Chaves, P., M. Schaafsma, D. Dabo, J. Z. Lomba, F. Mane, R. F. de Lima, J. M. Palmeirim, R. Rocha, S. Seck, J. Biai, S. Timóteo, C. F. J. Meyer, and A. Rainho. 2024. Friend or foe? Attitudes of rice farmers toward wild animals in West Africa. Ecology and Society 29 (4):24. https://doi.org/10.5751/ES-15486-290424

Research

Friend or foe? Attitudes of rice farmers toward wild animals in West Africa

Patrícia Chaves [1], Marije Schaafsma [2], Djunco Dabo [3], Judite Z. Lomba [3], Fode Mane [3], Ricardo F. de Lima [1], Jorge M. Palmeirim [1], Ricardo Rocha [4], Sambu Seck [3], Justino Biai [5], Sérgio Timóteo [6], Christoph F. J. Meyer [7] and Ana Rainho [1]

ABSTRACT. As the global human population grows and the demand for space and resources increases, human-wildlife interactions and conflicts are expected to rise, particularly in biodiversity-rich tropical agroecosystems where subsistence farmers and wildlife coexist. We investigated farmers' attitudes using the ABC framework, analyzing their affect, behavior, and cognition toward wild animals. Additionally, we explored how socio-demographic characteristics influence farmers' attitudes. Through individual interviews and focus groups, we assessed the responses of farmers from six villages in the Oio region of Guinea-Bissau, West Africa. Most farmers (56%) expressed positive emotions toward rice production, which is solely for subsistence, despite facing challenges such as animal pests (87%) and inadequate tools (78%). Farmers showed strong knowledge of local wildlife at the class level. However, even when 'bird' and 'bat' were accepted as correct, identification accuracy at lower taxonomic levels varied between 67.5% and 80.4% across different villages. Farmers have mixed emotions about wild animals, with a general tendency toward negative feelings due to crop damage (49%) and human harm (20%), while positive feelings are tied to cultural beliefs (51%), harmlessness (7%), proximity to water (4%), and edibility (4%). Although attitudes toward animals varied between villages, respondent age and education did not seem to affect these views. Wildlife crop protection behaviors were consistent across villages but varied by target animal. Most strategies were non-lethal, such as making noise (44%) or guarding fields (12%), but a common perception of their ineffectiveness may explain resistance to promoting beneficial animals in their fields. When asked about having beneficial animals in their fields, 89% of farmers either did not know or chose not to answer. These findings highlight the complex relationship between smallholder rice farmers and wildlife in developing regions. Understanding these dynamics is crucial for fostering coexistence and promoting both biodiversity and sustainable agriculture.

Key Words: *agroecosystems; coexistence; crop damage; Guinea-Bissau; human-wildlife interactions*

INTRODUCTION

As the human population continues to grow, so does the need for land and other resources (Grantham et al. 2020), which in turn can increase human-wildlife interactions (HWI). These are often reported in terms of conflicts that have dire consequences for people, wildlife, and the environment (Shanko et al. 2021). Humans experience individual, social, economic, and cultural impacts, whereas wildlife consequences include reductions in population size or even local extinctions. The most common causes of conflict are crop damage, cattle depredation, property damage, and human harm and death (FAO 2009, Shanko et al. 2021), which frequently lead to disproportionate responses from humans (Dickman 2010).

The effects of crop raiding and the destruction of stored food can be particularly daunting for people because they can be immediately felt through hunger, impaired health, and halted development of communities (Webber and Hill 2014). Families often experience an increased workload (Ogra 2008), with children skipping school to guard fields (Haule et al. 2002), and individuals becoming more prone to participate in illegal or dangerous activities such as poaching (Temesgen et al. 2022). Moreover, there can be an increase in physical harm from animals and diseases if people need to guard their fields at night (Naughton 2001, Treves et al. 2006). These social costs span generations as children miss school and adults miss opportunities (Manoa et al. 2020, Yeshey et al. 2023).

Rice is the main staple food for almost half of the human population worldwide (Muthayya et al. 2014). Its production increased from 216 million tons (mt) in 1961 to 520 mt in 2022 (FAO 2011, 2022a). Rice is responsible for more than one-fifth of the calories consumed by humans (Ali et al. 2019), and the single most important crop for food security (Gadal et al. 2019). Many farmers depend on their annual rice production to sustain their families and report it to be affected by crop raiding, climate unpredictability, crop diseases, soil fertility and irrigation, lack of appropriate tools, manpower, and insect pests (Hardwick et al. 2017). Wetlands have been highly modified toward rice production, becoming a shared ground for people and wild animals (Propper et al. 2020).

Moving from conflict to coexistence in shared agroecosystems, such as rice crops, requires a comprehensive assessment of farmers' attitudes toward wild animals, extending beyond the identification of negative interactions. Attitude is, however, a complex construct with varying dimensions and methods of analysis across studies (Manfredo and Bright 2008). We define it as a relatively enduring system of beliefs and perceptions (cognition), emotions (affect), and behavioral tendencies toward an object or concept (Hogg and Vaughan 2018). The individual attitude toward wild animals is thus composed of several facets, including the individual cognitive constructs and the cultural context of their upbringing (Costa et al. 2013). The latter is highly dependent on the norms, beliefs, and attitudes of society (Remis and Hardin 2009).

Attitudes toward wild animals, particularly crop raiders and insect pests, are also strongly influenced by the feeling of vulnerability and the individual assessment of risk (Gore and

[1]Centre for Ecology, Evolution and Environmental Changes, CHANGE - Global Change and Sustainability Institute, and Departamento de Biologia Animal, Faculdade de Ciências, Universidade de Lisboa, Portugal, [2]Institute for Environmental Studies, Vrije Universiteit Amsterdam, the Netherlands, [3]Federação KAFO, Guiné-Bissau, Centro Camponês de Djalicunda, Guinea-Bissau, [4]Department of Biology, University of Oxford, United Kingdom, [5]Instituto da Biodiversidade e das Áreas Protegidas, Bissau, Guinea-Bissau, [6]Centre for Functional Ecology, Associate Laboratory TERRA, Department of Life Sciences, University of Coimbra, Portugal, [7]School of Science, Engineering and Environment, University of Salford, United Kingdom

Kahler 2012, Kahler and Gore 2015, MacFarlane and Rocha 2020). Ezealor and Giles (1997) found that while 26% of wildlife in the Sahel was perceived by farmers as pests, more than 50% was also valued for its contributions to food, culture, and aesthetics. In rural communities, wild animals are usually an important part of the local folklore. In some cases, it leads to demonization, fear, and persecution (Prokop et al. 2009, Rocha et al. 2021a), whereas in other cases, ignites positive behaviors derived from religious beliefs (Inskip et al. 2016) and ecological benefits (Adeyanju et al. 2023). Attitudes are also influenced by subjective experiences and emotions, often stemming from rare events of extreme damage or pre-existing tensions (Naughton 2001, Gillingham and Lee 2003, Dickman 2010, Webber and Hill 2014). Emotions toward a particular species frequently depend on how the threat is perceived and on the novelty of that risk, both being the biggest motivators for hostility toward wildlife (Prokop et al. 2009, Dickman 2010).

For some animals, extensive research exists not only on the amount of damage caused to food crops but also on the perception of that damage (Mackenzie and Ahabyona 2012, Hill 2017). For example, larger, more conspicuous, or potentially dangerous species tend to generate more antagonism. Elephants, hippopotamuses, and primates often trigger higher levels of hostility in humans than smaller species that inflict far more damage to crops, such as mice and invertebrates (Naughton-Treves and Treves 2005, Dickman 2010, González et al. 2017). The habits of species also play a role, with nocturnal animals being less tolerated because farmers feel unable to protect themselves and their crops from animal attacks (Naughton-Treves et al. 1998, Hill 2004). Perceptions are also influenced by the level of control people feel they have over the activities of wild animals (Mishra 1997, Madden 2004).

Few studies have explored human-wildlife conflicts (HWC) in West Africa (e.g., Daboné et al. 2022, Digun-Aweto et al. 2022, Adeyanju et al. 2023). In Guinea-Bissau, HWC remain largely unexamined (but see e.g., Costa et al. 2013, Hockings and Sousa 2013), and limited research has investigated these conflicts in agricultural contexts (Hockings and Sousa 2012) in which competition for space and resources between local communities and wildlife is particularly intense (Matseketsa et al. 2019). This gap of knowledge on HWI needs to be urgently addressed in West African agroecosystems in which high biodiversity and significant reliance on locally produced food pose critical food security challenges. Understanding farmers' attitudes toward wild animals is essential for developing informed management strategies that promote coexistence and ensure sustainable food production. Attitudinal studies are also key for identifying farmers' willingness and capacity to facilitate or resist change, thus preventing potential conservation conflicts (sensu Redpath et al. 2013) that may arise from implementing these management strategies.

With that in mind, we drew on the affect-behavior-cognition (ABC) social psychology model, which posits that attitudes are based on three components: affective (feelings and emotions), behavioral, and cognitive (perceptions and beliefs; Breckler 1984, Hewstone et al. 2005, Whitehouse-Tedd et al. 2021). Using the ABC model as a conceptual framework, we analyzed data collected from interviews and focus groups with rice farmers in Guinea-Bissau, addressing the following questions: (1) Which emotions do farmers experience regarding rice production and interactions with wild animals? (2) How well do farmers know the wild animals that forage in their fields? (3) What measures do farmers resort to in order to mitigate wildlife damage to their rice crops? Additionally, we explored how specific socio-demographic characteristics of the population might influence farmers' attitudes.

METHODS

Study area

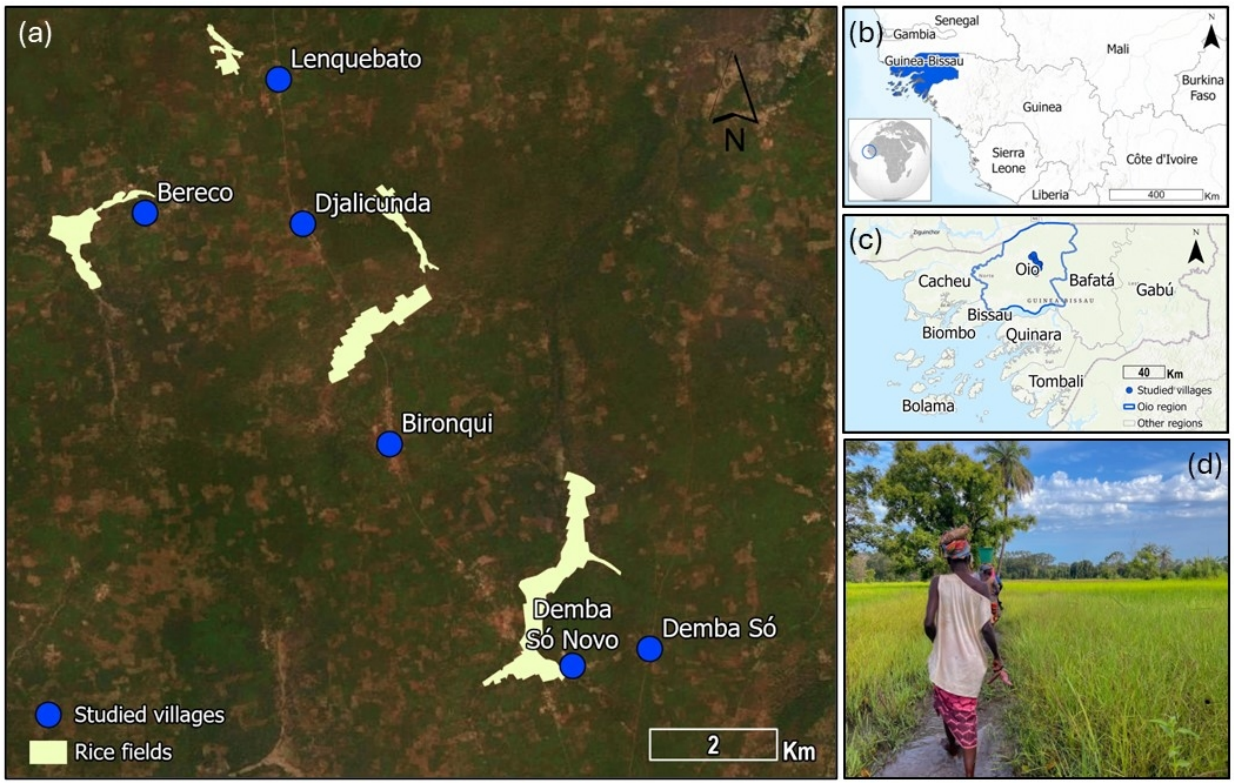
The West African country of Guinea-Bissau covers 36,125 km² and is home to ca. two million people, a population that has almost doubled since the 1990s (World Bank 2021, Santos and Mourato 2022). The climate is sub-humid, with a rainy season between May and November and a dry season between November and April (Jalloh et al. 2012). The country has a low human development index (0.480 in 2019), which is driven by poor governance and political instability, as well as the deterioration of social and economic conditions (Coruche 2018). Rice is the main staple food in Guinea-Bissau (Temudo and Cabral 2023). Although alternatives may exist, rice shortages often lead to perceived periods of hunger. Approximately 56% of the rice consumed in the country is produced by smallholder farmers (WFP 2016), and at 86 kg per capita per year, rice consumption is one of the highest in the continent (Coruche 2018). Since the 1970s, climatic instability has been deeply affecting rainfall, contributing to food insecurity (Temudo 2011). Furthermore, an increase in crop pests and plummeting revenues from cashew nuts, the country's main cash crop, have left local communities vulnerable and reliant on imported rice (FAO 2022b).

Our study was conducted from October to December in 2021 and 2022, in six villages: Djalicunda, Bironqui, Lenquebato, Bereco, Demba Só, and Demba Só Novo. These villages are located between Farim and Mansaba in Oio, a region in northern Guinea-Bissau covering an area of 5403.4 km² (Fig. 1). The Mandinka ethnic group is the largest in the study area, with the Fula- and Balanta-speakers representing a much smaller proportion. In the Oio region, the Mandinka are the second largest group, comprising 32.9% of the population (INE 2010a). Mandinka women are farmers, and the household usually consists of one man, one or more women, and their children (Lado 1992). The population heavily relies on agriculture, with smallholder farmers primarily cultivating rice, peanuts, and cashews, while tending community gardens.

Data collection

Interviews and focus group sessions were used to gather data on knowledge, emotions, and behaviors toward wild animals. No female collaborator was fluent in Mandinka, in both interviews and focus groups, thus we faced the challenge of having male collaborators working with female interviewees. To mitigate potential biases, we selected respected men that people associated with previous projects from a local development NGO, the Peasant Federation KAFO, and with a history of similar work in the community. Before the onset of interviews and focus group sessions, a brief introduction to the project was provided, explaining that participants would remain anonymous and had the right to exclude themselves from answering and/or to drop

Fig. 1. Study area: (a) Satellite image showing the locations of the six villages surveyed and their respective rice fields. Insets show (b) the location of Guinea-Bissau in West Africa, (c) the location of the Oio region within Guinea-Bissau, and (d) an image of the rice fields of Bironqui (sources © Esri, Earthstar Geographics, USGS, and GADM).



out at any time. No payment was provided for participation. Written or oral consent was obtained depending on the interviewee's literacy level. All data were anonymized and transcribed without the identification of the interviewee. Focus group discussions were translated by the moderators and transcribed into electronic text. The transcriptions were then double-checked with the moderators to ensure accuracy and eliminate errors.

Interviews were performed in 2021 by PC and DD. In the study region, rice is almost entirely produced by women, so we targeted 25 female volunteers per village. The selection criteria were as follows: participants had to be over 18 years old, farm rain-fed lowland rice, and, preferably, belong to different households. The committee of each village was informed about our goals and selection criteria. They determined the interview date, time, and place, and contacted the village farmers. We interviewed a total of 269 women from the 6 villages. In nearly all villages, we surpassed the target of 25 interviews: 35 in Bereco, 38 in Lenquebato, 53 in Demba Só, 61 in Demba Só Novo, and 66 in Bironqui. The exception was Djalicunda, where only eight women volunteered to participate. The proportion of farmers interviewed relative to the estimated total adult female population in each village was as follows: Bereco 100%, Lenquebato 84%, Demba Só 66%, Demba Só Novo 67%, Bironqui 33%, and Djalicunda 12% (all estimates based on INE 2010b, 2017). Interviews were conducted individually, face-to-face, in an informal setting, in the village of the interviewee. They lasted 20 to 30 minutes, and participants were asked not to share questions with other villagers. Interviews followed a semi-structured questionnaire (Table 1). We used a combination of binary, multiple-choice, and open-ended questions to gain a comprehensive understanding of farmers' attitudes. For instance, farmers were asked to identify animals affecting rice production and categorize their impact as positive or negative and provide detailed responses on their knowledge and behavior toward these animals. Ten taxa from five different classes, Insecta, Amphibia, Actinopterygii (fishes), Aves, and Mammalia, were illustrated using silhouettes, and they were selected based on their known presence in the country's rice fields. The full list of survey questions is provided in Appendix 1.

The answers obtained from interviews were further explored in focus groups, during which we used 24 open-ended questions focused on cognition, affect, and behaviors toward wildlife (Table 1; Appendix 2). In addition to the animal silhouettes used in the interviews, farmers were asked to identify 16 different animals from photographs, selected based on their known presence in the rice fields of the study area. This approach aimed to refine the information obtained during the interviews because animals within the same class can have varying impacts on rice farming. For example, some bird species are insectivorous and potentially beneficial, while others are granivorous and potentially harmful to crops. Farmers were asked to discuss how they felt about rice farming and wildlife in the region (affect) and were shown pictures and silhouettes and asked to

Table 1. Examples of the questions asked during the interviews (Intv) and focus group sessions (FG) to evaluate the affect, behavior, and cognition regarding wild animals in rice fields. Most questions presented farmers with options such as yes or no (Y/N) or multiple-choice, with the opportunity to add their own options. Some questions allowed for open-ended answers (OEA). Refer to Appendix 1 for additional details.

Dimension	Method	Examples
Affect	Intv	n/a
	FG	Do you like these animals? (Y/N) Why? (OEA)
Cognition	Intv	Do you recognize these animals? (Y/N)
		What do bats eat? (insects, fruit, other, don't know / don't answer)
	FG	What do you know about these animals and their habits? (OEA)
Behavior	Intv	What do you do when you find birds near your fields? (OEA)
	FG	What do you do when you see one of these animals in your fields? (OEA)

identify the animal (cognition) and substantiate why they liked or disliked a certain animal (affect). Strategies farmers employed to deter wildlife from using rice fields were also explored (behavior). Both the interviews and focus groups explored the willingness of farmers to promote beneficial animals in their fields.

Six focus group sessions were conducted in 2022 in the same villages where interviews were conducted. Each session included six farmers. Given the nearly 100% participation of female farmers in Bereco during the initial survey, and to maintain consistency across villages, we included only those farmers who had been previously interviewed. No other selection criteria were used. As before, farmers were contacted through their village committees. Two focus groups were led by JZL, an experienced moderator that facilitated the focus groups in Guinea-Bissau creole, the lingua franca of the country, and FM led four focus groups with Mandinka-speaking farmers. The questions were asked individually, ensuring everyone had the opportunity to participate, followed by a period of discussion of the answers. To prevent any one person from influencing the responses of others, we alternated the starting participant for each round of questions. Discussions lasted from one and a half to three hours. Sensitive topics, such as religion and politics, were entirely avoided.

Data analysis

We used descriptive statistics to summarize interview data. We used Fisher's exact tests for count data with Bonferroni correction to identify significant differences in the choices between farmers based on village, age, and education. ANOVA was used for continuous data or proportions, followed by Tukey's HSD test if significant differences were found. Pearson's chi-square goodness-of-fit standardized residuals were used to display observed differences. Pearson's Chi-square tests were accompanied by Cramer's V measures (Sukanan and Anthony 2019). To ensure robustness, groups with expected frequencies lower than five were excluded from the analysis. All statistical analyses were conducted using R version 4.4.1 (R Core Team 2024). Results were considered significant when $p < 0.05$.

The focus group transcriptions were uploaded to NVivo (version 12) and coded to answer: (1) How do farmers perceive rice production? (cognition); (2) What do farmers know about wildlife? (cognition); (3) How do farmers feel about wildlife? (affect); and (4) How do farmers act on the presence of wildlife in their fields? (behavior). PC and AR independently coded the texts for all focus group sessions. Classifications were thoroughly compared, and inconsistencies were discussed and adjusted accordingly. As we were unable to identify participants during translation and transcription, we analyzed the data based on "counts," i.e., the number of times individuals contributed to a topic. The total number of counts (N) will therefore vary depending on the issue under analysis. Numerical analyses followed the procedures previously described for interview data. All numerical information is presented as percentages. Interview data (Intv) are reported as the percentage of interviewees, while focus group data (FG) are reported as the percentage of farmers or of counts within a topic.

RESULTS

Socio-demographic features of the population

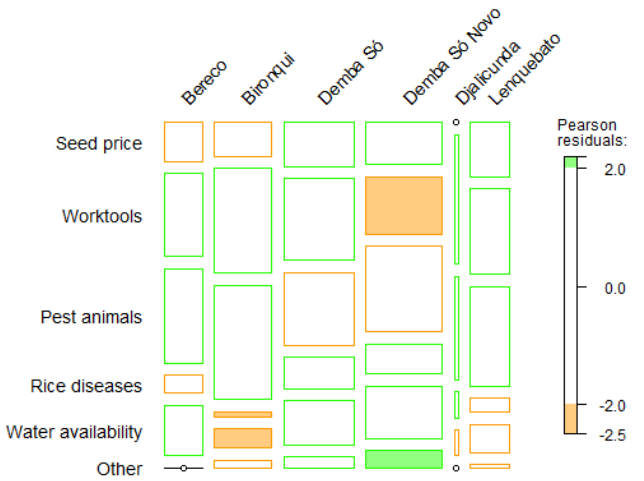
The interviewed farmers were predominantly Mandinka (99%), with only three identifying as Fula. On average (± SD), households consisted of 18.7 individuals ± 10, in which women were farmers while also taking care of the house and children. The age ranged from 18 to 80 years old, with an average of 33 ± 12.7. Of the 269 interviewees, 62% did not attend school, 27% attended between the first and fourth years, 10% between the fifth and ninth, and less than 1% completed the tenth year. Most of the households' income came from selling products from their community gardens and cashews (95% of the farmers interviewed), and rice was solely produced for sustenance. The average (± SD) rice field size was 2.3 ha ± 1.4 per household.

Affect: feelings toward rice production and wild animals

Rice production in the region faces several challenges that were valued differently by farmers during interviews. Specifically, wild animals (87%) and the lack of working tools (78%) were consistently identified as the main challenges (Fig. 2). Overall, no differences were found based on respondent age (p-value = 0.95) or education (p-value = 0.99). However, the responses differed significantly across villages (p-value < 0.001), primarily due to differences between Bironqui and both Demba Só Novo and Demba Só (p-values: 0.001 and 0.007, respectively). Farmers in Bironqui valued water availability and rice diseases less than expected, whereas those in Demba Só Novo were less concerned with work tools compared to other villages, while being more concerned with other issues (category other) such as the lack of labor, the price of fertilizers, and farmers' health (Fig. 2).

During the focus group sessions, when asked "How do you feel about how rice is produced in the region?" most farmers (56%) manifested positive feelings. For them rice farming equaled survival and household livelihood: "We and our families are happy if we have what to eat, due to a good harvest." There was a sense of awareness regarding the importance of the farmer's role for the household and food security of the entire community (FG: 52% of counts) because sharing rice with people in need is a customary practice (FG: 7%). Farmers also stated that rice production can be challenging, particularly due to physical strain (FG: 29% of counts to challenges) and due to the lack of work tools (FG: 13%), both of which leaves them fatigued and in pain. High labor demands were also noted (FG: 8%), sometimes linked to children attending school and being unable to help, while

Fig. 2. Pearson's residuals showing the proportion of positive answers concerning challenges to rice production identified by farmers in each village during the interviews. The height and width of each rectangle represents the number of answers in each challenge and village, respectively. Green and orange rectangles indicate higher and lower counts of perceived challenges than expected, respectively, with filled rectangles representing statistically significant departures. Combinations with no answers are marked as -o-.

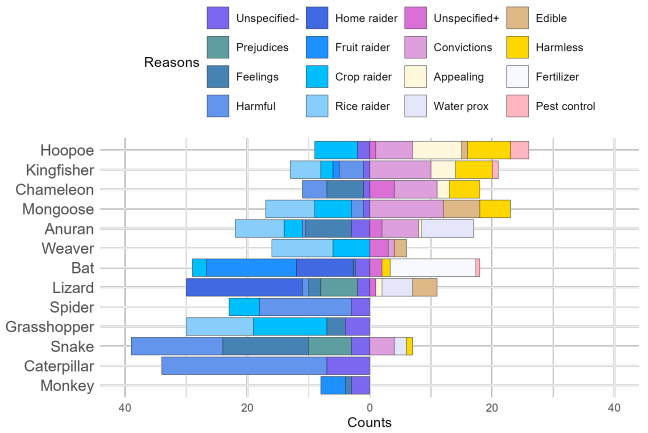


financial constraints precluded hiring additional workers (FG: 4%). They also expressed frustration regarding the low crop yields despite their efforts (FG: 8%). Noticeably, only one farmer mentioned wild animals: "Then the wild boar starts causing damage."

When asked directly farmers expressed negative emotions toward all animals (FG: 70.1% of all counts were negative). During the focus groups, 49% of negative counts across all taxa were linked to damage to rice and other crops: "I do not feel good about wild animals, because they eat what we are supposed to take home." Monkeys, caterpillars, spiders, and grasshoppers were the most disliked animals, with only negative counts (Fig. 3). Various reasons were given to justify this dislike, with these species primarily being labeled as harmful and as raiders of rice and other crops. Snakes were also strongly disliked (84.5% of negative counts for that taxa), mainly for being harmful and feared. Lizards (73.2%) were disliked largely due to predation of chicks by monitor lizards, and weavers (72.7%) were disliked for being rice raiders. Bats (61.7% of negative counts) and frogs and toads (anurans; 56.4%) elicited mixed reactions, but generally leaned toward negative feelings. The former were mainly disliked for being fruit and home raiders, and the latter for rice raiding and evoking negative feelings such as fear and rage.

The four most likable taxa, hoopoe, kingfisher, chameleon, and mongoose, encompassed 60% of all positive counts in focus groups (Fig. 3). Overall, positive feelings were mostly associated with convictions (31.3% of positive counts across all taxa), but also with being harmless (17.2%), appealing (10.5%), or indicating proximity to water (10.5%). For some animals, such as bats,

Fig. 3. Affect toward wildlife in focal groups. Negative emotions are on the left and positive emotions are on the right. Each bar stacks the number of counts for different reasons associated with these emotions.



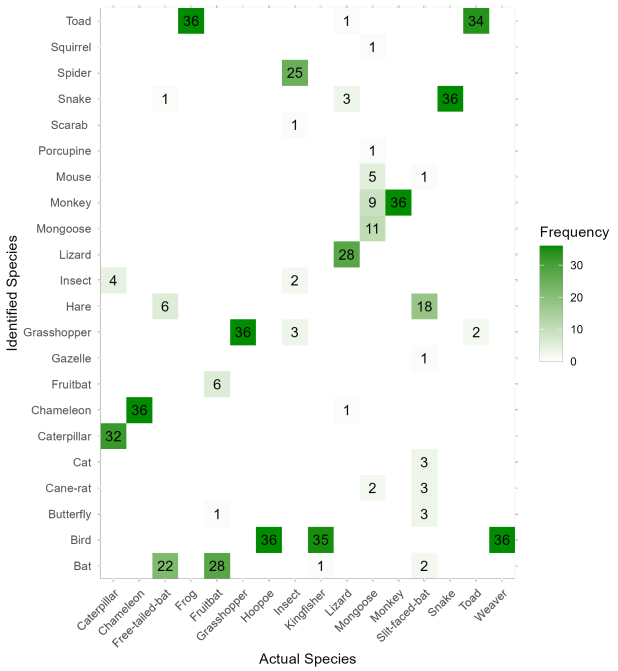
fertilizing and pest control services (FG: 77.8 and 3.7% of positive counts for this taxon, respectively) were mentioned as positive aspects. Specific convictions were associated with positive emotions: for example, mongooses were valued for symbolizing union, kingfishers (FG: 47.6% of positive counts for this taxon) and anurans (FG: 35.3%) were believed to bring or announce the arrival of rain, while snakes (FG: 57.1%) were considered protectors of the village and signs of a good harvest. Some animals were thought to pass their traits on to children when ingested by pregnant women: mongooses and monitor lizards were believed to pass on strength, while the hoopoe was associated with beauty.

Cognition: beliefs and perceptions of wild animals in rice production

During focus groups, farmers were invited to identify a wide range of animal taxa from pictures (Fig. 4, Appendix 2). Considering the identification of bird and bat as correct for the various taxa within these two groups, overall accuracy reached 72.2% (ranging from 67.5% in Lenquebato to 80.4% in Bironqui). Observed differences in accuracy between villages (ANOVA: $F(5, 30) = 3.77$, $p = 0.009$) were due to the lower accuracy in Lenquebato compared to Bereco (Tukey post-hoc: $p = 0.02$), Bironqui ($p = 0.02$), and Djalicunda ($p = 0.045$).

Chameleon, snake, monkey, and grasshopper were easily identified by the farmers with perfect accuracy (Fig. 4). Considering the identification of "bird" as correct, the three bird species (weaver, hoopoe, and kingfisher) were also clearly identified, with an accuracy of 100% for the first two species and 97% for the last. Farmers were also very accurate when identifying toads (94%) and fruit bats (94%), naming the latter as bats or even as "bats that eat mangoes." Poorer accuracy was shown when identifying frogs (0%). Even if sometimes recognizing differences, they were always identified as another anuran, i.e., toads. Accuracy was better for mongoose identification, though still low at 30.6%, with mongoose often being mistaken for monkeys, mice, or cane rats. Insectivorous bats were also poorly recognized (33%

Fig. 4. Confusion matrix heatmap of species identification across all villages. The heatmap shows the frequency of identified species (y-axis) compared to the actual species (x-axis) for all participants during focus groups. Color intensity represents the frequency of identifications, with higher frequencies indicated by more intense colors. Numbers in each cell indicate the count of identifications, with zeros omitted for clarity.

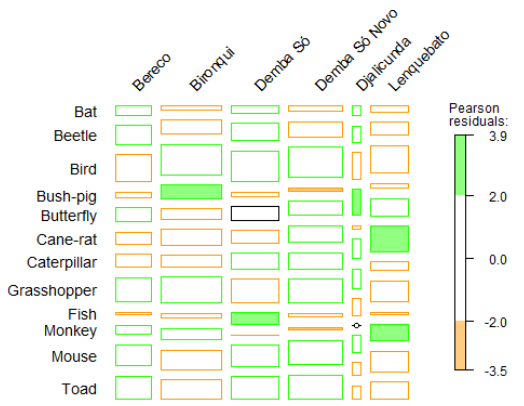


correctly identified as bats), especially the slit-faced bat, which was correctly identified as a bat in only 5% of responses and more often mistaken for a hare (Fig. 4).

During interviews, when asked about the diet of some animals, all farmers associated birds with rice (100%) and less often with other crops (19%) and insects (10%). Notably, 40% of farmers in the interviews did not know what bats eat. However, among the farmers that did answer, bats were associated with fruits (44% answers) and insects (12%).

Regarding perceptions of the impact on the rice fields, all animals shown during the interviews were considered damaging, and farmers additionally mentioned bush pigs, great cane rats, mongooses, and monkeys as rice raiders. Farmers described damage as stomping rice plants (bush pigs, hippopotamuses, and great cane rats), cutting the stems (grasshoppers, beetles, and anurans), feeding on sap (butterflies and beetles), and eating grains (birds and toads). Education level (p-value = 1) and age (p-value = 0.99) did not seem to affect perception of impacts. There was a significant association between the perception of animal impact and villages (p-value < 0.001). Interviewees in Bironqui and Djalicunda reported bush pigs as damaging significantly more often than expected, while those in Demba Só reported fish, and those in Lenquebato reported both the greater cane rat and monkeys. Conversely, respondents from Demba Só Novo reported cane rats and monkeys as rice raiders significantly less than in the other villages (Fig. 5). The strength of this association was weak (Cramer's V = 0.10).

Fig. 5. Pearson's residuals showing the proportion of answers about animals perceived as damaging to rice in each village during the interviews. The height and width of each rectangle represents the number of answers in each animal and village, respectively. Green and orange rectangles indicate higher and lower counts of perceived damage than expected, respectively, with filled rectangles representing statistically significant departures. No interviewees in Djalicunda considered fish as damaging (thus marked as -o-).



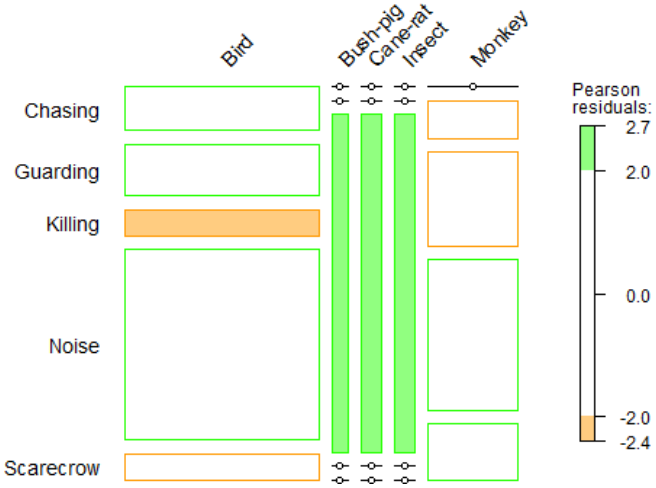
During the interviews, all farmers associated birds, 80% of grasshoppers, and 70% of anurans with rice damage. Birds, grasshoppers, and caterpillars were more frequently associated with damage in rice during the interviews than in focus groups, whereas monkeys, frogs, and mongooses showed the opposite trend. Bats were not mentioned as rice raiders during the focus group sessions, but 20% of farmers referred to them as such during the interviews.

Behavior: acting on wildlife crop damage

During focus groups, no differences were found in the use of control methods between villages (p-value = 0.42). However, there were clear differences in the methods used for each species (p-value < 0.001; Fig. 6). Producing loud noises was the most frequently mentioned rice protective behavior both during interviews (63% of respondents) and focus groups (44% of counts to control methods), followed by chasing and guarding (Intv: 30%, FG: 27.9%). As one farmer put it, "We farmers do not have a calendar, we should be permanently or every day at the rice fields." To deal with birds, interviewees mostly use loud noises, either by shouting "HA HA," hanging a zinc plate with stones so the wind clacks them together, or clashing pots and their lids while having their meals in the fields. To chase birds away, they also throw stones (Intv: 91%). The sound that deters birds from the fields does not work for monkeys, instead they shout "SU SU." Despite these efforts, farmers said that monkeys do not fear women, or anyone using a headscarf, so instead they resort to hunters. "If the hunters kill one or two monkeys, they will not return to the same spot." They also use scarecrows (Intv: 3%, FG: 8.8%).

Killing was not frequently used for birds; however, it was the sole method used for bush pigs, cane rats, and insects (FG: 27.9% of counts to control methods). Dealing with nocturnal animals

Fig. 6. Pearson's residuals showing the proportion of positive answers during focus groups concerning methods used by farmers to control wild animals in rice fields. The height and width of each rectangle represents the number of answers in each method and species, respectively. Green and orange rectangles indicate higher and lower counts of used methods than expected, respectively, with filled rectangles representing statistically significant departures. Combinations with no answers are marked as -o-.



posed a greater challenge for farmers because social norms prevent women from carrying guns or venturing out of the villages at night. To counteract the damage by nocturnal animals, such as great cane rats or bush pigs, women try to identify their presence through signs like paw prints or feces and then ask men to hunt them.

Farmers complained that their efforts were not enough to keep animals away (FG: 43% of counts toward efforts and success): "What we do helps, but on the day that we do not go to the rice field, the animals are going to throw a party." Most interviewees (89%) did not know or declined to say if they were interested in having more beneficial animals in their crops, and only 5% favored the idea, whereas 6% were against it. Most farmers (FG: 63%) were appalled by the suggestion of not chasing wildlife away. "If I cannot chase animals away, will you feed me for 10 years?" During the focus group sessions, 35% of interventions referred to the need to know more about the subject prior to establishing an opinion.

DISCUSSION

Our study delves into the intricate dynamics of HWI within agroecosystems, being the first in the context of rice farming in West Africa and offering insights relevant to farming systems worldwide. We highlight the significant challenges faced by farmers who rely on rice production for subsistence, including threats from wild animals, inadequate tools, and limited water availability. Emotions toward wild animals were mixed, with negative feelings mostly due to crop damage and human harm, while positive feelings were linked to cultural convictions, harmlessness, proximity to water, and edibility. Although there were differences in affect and cognition toward animals between the studied villages, respondents' age and education level did not seem to influence any of the attitudinal components. Behaviors to prevent wildlife crop damage primarily involved non-lethal methods, such as noise making or field guarding, yet many farmers perceived these strategies as ineffective, which may explain their reluctance to encourage beneficial animals in their fields.

Affect: feelings toward rice production and wild animals

Farmers consistently identified wild animals as their most significant agricultural challenge and the negative emotions toward these animals were primarily associated with crop foraging, including rice, fruit, and other valuable farm products. Communities that rely heavily on a single livelihood strategy tend to view animals that threaten their resources with hostility (Dickman 2010). Such lack of alternative subsistence pathways increases community vulnerability, leading to reduced tolerance to wildlife particularly in lower income countries (Gadd 2005, Arjunan et al. 2006).

The high importance given to animal pests aligns with other studies (Gillingham and Lee 2003, Webber and Hill 2014, Can-Hernández et al. 2019) in which farmers often rank wildlife as a primary constraint over factors like erratic rains, diseases, soil fertility, and irrigation (Gillingham and Lee 2003, Hoffmeier-Karimi and Schulte 2015). In this study farmers also expressed concerns regarding the lack of adequate work tools, which may present an important struggle for rice farming in the region. Many of these challenges were closely matched with their consequences, such as food and income insecurity, children skipping school, or the sustained loss of labor (Yeshey et al. 2022). Water scarcity was frequently mentioned as a concern, with some wild animals valued for indicating the arrival of rain or the proximity of water. Despite these challenges, farmers exhibited very positive emotions and highly valued rice production in the region. The emphasis on wild animals supports the idea that farmers perceive, or at least are more willing to express, external problems as more severe and difficult to manage than internal community issues, such as farming methods (Fitchen et al. 1987) or gender inequity.

Emotions toward wildlife are influenced not only by their economic impact but also by socio-cultural factors, including aesthetic, ethical, symbolic, spiritual, utilitarian, and ecological considerations (Macdonald et al. 2010, Athreya et al. 2018). In our study, these factors significantly shaped positive emotions, with feelings about birds linked to both convictions and morphological characteristics (Katuwal et al. 2021). Similarly, bats were viewed positively because their guano is used as fertilizer and because of their role in pest control (Rocha et al. 2021b, Sottomayor et al. 2024). Despite their essential ecological roles, bats also evoked antagonism and have historically received less affection from people (Shapiro and Willcox 2019). Additionally, chameleons, certain bird species, mongooses, and bats were considered harmless, reinforcing the idea that wildlife perceived as less threatening to crops elicits more positive feelings (Kansky et al. 2014).

Cognition: perceptions of wild animals in agroecosystems

Farmers were able to identify wild animals at a high taxonomic level, roughly to the Class level. However, they struggled to distinguish species within each Class and often could not

differentiate between pests and beneficial species. Birds were relatively better known, but clear examples of this issue include frogs and toads, both classified generally as toads, and bats. Despite the relative abundance of bats and the farmers' reports of their presence within their homes, most farmers were unaware of the existence of insectivorous bats. Unlike other studies (Prokop et al. 2009, Su et al. 2020), we found no evidence of an effect of education or age group on perceptions of wildlife impact on rice fields. This may be a result of the overall low literacy level because most respondents (> 60%) never attended school, and wildlife is not included in the early education curriculum. Consequently, wildlife knowledge is mostly disseminated by word of mouth within communities, explaining the observed differences in perceptions between villages. Additionally, despite their proximity, each village may experience different interactions with wildlife due to variations in the surrounding landscape structure and composition (Sharma et al. 2020, Katuwal et al. 2021, Rossinyol-Fernàndez et al. 2024).

Despite the differences in responses between villages, birds, grasshoppers, and mice were consistently identified as the primary animals causing rice damage. Although specific data from rice-producing landscapes is scarce (Adesina 1996, Propper et al. 2020), previous studies have similarly identified birds (Mojo et al. 2014, Katuwal et al. 2021), insects (Manfredo and Dayer 2004, Hoffmeier-Karimi and Schulte 2015), and mice (Gillingham and Lee 2003, Mojo et al. 2014) as perceived threats to rice crops. Nevertheless, larger mammals such as elephants, monkeys, wild pigs, and even ungulates are often perceived as more damaging than other smaller species (Linkie et al. 2007, Can-Hernández et al. 2019) due to their size, conspicuous presence, the nature of the damage they can inflict, and the perceived level of control farmers have over these animals (Hill 1997). Although elephants are rare in Guinea-Bissau (Palma et al. 2024), farmers identified other medium-sized species, such as monkeys and bush pigs, as damaging to rice. Farmers attributed crop damage, including rice and fruit, to monkeys, which may be linked to the spatial and ecological overlap between primates and humans (Hardwick et al. 2017). Several primate species including baboons, vervet monkeys, and macaques, increasingly incorporated crops into their diets due to their opportunistic and omnivorous feeding habits, and because they often live near human settlements (Else 1991, Hill 2000).

The inclusion of anurans (frogs and toads) among the major rice raiders in both interviews and focus group sessions was an intriguing finding, contrasting with other studies that identified these animals as beneficial for consuming insect pests in rice crops (Propper et al. 2020). This result may be attributed to the overall low educational level of the farmers, but also to the observed negative emotions toward these animals, stemming not only from their perceived role in rice raiding but also from feelings of fear and rage. Such emotions are often shaped by prejudices and folklore, and even if perceptions improve, lingering fear or anger may continue to foster antagonism (Dickman 2010).

Behavior: acting on wildlife crop damage

The methods chosen to control wildlife damage in rice fields were consistent across villages, all favoring non-lethal strategies to mitigate impacts. The most common deterrent against crop damage by wild animals involved making noise while engaging in farming activities or actively guarding rice fields. Guarding and chasing wildlife is a widely reported technique elsewhere (Gillingham and Lee 2003, Biset et al. 2019, Govind and Jayson 2021). Despite its effectiveness (Mekonen 2020, Shanko et al. 2021) and low cost, it is labor intensive, requires constant presence at the fields, and often involves all family members (Htay et al. 2022, Wang et al. 2023, Yeshey et al. 2023). Unlike reports from other regions such as India and Zimbabwe (Govind and Jayson 2021, Matseketsa et al. 2019), fencing in our study area was minimal due to its high cost and the fact that its effectiveness is heavily reliant on design, maintenance, and specific habitat characteristics (Wang et al. 2004, Kesch et al. 2014).

Although all animals considered in this study were viewed as rice raiders by farmers, only a few were actively targeted for control. This selection may arise from the perceived level of damage and the effectiveness of the control measures (Thapa 2010). Different species were controlled using various methods, with lethal strategies being the primary approach for managing bush pigs, cane rats, and insects, and occasionally used for monkeys. The use of lethal methods for these mammals may also be linked to their recognized value as a food source in these rural villages (Alexander et al. 2015). Nocturnal animals brought other challenges because local cultural rules do not allow female farmers to hunt. Men are asked to deal with monkeys but also with nocturnal wildlife, and other studies have shown that primates are more afraid of adult men than of women or children, and of people carrying guns (King and Lee 1987, Strum 1994). Contrary to previous research, farmers did not mention hunting as the main method to prevent wildlife crop damage (Mojo et al. 2014, Shapiro and Willcox 2019).

Farmers were reluctant not to chase animals away, mostly lacking knowledge or exhibiting unwillingness to address the potential benefits of increasing beneficial animal populations. Notably, exposure to nature awareness programs and knowledge about its benefits may influence behaviors toward protecting and consequently benefit from the presence of some animals (Herzon and Mikk 2007). In fact, education plays a crucial role in reducing hostility and negative behaviors toward wildlife (Prokop et al. 2009, Hardwick et al. 2017). Therefore, the low educational level of farmers in our study region may contribute to the resistance in considering that some wildlife will benefit their crops (Tarrant et al. 2016, Hassan et al. 2020).

Perspectives for coexistence in agroecosystems

Analyzing farmers' attitudes within the ABC framework allowed for a more comprehensive understanding of the various factors triggering conflicts, facilitating the identification of potential strategies and solutions for mediation of HWI. The complementarity of data collected through surveys and focus group sessions also proved important. Focus group sessions energized discussions among participants, enabling engagement with sensitive issues and the validation of information (Guest et al. 2017, Williamson 2018). However, our focus group approach had limitations, such as potential bias arising from selecting participants among interviewed farmers and using moderators associated with a local farmers' NGO, which could lead to more positive responses. Nevertheless, this approach complemented the interviews by offering deeper insights and a more nuanced understanding of the drivers of HWI.

Although our data primarily focused on one ethnic group within Africa's diverse ethnic landscape, the results reflect challenges faced by smallholder farmers regardless of cultural background. Our findings indicated that farmers' emotions and perceptions toward wildlife can vary between villages within the same region. This underscores the importance of local studies because historical events, experiences, and the landscape context can shape farmers' attitudes. Although it may not be feasible to identify all variables involved in HWI, case studies can provide valuable insights into the effects of coexistence, considering the realities, struggles, and aspirations of those directly involved (Rocha et al. 2021b). Given the lack of studies on HWI in agroecosystems and the growing food insecurity issues in Africa, this research provides critical insights that can inform future ecological intensification and management initiatives.

Farmers' emotions regarding wildlife were mostly negative, often affecting perceptions of wild animals even when they may be beneficial to crops. This perception seems further influenced by the overall low literacy rates among the farming population in the region. Changing these emotions and perceptions in adult farmers may be challenging; however, investing in education through local schools (Dinis et al. 2023) and integrating biodiversity, wildlife ecology, and ecosystem services into the curricula might equip the next generation with tools for knowledge-based decisions on sustainable crop management (Silva dos Santos et al. 2020). Additionally, community outreach through well-established organizations may help disseminate the benefits of wildlife for pest control while promoting eco-friendly approaches (Tuneu-Corral et al. 2023, Xavier et al. 2023).

Agroecosystems are generally simplified environments in which the presence and abundance of threatened species are low. In this context, management may focus less on specific conservation measures, potentially reducing the risk of conservation conflicts (Redpath et al. 2013). However, while preserving biodiversity outside protected areas is crucial, the balance, productivity, and sustainability of agricultural systems also depend on healthy ecosystems. Improved co-existence and the success of eco-friendly measures rely on farmers' willingness to implement them, which is influenced by their attitudes toward wildlife. Farmers displayed little openness to increasing the abundance of beneficial species, even when payment was considered. Therefore, more integrated strategies should be explored, including discussions with farmers on effective and regulated pest control options alongside wildlife promotion measures. Despite negative attitudes, mentions of ecosystem services, such as pest control and fertilization, suggest that building a network of ecosystem services encompassing farmland and neighboring areas could provide a more holistic approach. Integrating livelihood and sustenance into management strategies while considering community attitudes may foster greater tolerance toward wildlife and its impacts by highlighting benefits and addressing their needs (Propper et al. 2020).

Acknowledgments:

During the field work, we had the collaboration and logistic support of the KAFO Peasant Federation in Guinea-Bissau. We thank the secretary-general Eng. Sambu Seck for his support. We thank all the staff of KAFO's Djalicunda center, particularly those who facilitated our day-to-day activities providing support at all levels, Djari, Djara, Aua, Ami, Belomi, Ioba, and so many more. We are grateful to the communities and the female farmers who welcomed us and agreed to participate in our research. Without them, this would have been impossible. FUNDING: This study was funded by Fundação para a Ciência e Tecnologia, I.P./MCTES through national funds (PIDDAC) via project PTDC/ASP-AGR/0876/2020 (DOI: 10.54499/ PTDC/ASP-AGR/0876/2020), a PhD grant to PPC (PD/BD/150566/2020), an individual contract to ST (CEECIND/00135/201), and structural funds to CE3C (UID/BIA/00329/2023) and CHANGE (LA/P/0121/2020).

Data Availability:

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

LITERATURE CITED

Adesina, A. A. 1996. Factors affecting the adoption of fertilizers by rice farmers in Côte d'Ivoire. Nutrient Cycling in Agroecosystems 46:29–39. https://doi.org/10.1007/BF00210222

Adeyanju, T. E., A. A. Alarape, S. Musila, A. T. Adeyanju, T. C. Omotoriogun, W. Medina-Jerez, U. E. Yellow, and P. Prokop. 2023. Human-bat relationships in Southwestern Nigerian communities. Anthrozoos 36:407–425. https://doi.org/10.1080/08927936.2023.2166715

Alexander, J. S., J. McNamara, J. M. Rowcliffe, J. Oppong, and E. J. Milner-Gulland. 2015. The role of bushmeat in a West African agricultural landscape. Oryx 49(4):643–651. https://doi.org/10.1017/S0030605313001294

Ali, M. P., M. N. Bari, S. S. Haque, M. M. M. Kabir, S. Afrin, F. Nowrin, M. S. Islam, and D. A. Landis. 2019. Establishing next-generation pest control services in rice fields: eco-agriculture. Scientific Reports 9:10180. https://doi.org/10.1038/s41598-019-46688-6

Arjunan, M., C. Holmes, J.-P. Puyravaud, and P. Davidar. 2006. Do developmental initiatives influence local attitudes toward conservation? A case study from the Kalakad-Mundanthurai Tiger Reserve, India. Journal of Environmental Management 79:188–197. https://doi.org/10.1016/j.jenvman.2005.06.007

Athreya, V., S. Pimpale, A. S. Borkar, N. Surve, S. Chakravarty, M. Ghosalkar, A. Patwardhan, and J. D. C. Linnell. 2018. Monsters or Gods? Narratives of large cat worship in western India. CATNews 67:23–26.

Biset, A., G. Mengesha, and Z. Girma. 2019. Human-wildlife conflict in and around Borena Sayint National Park, Northern Ethiopia. Human-Wildlife Interactions 13:111–124. https://doi.org/10.26076/fk60-mp27

Breckler, S. J. 1984. Empirical validation of affect, behavior, and cognition as distinct components of attitude. Journal of Personality and Social Psychology 47(6):1191–1205. https://doi.org/10.1037/0022-3514.47.6.1191

Can-Hernández, G., C. Villanueva-García, E. J. Gordillo-Chávez, C. J. Pacheco-Figueroa, E. Pérez-Netzahual, and R. García-Morales. 2019. Wildlife damage to crops adjacent to a protected

area in southeastern Mexico: farmers' perceptions versus actual impact. Human-Wildlife Interactions 13:423–438. https://doi.org/10.26077/9gqj-5m75

Coruche, M. P. A. L. 2018. Economics essays on rice seed security and sovereignty in Guinea-Bissau. Dissertation. London School of Economics and Political Science Economics, London, UK. https://etheses.lse.ac.uk/4203/

Costa, S., C. Casanova, C. Sousa, and P. Lee. 2013. The good, the bad and the ugly: perceptions of wildlife in Tombali (Guinea-Bissau, West Africa). Journal of Primatology 02:1-7. http://hdl.handle.net/1893/16964

Daboné, C., A. Ouéda, L. J. Thompson, J. B. Adjakpa, and P. D. M. Weesie. 2022. Local perceptions and sociocultural value of Hooded Vultures *Necrosyrtes monachus* in Burkina Faso, West Africa. Ostrich 93:233–247. https://doi.org/10.2989/00306525.2-022.2120558

Dickman, A. J. 2010. Complexities of conflict: the importance of considering social factors for effectively resolving human-wildlife conflict. Animal Conservation 13:458–466. https://doi.org/10.1111/j.1469-1795.2010.00368.x

Digun-Aweto, O., P. Van Der Merwe, and M. Saayman. 2022. Tolerance factors in human-wildlife conflicts in protected areas: the case of Cross River National Park, Cross River State Nigeria. GeoJournal 87:349–361. https://doi.org/10.1007/s10708-020-10254-9

Dinis, A., A. Rainho, C. B. de Campos, and C. S. G. Martins. 2023. Promoting coexistence with jaguars and pumas in the Caatinga: two approaches to reach school children. Human Dimensions of Wildlife 29(2):210-227. https://doi.org/10.1080/10871209.2023.2212693

Else, J. G. 1991. Nonhuman primates as pests. Pages 155–165 in H. O. Box, editor. Primate responses to environmental change. Springer Netherlands, Dordrecht, The Netherlands. https://doi.org/10.1007/978-94-011-3110-0_8

Ezealor, A. U., and R. H. Giles, Jr. 1997. Vertebrate pests of a Sahelian wetland agro-ecosystem: perceptions and attitudes of the indigenes and potential management strategies. International Journal of Pest Management 43(2):97–104. https://doi.org/10.1080/096708797228762

Fitchen, J. M., J. S. Heath, and J. Fessenden-Raden. 1987. Risk perception in community context: a case study. Pages 31–54 in B. B. Johnson and V. T. Covello, editors. The social and cultural construction of risk. Springer Netherlands, Dordrecht, The Netherlands. https://doi.org/10.1007/978-94-009-3395-8_2

Food and Agriculture Organization of the United Nations (FAO). 2009. Human-wildlife conflict in Africa: causes, consequences and management strategies. FAO, Rome, Italy. https://www.fao.org/4/i1048e/i1048e00.htm

Food and Agriculture Organization of the United Nations (FAO). 2011. Rice market monitor 2011, trade and markets division. Volume XIV - Issue No. 3. FAO, Rome, Italy. https://openknowledge.fao.org/handle/20.500.14283/am721e

Food and Agriculture Organization of the United Nations (FAO). 2022a. Market summaries: rice. Food outlook, June 2022. FAO, Rome, Italy. https://www.fao.org/3/cb9427en/cb9427en_rice.pdf

Food and Agriculture Organization of the United Nations (FAO). 2022b. FAOSTAT online statistical service. FAO, Rome, Italy. https://www.fao.org/faostat/en/#home

Gadal, N., J. Shrestha, M. N. Poudel, and B. Pokharel. 2019. A review on production status and growing environments of rice in Nepal and in the world. Archives of Agriculture and Environmental Science 4:83–87. https://doi.org/10.26832/24566-632.2019.0401013

Gadd, M. E. 2005. Conservation outside of parks: attitudes of local people in Laikipia, Kenya. Environmental Conservation 32:50–63. https://doi.org/10.1017/S0376892905001918

Gillingham, S., and P. C. Lee. 2003. People and protected areas: a study of local perceptions of wildlife crop-damage conflict in an area bordering the Selous Game Reserve, Tanzania. Oryx 37:316–325. https://doi.org/10.1017/S0030605303000577

González, L., F. G. D. Montoto, T. Mereck, J. Alves, J. Pereira, P. Fernández de Larrinoa, A. Maroto, L. Bolonio, and N. El-Kadhir. 2017. Preventing crop raiding by the Vulnerable common hippopotamus *Hippopotamus amphibius* in Guinea-Bissau. Oryx 51(2):222–229. https://doi.org/10.1017/S003060531500109X

Gore, M. L., and J. S. Kahler. 2012. Gendered risk perceptions associated with human-wildlife conflict: implications for participatory conservation. PLoS One 7:e32901. https://doi.org/10.1371/journal.pone.0032901

Govind, S. K., and E. A. Jayson. 2021. Human-wildlife interactions and people's attitudes towards conservation: a case study from Central Kerala, India. Animal Biodiversity and Conservation 44:139–151. https://doi.org/10.32800/abc.2021.44.0139

Grantham, H. S., A. Duncan, T. D. Evans, K. R. Jones, H. L. Beyer, R. Schuster, J. Walston, J. C. Ray, J. G. Robinson, M. Callow, T. Clements, H. M. Costa, A. DeGemmis, P. R. Elsen, J. Ervin, P. Franco, E. Goldman, S. Goetz, A. Hansen, E. Hofsvang, P. Jantz, S. Jupiter, A. Kang, P. Langhammer, W. F. Laurance, S. Lieberman, M. Linkie, Y. Malhi, S. Maxwell, M. Mendez, R. Mittermeier, N. J. Murray, H. Possingham, J. Radachowsky, S. Saatchi, C. Samper, J. Silverman, A. Shapiro, B. Strassburg, T. Stevens, E. Stokes, R. Taylor, T. Tear, R. Tizard, O. Venter, P. Visconti, S. Wang, and J. E. M. Watson. 2020. Anthropogenic modification of forests means only 40% of remaining forests have high ecosystem integrity. Nature Communications 11(1):5978. https://doi.org/10.1038/s41467-020-19493-3

Guest, G., E. Namey, J. Taylor, N. Eley, and K. McKenna. 2017. Comparing focus groups and individual interviews: findings from a randomized study. International Journal of Social Research Methodology 20(6):693–708. https://doi.org/10.1080/13645579.-2017.1281601

Hardwick, J. L., N. E. C. Priston, T. E. Martin, D. G. Tosh, A. H. Mustari, and K. E. Abernethy. 2017. Community perceptions of the crop-feeding Buton Macaque (*Macaca ochreata brunnescens*): an ethnoprimatological study on Buton Island, Sulawesi. International Journal of Primatology 38:1102–1119. https://doi.org/10.1007/s10764-017-9999-0

Hassan, M. M., M. A. Kalam, M. Alam, S. Shano, A. Al Faruq, M. S. Hossain, M. N. Islam, S. A. Khan, and A. Islam. 2020.

Understanding the community perceptions and knowledge of bats and transmission of Nipah Virus in Bangladesh. Animals 10:1814. https://doi.org/10.3390/ani10101814

Haule, K. S., F. H. Johnsen, and S. L. S. Maganga. 2002. Striving for sustainable wildlife management: the case of Kilombero Game Controlled Area, Tanzania. Journal of Environmental Management 66:31–42. https://doi.org/10.1006/jema.2002.0572

Herzon, I., and M. Mikk. 2007. Farmers' perceptions of biodiversity and their willingness to enhance it through agri-environment schemes: a comparative study from Estonia and Finland. Journal for Nature Conservation 15:10–25. https://doi.org/10.1016/j.jnc.2006.08.001

Hewstone, M., F. D. Fincham, and J. Foster. 2005. Psychology. Blackwell, Oxford, UK.

Hill, C. M. 1997. Crop-raiding by wild vertebrates: the farmer's perspective in an agricultural community in western Uganda. International Journal of Pest Management 43:77–84. https://doi.org/10.1080/096708797229022

Hill, C. M. 2000. Conflict of interest between people and baboons: crop raiding in Uganda. International Journal of Primatology 21:299–315. https://doi.org/10.1023/A:1005481605637

Hill, C. M. 2004. Farmers' perspectives of conflict at the wildlife-agriculture boundary: some lessons learned from African subsistence farmers. Human Dimensions of Wildlife 9:279–286. https://doi.org/10.1080/10871200490505710

Hill, C. M. 2017. Primate crop feeding behavior, crop protection, and conservation. International Journal of Primatology 38:385–400. https://doi.org/10.1007/s10764-017-9951-3

Hockings, K. J., and C. Sousa. 2012. Differential utilization of cashew—a low-conflict crop—by sympatric humans and chimpanzees. Oryx 46(3):375–381. https://doi.org/10.1017/S003060531100130X

Hockings, K. J., and C. Sousa. 2013. Human-chimpanzee sympatry and interactions in Cantanhez National Park, Guinea-Bissau: current research and future directions. Primate Conservation 26(1):57–65. https://doi.org/10.1896/052.026.0104

Hoffmeier-Karimi, R. R., and B. A. Schulte. 2015. Assessing perceived and documented crop damage in a Tanzanian village impacted by human-elephant conflict (HEC). Pachyderm 56:51-60. https://pachydermjournal.org/index.php/pachyderm/article/view/371

Hogg, M. A., and G. M. Vaughan. 2018. Social psychology. Eighth edition. Pearson Education, Harlow, UK. https://doi.org/10.4135/9781446263471

Htay, T., T. H. Ringsby, E. Røskaft, and P. S. Ranke. 2022. Promoting bird conservation in wetland-associated landscapes: factors influencing avian crop damage and farmers' attitudes. Global Ecology and Conservation 38:e02212. https://doi.org/10.1016/j.gecco.2022.e02212

Inskip, C., N. Carter, S. Riley, T. Roberts, and D. MacMillan. 2016. Toward human-carnivore coexistence: understanding tolerance for tigers in Bangladesh. PLoS One 11:e0145913. https://doi.org/10.1371/journal.pone.0145913

Instituto Nacional de Estatística (INE). 2010a. Terceiro recenseamento geral da população e habitação de 2009 - características socioculturais. Instituto Nacional de Estatística, Bissau, Guiné-Bissau. https://stat-guinebissau.com/Menu_principal/IV_RGPH/rgph1/caracteristicas_socio_cultural.pdf

Instituto Nacional de Estatística (INE). 2010b. Terceiro recenseamento geral da população e habitação de 2009 - estado e estrutura da população. Instituto Nacional de Estatística (INE), Bissau, Guiné-Bissau. https://www.stat-guinebissau.com/Menu_principal/IV_RGPH/rgph1/estado_estrura_pop.pdf

Instituto Nacional de Estatística (INE). 2017. Boletim estatístico da Guiné-Bissau: Guiné-Bissau em números 2017. Instituto Nacional de Estatística (INE), Bissau, Guiné-Bissau. https://www.stat-guinebissau.com/Menu_principal/Pubicações/anuario/boletim_estatistico_GB/guinebissau-em-numero2017.pdf

Jalloh, A., H. Roy-Macauley, and P. Sereme. 2012. Major agro-ecosystems of West and Central Africa: brief description, species richness, management, environmental limitations and concerns. Agriculture, Ecosystems and Environment 157:5–16. https://doi.org/10.1016/j.agee.2011.11.019

Kahler, J. S., and M. L. Gore. 2015. Local perceptions of risk associated with poaching of wildlife implicated in human-wildlife conflicts in Namibia. Biological Conservation 189:49–58. https://doi.org/10.1016/j.biocon.2015.02.001

Kansky, R., M. Kidd, and A. T. Knight. 2014. Meta-analysis of attitudes toward damage-causing mammalian wildlife. Conservation Biology 28:924–938. https://doi.org/10.1111/cobi.12275

Katuwal, H. B., M. Zhang, H. S. Baral, H. P. Sharma, and R.-C. Quan. 2021. Assessment of farmers' knowledge and perceptions towards farmland birds show the need for conservation interventions. Global Ecology and Conservation 27:e01563. https://doi.org/10.1016/j.gecco.2021.e01563

Kesch, K. M., D. T. Bauer, and A. J. Loveridge. 2014. Undermining game fences: who is digging holes in Kalahari sands? African Journal of Ecology 52:144–150. https://doi.org/10.1111/aje.12096

King, F. A., and P. C. Lee. 1987. A brief survey of human attitudes to a pest species of primate—*Cercopithecus aethiops*. Primate Conservation 8:82–84.

Lado, C. 1992. Female labour participation in agricultural production and the implications for nutrition and health in rural Africa. Social Science and Medicine 34:789–807. https://doi.org/10.1016/0277-9536(92)90366-X

Linkie, M., Y. Dinata, A. Nofrianto, and N. Leader-Williams. 2007. Patterns and perceptions of wildlife crop raiding in and around Kerinci Seblat National Park, Sumatra. Animal Conservation 10:127–135. https://doi.org/10.1111/j.1469-1795.2006.00083.x

Macdonald, D. W., A. J. Loveridge, and A. Rabinowitz. 2010. Felid futures: crossing disciplines, borders, and generations. Biology and Conservation of Wild Felids. Oxford University Press, Oxford, UK.

MacFarlane, D., and R. Rocha. 2020. Guidelines for communicating about bats to prevent persecution in the time of COVID-19. Biological Conservation 248:108650. https://doi.org/10.1016/j.biocon.2020.108650

Mackenzie, C. A., and P. Ahabyona. 2012. Elephants in the garden: financial and social costs of crop raiding. Ecological Economics 75:72–82. https://doi.org/10.1016/j.ecolecon.2011.12.018

Madden, F. 2004. Creating coexistence between humans and wildlife: global perspectives on local efforts to address human-wildlife conflict. Human Dimensions of Wildlife 9:247–257. https://doi.org/10.1080/10871200490505675

Manfredo, M. J., and A. P. Bright. 2008. Attitudes and the study of human dimensions of wildlife. Pages 75–109 in M. J. Manfredo, editor. Who cares about wildlife? Springer, New York, New York. https://doi.org/10.1007/978-0-387-77040-6_4

Manfredo, M. J., and A. A. Dayer. 2004. Concepts for exploring the social aspects of human-wildlife conflict in a global context. Human Dimensions of Wildlife 9:1–20. https://doi.org/10.1080/10871200490505765

Manoa, D. O., F. Mwaura, T. Thenya, and S. Mukhovi. 2020. A review of the visible and hidden opportunity costs of human-wildlife conflict in Kenya. Journal of Biodiversity Management and Forestry 9:2–8. https://doi.org/10.37532/jbmf.2020.9(1).228

Matseketsa, G., N. Muboko, E. Gandiwa, D. M. Kombora, and G. Chibememe. 2019. An assessment of human-wildlife conflicts in local communities bordering the western part of Save Valley Conservancy, Zimbabwe. Global Ecology and Conservation 20: e00737. https://doi.org/10.1016/j.gecco.2019.e00737

Mekonen, S. 2020. Coexistence between human and wildlife: the nature, causes and mitigations of human-wildlife conflict around Bale Mountains National Park, Southeast Ethiopia. BMC Ecology 20:51. https://doi.org/10.1186/s12898-020-00319-1

Mishra, C. 1997. Livestock depredation by large carnivores in the Indian trans-Himalaya: conflict perceptions and conservation prospects. Environmental Conservation 24:338–343. https://doi.org/10.1017/S0376892997000441

Mojo, D., J. Rothschuh, and M. Alebachew. 2014. Farmers' perceptions of the impacts of human-wildlife conflict on their livelihood and natural resource management efforts in Cheha Woreda of Guraghe Zone, Ethiopia. Human-Wildlife Interactions 8:67–77. https://doi.org/10.26077/eqph-5w63

Muthayya, S., J. D. Sugimoto, S. Montgomery, and G. F. Maberly. 2014. An overview of global rice production, supply, trade, and consumption. Annals of the New York Academy of Sciences 1324:7–14. https://doi.org/10.1111/nyas.12540

Naughton. 2001. Farmers, wildlife and the forest fringe. Pages 369–284 in A. Weber, L. White, A. Vedder, and L. Naughton-Treves, editors. African rain forest ecology and conservation. Yale University Press, New Haven, Connecticut, USA.

Naughton-Treves, L., and A. Treves. 2005. Socio-ecological factors shaping local support for wildlife: crop-raiding by elephants and other wildlife in Africa. Pages 252–277 in R. Woodroffe, S. Thirgood, and A. Rabinowitz, editors. People and wildlife: conflict or coexistence. Cambridge University Press, Cambridge, UK. https://doi.org/10.1017/CBO9780511614774.017

Naughton-Treves, L., A. Treves, C. Chapman, and R. Wrangham. 1998. Temporal patterns of crop-raiding by primates: linking food availability in croplands and adjacent forest. Journal of Applied Ecology 35(4):596–606. https://doi.org/10.1046/j.1365-2664.1998.3540596.x

Ogra, M. V. 2008. Human-wildlife conflict and gender in protected area borderlands: a case study of costs, perceptions, and vulnerabilities from Uttarakhand (Uttaranchal), India. Geoforum 39:1408–1422. https://doi.org/10.1016/j.geoforum.2007.12.004

Palma, L., R. Godinho, Q. Quecuta, T. Mereck, J. Mandeck, T. U. Só, J. P. Cancela, and P. Beja. 2024. African forest elephants persist in Guinea-Bissau but require an emergency conservation plan. Oryx 58(1):125–128. https://doi.org/10.1017/S0030605323000674

Prokop, P., J. Fančovičová, and M. Kubiatko. 2009. Vampires are still alive: Slovakian students' attitudes toward bats. Anthrozoös 22:19–30. https://doi.org/10.2752/175303708X390446

Propper, C. R., L. J. Hardy, B. D. Howard, R. J. B. Flor, and G. R. Singleton. 2020. Role of farmer knowledge in agro-ecosystem science: rice farming and amphibians in the Philippines. Human-Wildlife Interactions 14:273–286. https://doi.org/10.26077/7c28-0418

R Core Team. 2024. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

Redpath, S. M., J. Young, A. Evely, W. M. Adams, W. J. Sutherland, A. Whitehouse, A. Amar, R. A. Lambert, J. D. Linnell, A. Watt, and R. J. Gutiérrez. 2013. Understanding and managing conservation conflicts. Trends in Ecology and Evolution 28(2):100–109. https://doi.org/10.1016/j.tree.2012.08.021

Remis, M. J., and R. Hardin. 2009. Transvalued species in an African forest. Conservation Biology 762(23):1588–1596. https://doi.org/10.1111/j.1523-1739.2009.01290.x

Rocha, R., Á. Fernández-Llamazares, A. López-Baucells, S. F. M. Andriamitandrina, Z. E. Andriatafika, E. M. Temba, L. Torrent, D. Burgas, and M. Cabeza. 2021a. Human-bat interactions in rural southwestern Madagascar through a biocultural lens. Journal of Ethnobiology 41:53–69. https://doi.org/10.2993/0278-0771-41.1.53

Rocha, R., A. López-Baucells, and Á. Fernández-Llamazares. 2021b. Ethnobiology of bats: exploring human-bat inter-relationships in a rapidly changing world. Journal of Ethnobiology 41(1):3–17. https://doi.org/10.2993/0278-0771-41.1.3

Rossinyol-Fernàndez, A., D. Dabo, F. dos Reis Silva, R. Oliveira, S. Seck, A. Rainho, M. Cabeza, and A. F. Palmeirim. 2024. Use of native and human-modified habitats by different mammal guilds in West Africa. Global Ecology and Conservation 54: e03099. https://doi.org/10.1016/j.gecco.2024.e03099

Santos, C., and J. M. Mourato. 2022. 'I was born here, I will die here': climate change and migration decisions from coastal and insular Guinea-Bissau. Geographical Annals: Series B, Human Geography 106:1–19. https://doi.org/10.1080/04353684.2022.2154689

Shanko, G., B. Tona, and B. Adare. 2021. Human-wildlife conflict around Belo-Bira Forest, Dawro Zone, Southwestern Ethiopia. International Journal of Ecology 2021(1):9944750. https://doi.org/10.1155/2021/9944750

Shapiro, H. G., and A. S. Willcox. 2019. Farmer attitudes towards wildlife in the Vaca Forest Reserve, Belize. Human Dimensions of Wildlife 24:488–495. https://doi.org/10.1080/10871209.2019.1626102

Sharma, P., N. Chettri, K. Uddin, K. Wangchuk, R. Joshi, T. Tandin, A. Pandey, K. S. Gaira, K. Basnet, S. Wangdi, T. Dorji, N. Wangchuk, V. Sudhir Chitale, Y. Uprety. 2020. Mapping human-wildlife conflict hotspots in a transboundary landscape, Eastern Himalaya. Global Ecology and Conservation 24:e01284. https://doi.org/10.1016/j.gecco.2020.e01284

Silva dos Santos, M., K. D. Kelsey, N. E. Fuhrman, and K. Irwin. 2020. Animals in environmental education: assessing individuals–emotional reactions to interactions with wildlife. Journal of Agricultural Education 61(4):61–77. https://doi.org/10.5032/jae.2020.04061

Sottomayor, M., A. F. Palmeirim, C. F. J. Meyer, R. F. de Lima, R. Rocha, and A. Rainho. 2024. Nature-based solutions to increase rice yield: an experimental assessment of the role of birds and bats as agricultural pest suppressors in West Africa. Agriculture, Ecosystems and Environment 370:109067. https://doi.org/10.1016/j.agee.2024.109067

Strum, S. C. 1994. Prospects for management of primate pests. Revue d'Ecologie (La Terre et la Vie) 49:295–306. https://doi.org/10.3406/revec.1994.2479

Su, K., J. Ren, J. Yang, Y. Hou, and Y. Wen. 2020. Human-elephant conflicts and villagers' attitudes and knowledge in the Xishuangbanna Nature Reserve, China. International Journal of Environmental Research and Public Health 17:8910. https://doi.org/10.3390/ijerph17238910

Sukanan, D., and B. P. Anthony. 2019. Community attitudes towards bears, bear bile use, and bear conservation in Luang Prabang, Lao PDR. Journal of Ethnobiology and Ethnomedicine 15:15. https://doi.org/10.1186/s13002-019-0292-5

Tarrant, J., D. Kruger, and L. H. du Preez. 2016. Do public attitudes affect conservation effort? Using a questionnaire-based survey to assess perceptions, beliefs, and superstitions associated with frogs in South Africa. African Zoology 51:13–20. https://doi.org/10.1080/15627020.2015.1122554

Temesgen, Z., G. Mengesha, and T. B. Endalamaw. 2022. Human-wildlife conflict in the surrounding districts of Alage College, Central Rift Valley of Ethiopia. Ecology and Evolution 12:e8591. https://doi.org/10.1002/ece3.8591

Temudo, M. P. 2011. Planting knowledge, harvesting agro-biodiversity: a case study of southern Guinea-Bissau rice farming. Human Ecology 39:309–321. https://doi.org/10.1007/s10745-011-9404-0

Temudo, M. P., and A. I. R. Cabral. 2023. Climate change as the last trigger in a long-lasting conflict: the production of vulnerability in northern Guinea-Bissau, West Africa. Journal of Peasant Studies 50(1):315–338. https://doi.org/10.1080/0306615-0.2021.1996355

Thapa, S. 2010. Effectiveness of crop protection methods against wildlife damage: A case study of two villages at Bardia National Park, Nepal. Crop Protection 29(11):1297–1304. https://doi.org/10.1016/j.cropro.2010.06.015

Treves, A., R. B. Wallace, L. Naughton-Treves, and A. Morales. 2006. Co-managing human-wildlife conflicts: a review. Human Dimensions of Wildlife 11:383–396. https://doi.org/10.1080/10871200600984265

Tuneu-Corral, C., X. Puig-Montserrat, D. Riba-Bertolín, D. Russo, H. Rebelo, M. Cabeza, and A. López-Baucells. 2023. Pest suppression by bats and management strategies to favour it: a global review. Biological Reviews 98:1564–1582. https://doi.org/10.1111/brv.12967

Wang, J., Y. Chen, Y. Sun, Z. Lyu, and K. Shi. 2023. Inferring human-elephant coexistence based on characteristics of human-elephant interactions in Nangunhe of Yunnan, China. Chinese Geography Science 33:363–376. https://doi.org/10.1007/s11769-023-1332-6

Wang, W. W., P. D. Curtis, and J. P. Lassoie. 2004. Farmer perceptions of crop damage by wildlife in Jigme Singye Wangchuck National Park, Bhutan. Wildlife Society Bulletin 34:359–365. https://doi.org/10.2193/0091-7648(2006)34[359:FPOCDB]2.0.CO;2

Webber, A. D., and C. M. Hill. 2014. Using participatory risk mapping (PRM) to identify and understand people's perceptions of crop loss to animals in Uganda. PLoS One 9:e102912. https://doi.org/10.1371/journal.pone.0102912

Whitehouse-Tedd, K., J. Abell, and A. K. Dunn. 2021. Evaluation of the use of psychometric scales in human-wildlife interaction research to determine attitudes and tolerance toward wildlife. Conservation Biology 35:533–547. https://doi.org/10.1111/cobi.13599

Williamson, K. 2018. Questionnaires, individual interviews and focus group interviews. Pages 379–403 in K. Williamson and G. Johanson, editors. Research methods: information, systems, and contexts. Second edition. Elsevier, Amsterdam, The Netherlands. https://doi.org/10.1016/B978-0-08-102220-7.00016-9

World Bank. 2021. Indicators | data. World Bank, Washington, D.C., USA. https://databank.worldbank.org/source/world-development-indicators

World Food Programme in Guinea-Bissau (WFP). 2016. Standard project report 2016. World Food Programme in Guinea-Bissau, Republic of (GW), Rome, Italy. https://docs.wfp.org/api/documents/faa7fb7814c8442cbbbcbecf92cb6049/download/?_ga=2.211363154.674213817.1731514240-1124751283.1731514240

Xavier, B. S., A. Rainho, A. M. Santos, M. V. Vieira, and W. D. Carvalho. 2023. Global systematic map of research on bats in agricultural systems. Frontiers in Ecology and Evolution 11:1214176. https://doi.org/10.3389/fevo.2023.1214176

Yeshey, R. M. Ford, R. J. Keenan, and C. R. Nitschke. 2022. Subsistence farmers' understanding of the effects of indirect impacts of human wildlife conflict on their psychosocial well-being in Bhutan. Sustainability 14:14050. https://doi.org/10.3390/su142114050

Yeshey, R. J. Keenan, R. M. Ford, and C. R. Nitschke. 2023. Sustainable development implications of human wildlife conflict: an analysis of subsistence farmers in Bhutan. International Journal of Sustainable Development and World Ecology 30:548–563. https://doi.org/10.1080/13504509.2023.2167242

Appendix 1 - Interview Guide

Nr.

I. Present the project, following the topics from the Information Brochure.

II. Request consent to conduct the interview by completing the Informed Consent Form. Verify whether the form can be signed or not. Provide a copy of the form to the respondent. Begin the interview only if consent is obtained.

III. Survey:

Date:	Sector:	Village:
Interviewer:	Translator:	
Comments:		

1. Socio-Demographic information

Interviewee:

Gender:	Age:	Ethnicity:
Education:	Household size: Children: Adults:	Profession:

1.1. Main source of income:

☐ Agriculture ☐ Other. Which? ☐

1.2. The fields where you work are:

☐ Yours ☐ Your family's ☐ Another person's ☐ Other. Which? ☐

3. What is the nr and area of the fields where you work? | Nr: | Total area |

2. Challenges of rice production

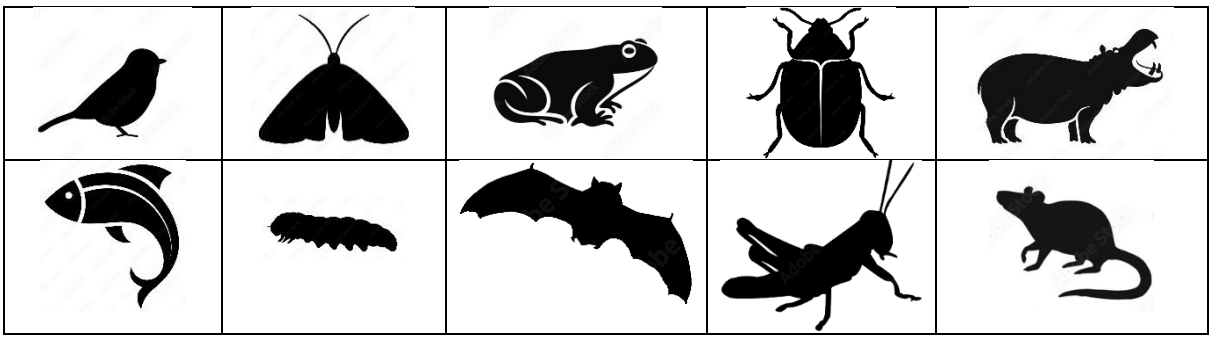
2.1. What are the main difficulties in rice production?

☐ Water availability ☐ Animal pests ☐ Rice diseases ☐ Low production

☐ Seed price ☐ Other. Which? ☐

3. Perceptions of wild animals and their impact on rice

3.1. Do you recognize these animals?



3.2. Did any of these animals impact your rice fields? ☐ Yes ☐ No ☐ DK/DA

3.3. The impacts were: ☐ Positive ☐ Negative ☐ DK/DA

3.4. Can you order the effect of these species, from the most positive (1) to the most negative (3)?

3.5. Are there any other animals you believe affect rice production? If so, which animals and do they have a positive or negative impact?

	+	-		+	-
	+	-		+	-
	+	-		+	-

4. Knowledge and behaviour towards wild animals

4.1. Do you ever see bats in your rice fields? ☐ Yes ☐ No ☐ DK/DA

4.2. What do bats eat? ☐ Insects ☐ Fruit ☐ _____ ☐ DK/DA

4.3. What effects do bats have on rice fields? ☐

4.4. What do you do when you find bats near your fields? ☐

4.5. Do you ever see birds in your rice fields? ☐ Yes ☐ No ☐ DK/DA

4.6. What do birds eat? ☐ Insects ☐ Rice ☐ _____ ☐ DK/DA

4.7. What effects do birds have on rice fields? ☐

4.8. What do you do when you find birds near your fields? ☐

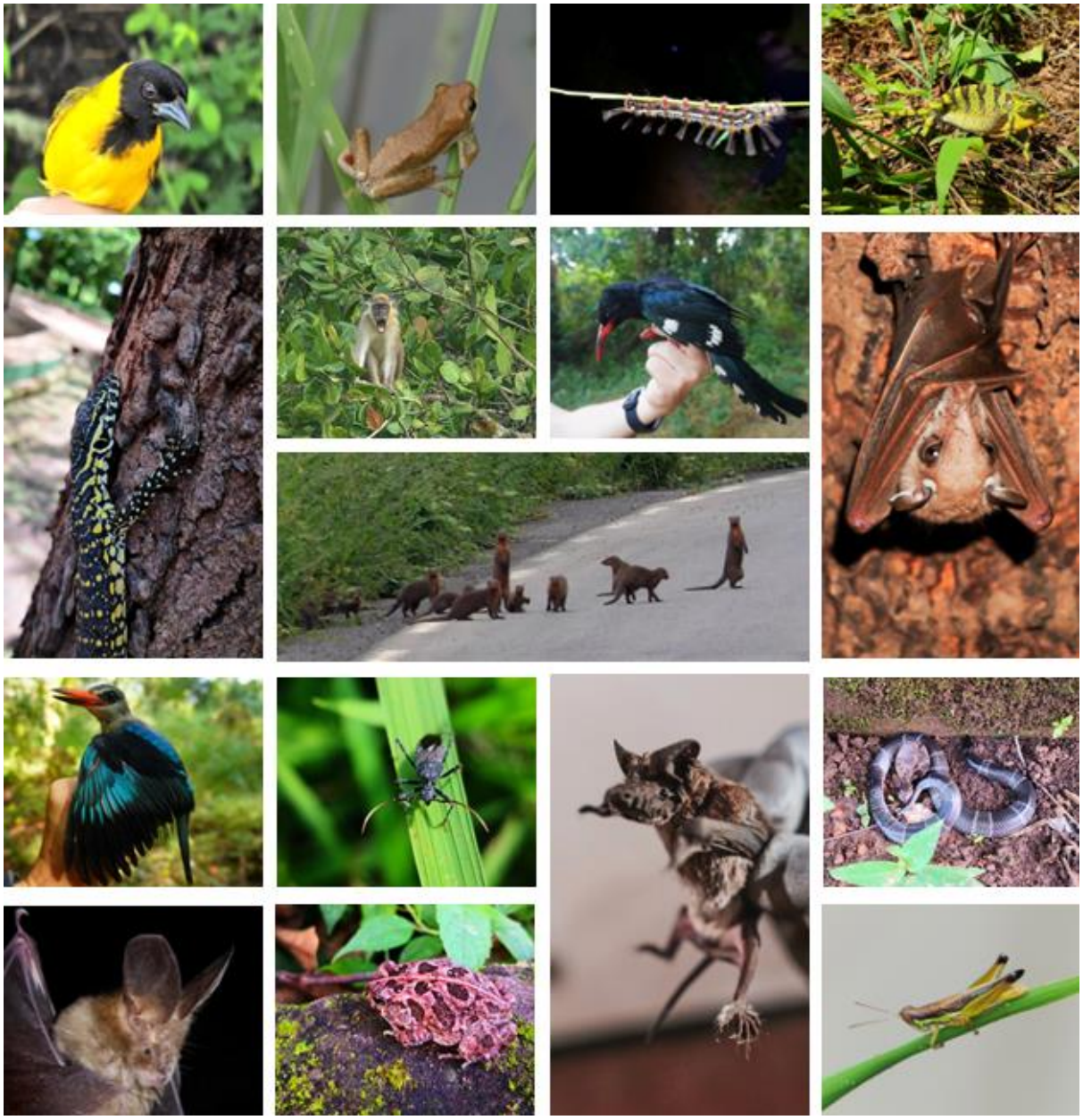
4.9. Would you be interested in increasing the number of beneficial animals in your fields?

☐ Yes, sure ☐ If it has no costs ☐ If I have financial support ☐ No

IV. Clarify any questions raised by the respondent, explaining the project objectives again if necessary. Ensure that no doubts or discomfort remain.

Appendix 2 - Focus Group Session

0. Explanation of the project (5 minutes) and icebreaker
    a. How are you feeling today?
    b. How old are you?
    c. How do you feel about the way rice is produced in the region?
    d. How do you feel about wild animals in the region? Which ones do you find useful and damaging?
1. Knowledge about wild animals (visual representation - silhouettes)
    a. Do you recognize these animals? Name them, please.
2. What do you know about these animals and their habits? Knowledge and feelings towards wild animals (visual representation - photos)



a. Do you know these animals?

b. Do you like these animals?

c. Why do you dislike them? (the ones disliked)

d. Why do you like them? (the ones liked)

3. Perception of negative impacts on crops

a. Were your fields damaged in the past 2 years? By which animal(s)?

    b. How do you feel about it?

4. Perception of positive impacts of wild animals

    a. Taking the ones that you like more: Do you think they can be useful? Which ones?

    b. How? Can they help in rice production? Which ones?

5. Behaviors towards wild animals

    a. What do you do when you see one of these animals in your fields?

    b. Do you manage to protect your crops? What other things could you do to protect them?

    c. Are there any animals that you try to have more of in your fields? If so, why?

6. Wildlife management and ecological intensification

    a. How would you feel if the number of animals increased in your fields?

How would you feel if you were not allowed to scare off some animals from your field