring by chance. This statistical relationship supports the premise that producers tailor their control strategies based on the specific vulnerabilities and behaviors of crop raiders, while also considering the crops' economic importance. Nevertheless, caution regarding the approximation of the test suggests that adjustments for limited sample sizes in certain cases should be considered.

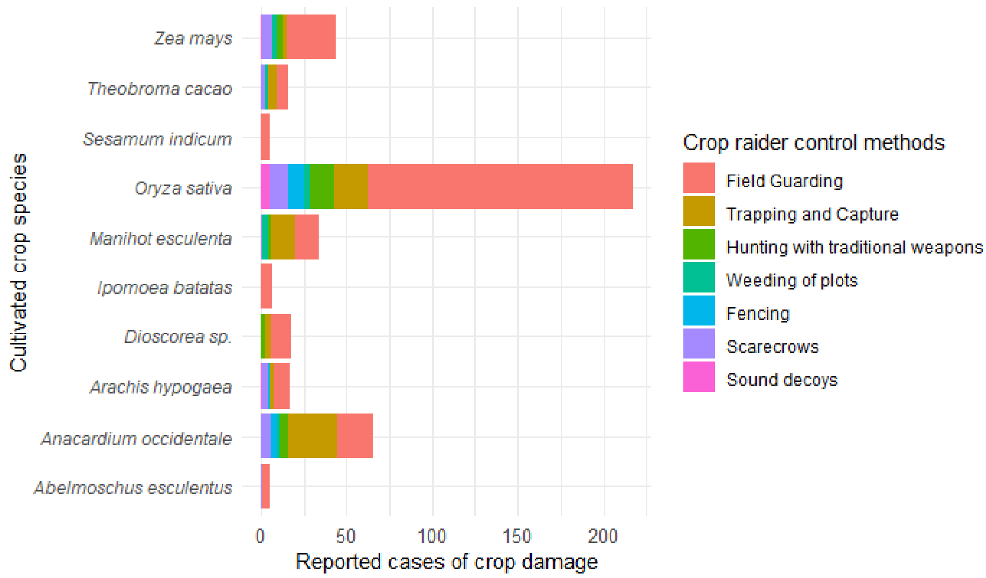

Figure 3. Relationship between crop species and the selection of control methods.

The ecological assessment identifies a substantial diversity of crop-raider taxa, documenting 25 distinct animal species distributed across 16 taxonomic families (Figure 4). This diversity indicates a cultivated ecosystem experiencing considerable biotic pressure. The findings underscore a pronounced specificity between crop-raider species and the management strategies implemented by cultivators, corroborated by a highly significant chi-squared test result ($\chi^2 = 672.59$; ddl = 120; $p < 2.2 \times 10^{-16}$). Primates such as the patas monkey (*Erythrocebus patas*; Schreber 1774), (61 observations) and the green monkey (*Chlorocebus sabaeus*; Linnaeus 1766), (10 observations) are predominantly controlled by human guards, likely due to their arboreal movement capabilities. Seed-eating avian species, including the red-headed quelea (*Quelea erythrops*; Hartlaub 1848), (124 observations), the double-spurred francolin (*Francolinus bicalcaratus*; Linnaeus 1766), (35 observations), and the helmeted guineafowl (*Numida meleagris*; Linnaeus 1758), (8 observations), are primarily deterred via guarding, supplemented occasionally by scarecrows and acoustic deterrents. Conversely, burrowing rodents such as the grass cutter (*Thryonomys swinderianus*; Temminck 1827) and the northern giant pouched rat (*Cricetomys gambianus*; Waterhouse 1840) exhibit distinct control profiles; trapping (28 and 15 observations, respectively) is the predominant method, supplemented by hunting, weeding, and even fencing for the grass cutter. These observations suggest a well-adapted management strategy, tailored to the ecological behaviors of crop-raiders: subterranean or elusive species require more focused and often challenging control strategies. Less frequently encountered species such as the crested porcupine (*Hystrix cristata*; Linnaeus 1758), the African savanna hare (*Lepus victoriae*; Thomas, 1893), or the green bush squirrel (*Paraxerus poensis*; A. Smith 1830) exhibit varied responses aligned with their specific ecological niches, whether subterranean, arboreal, or otherwise.

When the damage is evaluated as "negligible," minimal interventions are executed, with merely two households reporting the employment of trapping (Fig.5). At a damage level deemed "fairly important," there is an initiation of active management strategies, evidenced by 8 households engaging in guarding and 9 utilizing trapping, while other methods remain sparse. As the perception of damage escalates to "very significant," the implementation of guarding rises to 39 households, trapping to 18, and the usage of scarecrows is recorded in 10 instances. At the "catastrophic" threshold, the adoption of guarding reaches its peak with 216 households utilizing it, followed by trapping (46), hunting (25), and a diverse array of techniques such as fencing, weeding, and sound decoys, employed by 6 to 21 households respectively. The χ^2 test (χ^2 = 38.13; ddl = 18; p = 0.0037) indicates a substantial variation in the distribution of control methods contingent on the perceived severity of damage: as losses intensify, farmers increasingly employ active strategies.

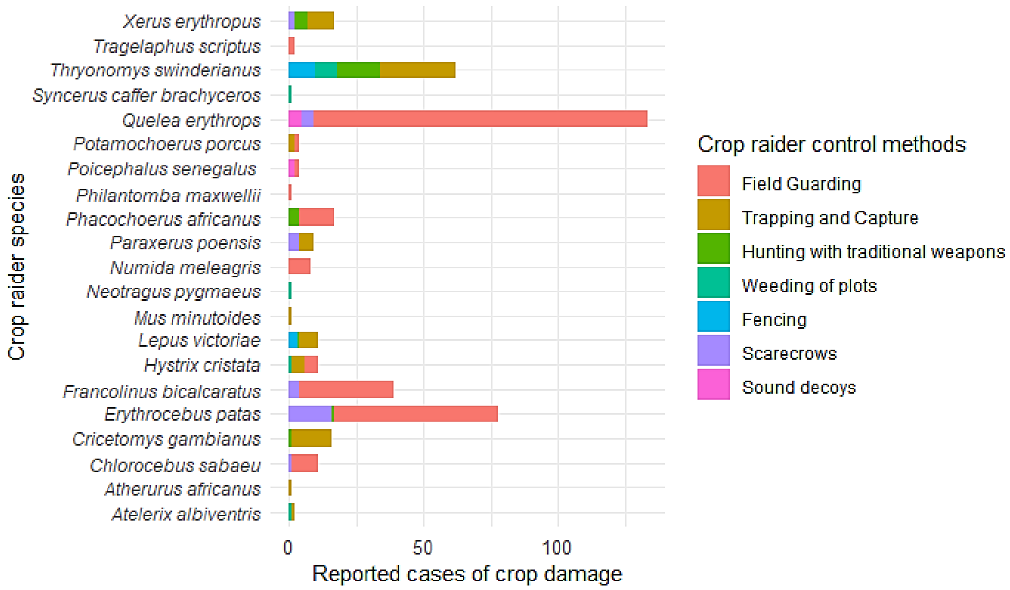

Figure 4. Relationship between animal species and the selection of control methods.

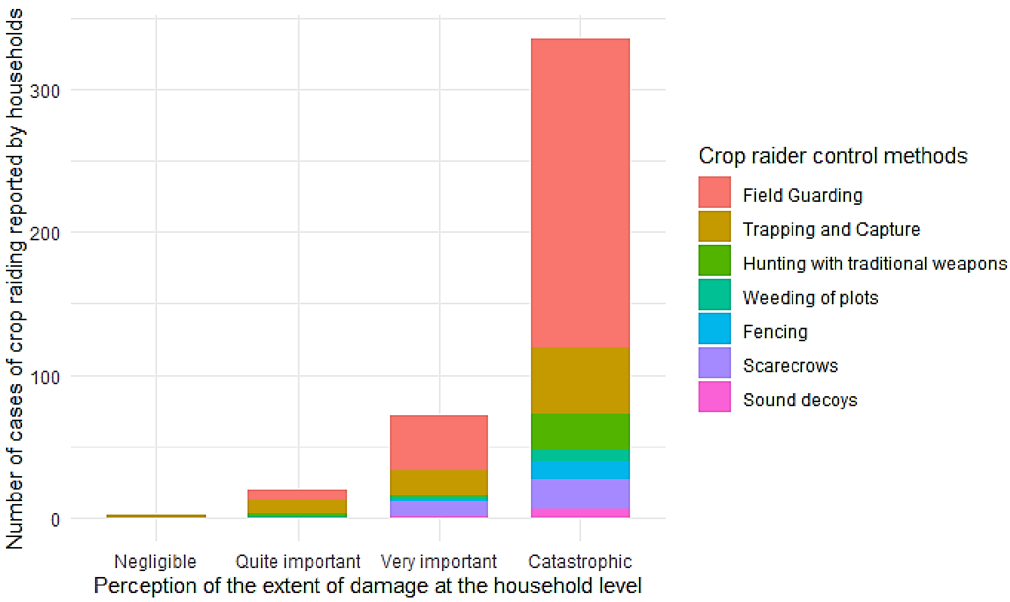

Figure 5. Relationship between perception of damage and the selection of control methods.

The model (Table 1) indicates that when the damage is perceived as "negligible," the log-odds of adopting a method are –1.8718, equating to an estimated probability of approximately 13%. Conversely, evaluating the damage as "quite large" enhances the likelihood of adoption by roughly 2.9 times (OR = exp(1.0609)), whereas considering it "very important" augments the likelihood by approximately 2.5 times (OR = exp(0.9227)). However, these effects do not achieve statistical significance ($p > 0.05$). On the other hand, categorizing the damage as "catastrophic" yields an odds ratio of about 5.3 (OR = exp (1.6649), p = 0.029), signifying that such households are more than five times as likely to adopt a control method compared to those who view the damage as negligible. The decrease in deviance from 1456.3 (null model) to 1425.1 (fitted model) across 3 degrees of freedom, along with an AIC of 1433.1, suggests that the perception of damage provides a modest yet meaningful explanatory enhancement. Ultimately, only those households perceiving the damage as "catastrophic" exhibit a significantly greater tendency for adoption.

Table 1. Result of the logistic regression analysis assessing the association between perception and the probability of adoption.

Variables	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	-1.8718	0.7596	-2.464	0.0137	*
Quite important	1.0609	0.8057	1.317	0.1879	
Very important	0.9227	0.7721	1.195	0.2321	
Catastrophic	1.6649	0.7631	2.182	0.0291	*

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘’ 1
(Dispersion parameter for binomial family taken to be 1)
Null deviance: 1456.3 on 1084 degrees of freedom
Residual deviance: 1425.1 on 1081 degrees of freedom
AIC: 1433.1
Number of Fisher Scoring iterations: 4

The observation that 61.8% of households do not adopt measures for protection against wildlife crop raiders highlights a concerning strategic inertia, suggesting a disengagement in the presence of an evident risk. This mindset can be ascribed to a combination of structural and cognitive factors, comprising economic constraints, limited access to efficacious solutions, decision fatigue, and the normalization of risk within routine agricultural practices (Banerjee and Duflo 2019). This situation reflects a well-documented logic of resignation common in low-resource agricultural systems, where producers, faced with recurrent losses, ultimately come to regard hazard as an unavoidable component of their operations (Hill, 1998; Pretty *et al.,* 2001). The observed agronomic diversity functions as a critical lever for adaptation, enabling a spectrum of technical responses. The distinct adoption of protection methods between crops, particularly between cashew (a cash crop) and rice (a food crop), underscores the presence of adaptive strategies that correspond with the economic value of the crops and the biotic pressures they encounter (Altieri, 1999; FAO, 2022). The χ^2 test provides statistical validation for this differentiation, signifying that producers undertake informed trade-offs based on their economic priorities and their practical comprehension of ecological dynamics (Van den Berg and Jiggins 2007).

The identification of 25 crop raider species distributed across 16 taxonomic families underscores a considerable heterogeneity in faunal pressure, both regarding diversity and ecological behavior. The capability of producers to adapt their control strategies based on crop raider characteristics—be they arboreal, burrowing, or seed-feeding—demonstrates an agroecological intelligence that is frequently underestimated (Horgan, 2017; Pretty and Pervez Bharucha 2015; Schroth *et al.,* 2004). The χ^2 test further substantiates the significance of this sophisticated adaptation, akin to a form of integrated crop raider management informed by local experience and indigenous knowledge (Berkes *et al.,* 2000). Logistic modeling provides substantial insights, demonstrating that the perception of damage characterized as "catastrophic" significantly influences the implementation of protective measures (OR = 5.3; p = 0.029). This outcome emphasizes the essential role of subjective interpretations in the dynamics of adoption (Kollmuss and Agyeman 2002). It suggests the existence of a psychological threshold at which taking action becomes imperative, thereby reinforcing the concept that agricultural decisions are dictated not only by objective determinants but also by perceptions, emotions, and previous experiences. In this framework, the decisions made by producers manifest as economically and cognitively rational compromises, integrating both present constraints and future expectations.

CONCLUSION

This research highlights the complexities inherent in peasant management strategies when faced with wildlife crop raiders within tropical agricultural systems. The analysis identifies a significant prevalence of inaction among households, suggesting a concerning level of strategic inertia which may be attributed to structural constraints, a lessened perception of risk, or resignation due to the perceived ineffectiveness of control measures. Nevertheless, the study also demonstrates the substantial adaptability of farmers, as evidenced by their implementation of varied strategies dependent on the type of crops grown, the nature of the crop raider threat, and their evaluation of the damage severity. The observed diversity in agronomic and faunal practices, coupled with specific technical interventions (such as guarding, trapping, and the application of auditory devices), indicates an agroecological acumen deeply embedded in local knowledge systems. Statistical analyses reveal that the selection of protective measures is not arbitrary; rather, it bears a significant relationship with the ecological characteristics of the crop raiders and the economic value of the crops. In addition, logistic modeling underscores the pivotal role of farmers' subjective loss perceptions, with those categorizing damage as "catastrophic" being substantially more likely to adopt control methods. These findings underscore the necessity for an enhanced recognition of farmers' insights in the formation of integrated crop raider management policies and the institution of support mechanisms that are attuned to local perceptions, economic conditions, and particular ecological dynamics. By strengthening the linkage between scientific insights and indigenous practices, a cooperative approach can be fostered, enabling the development of resilience strategies that are more aptly aligned with the realities of tropical agriculture.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

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AI TOOL DECLARATION

The authors declares that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

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