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Predicting people's priorities for reconciling food security and biodiversity conservation in Kasungu, Malawi

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Abstract

Balancing agricultural productivity with biodiversity conservation is a critical challenge in rural Africa, where food insecurity and poverty intersect with growing ecological pressures. Understanding how communities anticipate and respond to socio-ecological change is essential for designing interventions that sustain livelihoods while safeguarding biodiversity. Using scenario-based methods with 317 household interviews near Kasungu National Park, Malawi, we explored how plausible futures, spanning conservation strategies, agricultural policies, and public interventions, might influence food security, natural resource use, people-park relations, and wellbeing. Scenarios involving increased farm input prices and wildlife translocations were widely expected to reduce food security and wellbeing and were perceived as unfair. In contrast, universal input subsidies and wildlife damage compensation were seen as fair and beneficial, though questions remain about their sustainability and governance. Buffer zone restoration generated geographically divergent responses: generally accepted in fenced communities but strongly opposed in unfenced areas due to expected restrictions on farmland and resource access. These findings demonstrate that interventions are experienced unevenly, shaped by geography, history, and social context. Policies that apply blanket approaches risk reinforcing inequities and undermining legitimacy. More effective strategies should integrate local perspectives, anticipate trade-offs, and align biodiversity goals with food security and human wellbeing.

KEYWORDS

conservation policy, human behavior, land use, scenarios, sustainable livelihoods, trade-offs

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1 | INTRODUCTION AND BACKGROUND

Achieving productive agriculture while conserving biodiversity remains a global challenge (Balmford, 2021; Herrero et al., 2020), particularly in sub-Saharan Africa, where ecologically rich regions such as Miombo woodlands are increasingly threatened by persistent poverty and food insecurity (Salerno et al., 2021). While agriculture underpins food security and poverty reduction, it is also a leading driver of biodiversity loss, with impacts expected to intensify (Tilman et al., 2017; Williams et al., 2021). The expansion of area-based conservation, often pursued through protected areas and buffer zones (Langhammer et al., 2019), compounds these tensions by restricting access to land and resources, frequently exacerbating human-wildlife conflict and undermining local livelihoods (Büscher & Thakholi, 2024; Salerno et al., 2020, 2021; Vallin et al., 2025). These dynamics highlight a persistent issue of addressing the crises of biodiversity loss and food insecurity in parallel rather than together, which often fails to adequately engage with the trade-offs between ecological integrity and human wellbeing (König et al., 2021; Salerno et al., 2020).

Fragmented policy processes—for example, at the national level—further hinder coherent and inclusive responses to address the food-biodiversity nexus (Makwinja et al., 2021, 2025). In Malawi, policy frameworks such as the National Agriculture Policy (Government of Malawi [GoM], 2024) and the National Biodiversity Strategy and Action Plan II: 2015–2025 (Government of Malawi [GoM], 2015) aim to address food security, ecosystem management, and climate adaptation, respectively. However, these instruments are often implemented through separate sectoral ministries and local government structures with limited coordination. Key legislative frameworks, including the National Parks and Wildlife Act (Government of Malawi [GoM], 2017), further emphasize conservation enforcement but provide limited guidance on integrating livelihood needs. Together, this fragmented governance landscape at both national and district levels constrains coherent and inclusive action at the food–biodiversity interface. Integrated approaches that explicitly confront the trade-offs between food security and biodiversity conservation are therefore urgently needed (König et al., 2021).

Understanding how people respond to trade-offs between conservation and development, often driven by external factors, is crucial to designing effective strategies for reconciling competing land use demands (Travers et al., 2016). Agricultural farm input subsidies, for example, can boost yields (Kihara et al., 2016; Mdee et al., 2021), but may incentivize expansion into ecologically sensitive areas, exacerbating habitat loss and conflict (Li et al., 2021; Meng et al., 2023). Similarly, buffer zones, intended to protect park boundaries, are often cultivated, amplifying human-wildlife encounters, further intensifying land use conflicts between farming and conservation (Kosamu, 2017; Vallin et al., 2025). Such interventions highlight the fundamentally distributional nature of conservation–development trade-offs, in which the benefits of conservation and development are unevenly allocated while costs are disproportionately borne by particular social groups. These uneven distributions shape local perceptions of fairness and legitimacy, underscoring the importance of explicitly engaging with distributional inequities as a central component of coexistence and conservation planning (Kansky, 2022; Kansky et al., 2021).

Scenarios, defined as coherent descriptions of plausible hypothetical futures, provide a valuable tool for navigating such trade-offs (Özkaynak & Rodríguez-Labajos, 2010; Schaafsma et al., 2018). Scenarios allow researchers to anticipate intervention outcomes, examine behavioral responses, and communicate alternative trajectories in ways that combine quantitative and qualitative insights (Brittain et al., 2022; Travers et al., 2016, 2019). While sometimes criticized for limited reproducibility due to reliance on expert judgment (Weimer-Jehle et al., 2016), scenarios are increasingly used to explore conservation and livelihood trade-offs, resource management, and coexistence strategies (Brittain et al., 2022; Nana et al., 2025; van Velden et al., 2020).

We used scenario-based interviews to examine how possible future changes in conservation, agricultural policies, and public interventions might affect people and wildlife around Kasungu National Park, Malawi. Malawi exemplifies the challenge of balancing smallholder agriculture and biodiversity conservation (Davis et al., 2021; Kamanga et al., 2009). While farmland expansion supports food security and development, it undermines long-term ecological integrity (Phalan et al., 2011; Williams et al., 2021). We: (i) developed plausible scenarios linked to conservation interventions, exogenous price changes, and welfare policies; (ii) assessed expected impacts on food security, resource use, wellbeing, and fairness; and (iii) explored behavioral intentions under each scenario to consider their implications for conservation and social outcomes.

2 | METHODS

2.1 | Study system

Kasungu National Park (Figure 1) is part of the 30,621 km^2 Malawi-Zambia Transfrontier Conservation Area (MZTFCA) and has been managed by the Malawi government with international support since its

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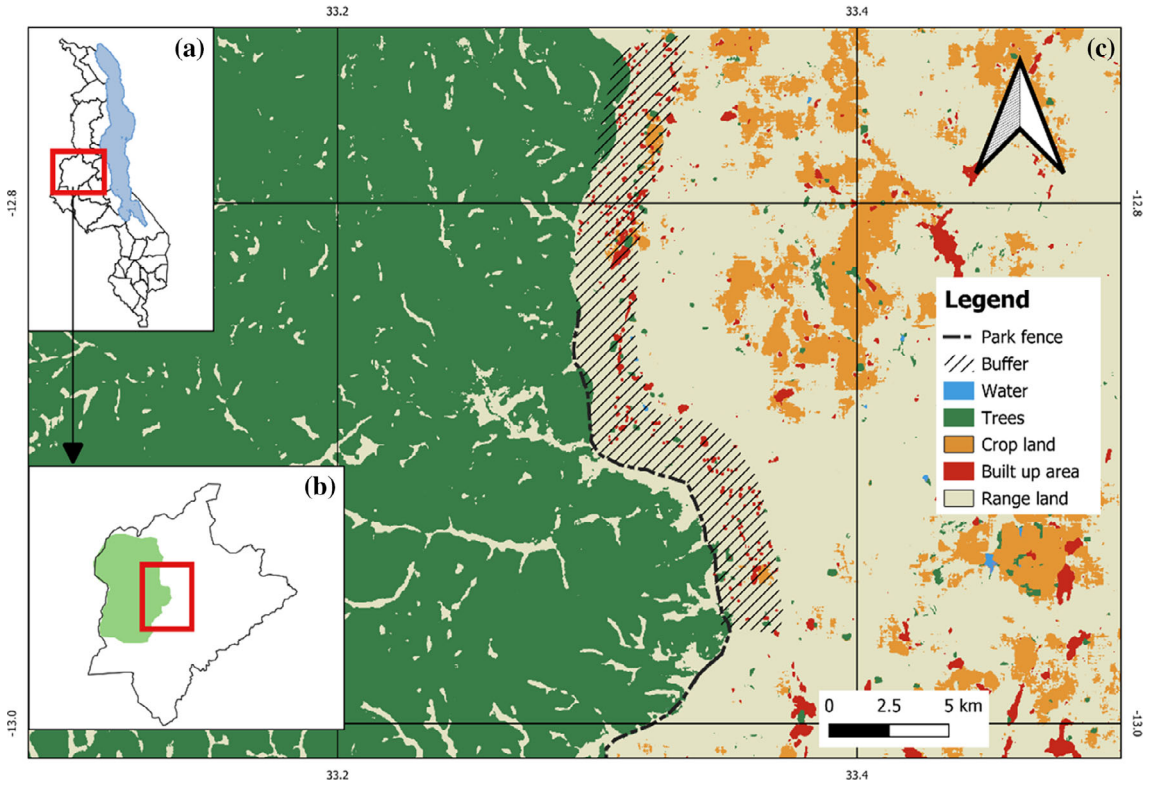

FIGURE 1 Map of Malawi indicating the general location of the Kasungu National Park (A), shown in green on panel B, and the various land uses along the eastern park boundaries (C). Land cover reflects conditions for 2023, based on ESRI (2023). *Source*: Author.

establishment in 1970. Despite its legal protection, the park has faced persistent encroachment, particularly cultivation within its 75 km long, 2.1 km wide buffer zone, where farming, hunting, and settlement are prohibited (Davis et al., 2023; Mkanda & Munthali, 1994).

Between 2017 and 2022, Kasungu National Park (KNP) authorities constructed an 87.5 km electrified fence along the park's eastern boundary to reduce what they described as "elephant raids" and "wildlife crimes." In parallel, 263 elephants and 431 other species were translocated by the park authorities (i.e., Department of National Parks and Wildlife) with their stated aim being to restore wildlife population. While fencing reportedly reduced livestock predation and crop damage in fenced areas, it intensified human-wildlife conflict along unfenced boundaries (Mandoloma et al., 2025). Construction was halted by the authorities in late 2022 amid boundary disputes and community concerns over farmland loss and escalating risks. With Malawi's Wildlife Policy (GoM, 2017) offering no provision for compensation for wildlife damage, tensions between park authorities and surrounding communities have since increased (Mandoloma, personal observation; https://mwnation.com/fencing-out-the-vulnerable/).

2.2 | Scenario development

We developed five hypothetical scenarios, along with a Business as Usual (BAU) baseline (Table 1), drawing on insights from previous research (Mandoloma et al., 2025) and a participatory process involving four focus group discussions (FGDs) and seven key informant interviews (KIIs). Focus groups were conducted separately with men and women across villages varying in proximity (close vs. distant) and park boundary type (fenced vs. unfenced) to capture diverse perspectives on conservation, land use, and food security. Participants were prompted to reflect on past and present drivers of change as well as plausible future developments. Key informants, including traditional authorities, local government representatives, park officials, and agricultural extension workers, contributed institutional insights on ongoing policy shifts and socio-ecological dynamics. We operationalized the scenarios through a structured household questionnaire (described in Section 2.3). We piloted the questionnaire with 10 households to test clarity, feasibility, and contextual relevance. Feedback from the pilot informed refinements in wording and framing to improve comprehension and ensure alignment with local realities.

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TABLE 1 Description of each scenario, rationale for inclusion, and hypothesized outcomes based on our pilot studies and previous research.

Scenario name	Description	Rationale for inclusion	Hypothesized outcomes
Business as usual	Current socio-economic, agricultural, and environmental conditions and trends would remain the same over the next 5 years (trends specified by respondents rather than pre-determined).	Provides a baseline for comparison by capturing how respondents expect existing conditions and trends to evolve in the absence of new policy or conservation interventions.	Under BAU, average food security and wellbeing are expected to decline, while reliance on natural resources and tensions with the park are anticipated to increase. These trends reflect ongoing pressures, including climate related stressors such as prolonged dry spells, short rainy season, which respondents reported have intensified over the past 5 years and are expected to continue.
Farm input price	Fertilizer prices increase by 100% over the 5-year period.	Reflects pricing of commodities rising faster than current trends.	The increased cost of fertilizer inputs would decrease access to fertilizer, reducing crop yields and human well-being, and lead to an increase in natural resource use to compensate for lost income. Respondents would consider this to be unfair. It would not affect their relationship with the park.
Universal farm input subsidy	A universal fertilizer subsidy accessible to all farmers.	Addresses limitations of Malawi's current targeted affordable inputs program.	Universal subsidy would increase farmers' access to fertilizer, increase crop yields, food security, and well-being, while reducing their natural resource use. Respondents would consider this to be fair. It would not affect their relationship with the park.
Buffer zone restoration	Restoration of the park buffer zone, requiring some farms to vacate.	Proposed by NGOs and government to curb farmland encroachment, restore vegetation, and reduce wildlife conflict.	Buffer zone restoration would reduce farmland availability, therefore decreasing crop yield and wellbeing, increasing natural resource use and worsening people's relationship with the park. Respondents would consider this to be unfair.
Wildlife translocation	An additional 250 elephants are translocated into the park within 5 years.	This scenario reflects planned wildlife restoration efforts for the park, under which further elephant translocations from other national parks into Kasungu National Park are likely to occur within the next few years.	Wildlife translocation would increase human wildlife conflict, reduce crop yields, and well-being, raising reliance on natural resource use and worsening people's relationship with the park. Respondents would consider this to be unfair.
Wildlife damage compensation	Communities receive compensation for wildlife-related losses.	Identified by communities as a preferred mechanism to mitigate human-wildlife conflict.	Compensation would improve people's food security, well-being and relationship with the park, while reducing natural resource use. Respondents would consider this to be fair.

Note: We asked respondents how each scenario would affect their food security, resource use, park relations, and well-being, as well as perceived fairness.

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The final scenarios integrated biophysical and socio-economic dimensions, representing plausible changes in conservation investments, market dynamics, and welfare interventions. They were designed to elicit not only approval or disapproval but also perceptions of fairness, anticipated trade-offs, and likely behavioral responses (e.g., land expansion, resource extraction, livelihood diversification), as well as broader implications for food security, natural resource use, wellbeing, and people–park relations. We discuss the limitations of scenario framing, implications of potential response biases and the challenges of eliciting nuanced responses concerning trade-offs in Section 4.4.

2.3 | Study design

We randomly selected 12 villages from a list previously surveyed on human-nature interactions (Mandoloma et al., 2025). Six villages were within 0–5 km of the park boundary (three fenced, three unfenced), and six were 6–15 km away (also evenly split between fenced and unfenced) (see Appendix S1). We categorized these as fenced-close, fenced-distant, unfenced-close, and unfenced-distant. The 5 km threshold between "close" and "distant" villages reflects both logistical considerations and prior evidence that wildlife-related damage is concentrated within a few kilometers of the park boundary (Mandoloma et al., 2025).

We surveyed a total of 317 households using proportional stratified random sampling. We sampled approximately 20% of households in each village, proportional to village size. Within villages, we randomly selected households from a complete household list to avoid bias. We interviewed one primary respondent per household, usually the household head or another adult with detailed knowledge of livelihoods, food security, and land use. Although we aimed for gender balance, women were more frequently available during survey times, leading to greater female representation, a potential source of bias we acknowledge in interpreting results.

We asked the respondents about expected socio-economic and agricultural changes over the next 5 years under a Business as Usual (BAU) scenario followed by the five alternative scenarios, presented in a random order to avoid bias and minimize order effects (Newing et al., 2011). For each scenario, we asked how the changes might affect their food security, resource use, community-park relations, and well-being, and how they would respond and adjust their behavior. Behavioral intentions (including no change, income diversification, crop diversification, farm expansion, making manure, planting trees, shifting farmlands, reducing farmland, irrigation, migration, and others) were collected using pre-defined options generated during focus groups and the pilot study. We measured perceptions of fairness using a five-point Likert scale (1 = very unfair to 5 = very fair), along with open-ended questions to understand their reasoning. All interviews were conducted in Chichewa, the local language.

We emphasized that the scenarios were purely hypothetical to avoid raising expectations. We defined key terms with respondents before administering the questionnaire to ensure shared understanding. We defined food security as having sufficient food in the household; well-being as a good quality of life; and resource use as the extraction and use of natural resources such as firewood, wild foods, medicinal plants, timber, and thatch from community forests, customary land, or (sometimes illegally) from the park. Community-park relations referred to positive engagement between the residents and the park authorities. Fairness was framed in terms of equity: who benefits, who bears costs, and how decisions are made.

2.4 | Data analysis

We analyzed responses using cumulative link mixed models (CLMM) in the "ordinal" package (Archer, 2015) in R version 4.4.1 (R Core Team, 2024). Models assessed the influence of scenarios on wellbeing outcomes and perceived fairness, with *business-as-usual* (BAU) as the reference category. Predicted probabilities of a decrease, no change, or increase in each dependent variable were calculated for all scenarios. Respondent ID was included as a random effect to account for multiple responses per individual. Graphs were generated using *ggplot2* (Wickham, 2016). To complement quantitative analysis, we conducted a thematic analysis of open-ended responses to understand the reasoning behind scenario evaluations (Braun & Clarke, 2012).

3 | RESULTS

3.1 | Respondent characteristics

The study participants ($n = 317$) were evenly distributed across all four locations: fenced-close ($n = 73$), unfenced-close ($n = 89$), fenced-distant ($n = 76$), and unfenced-distant ($n = 79$) (Appendix S2). Gender was relatively balanced across locations, with 45% of respondents identifying as male and 55% as female. The average age of respondents varied by location, ranging from 38 years in unfenced-close areas to 49 years in unfenced-distant areas. The mean household size was consistently around

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five people across all locations. A majority (83%) of participants identified as Chewa, while 17% were Tumbuka. Most respondents (84%) were married, and levels of formal education were generally low. Approximately 69% of participants had attained primary education, 24% had secondary education, and 7% reported having no formal education.

The primary source of income was farming, reported by 91% of households. Other sources included small-scale business (5%) and casual work (4%). Farming was most prevalent in the unfenced-close location, which also recorded the highest mean land owned (5.9 acres) and farmed (4.9 acres). Across all sites, the average farmed land area was approximately 4 acres, ranging from a minimum of 1 acre to a few outliers farming up to 27 acres. These larger land-holdings were most frequently observed in the unfenced-close and unfenced-distant locations. In all locations, some respondents reported owning more land than they actively farmed, suggesting the presence of fallow land, land rented out, or land allocated for other uses.

Livestock ownership was high, reported by 89% of respondents, with households commonly keeping chickens, goats, pigs, and other small livestock. In terms of settlement duration, most participants (68%) had lived in their respective villages for more than 20 years, with 18% reporting 10–20 years, and 14% reporting less than 10 years.

3.2 | Business as usual

Under the BAU scenario, in which current socio-economic and environmental trends are expected to continue over the next 5 years, approximately 50% of participants across all locations anticipated a decline in food security. The proportion expecting decreased food security varied by location: fenced-close (39%), unfenced-close (73%), fenced-distant (39%), and unfenced-distant (51%). Commonly cited reasons included rising commodity prices, especially for agricultural inputs, and declining productivity. In the unfenced areas, respondents additionally highlighted crop and livestock losses due to wildlife depredation as a major contributor to expected food insecurity. As one farmer noted: "*The animals keep destroying our crops, what we harvest is what remains, which is very little*" (woman, unfenced-close).

Conversely, 38% of respondents anticipated improved food security, attributing this to ongoing adaptation strategies such as crop diversification, planting early maturing and drought-resistant crops, and the use of organic manure as a cost-saving alternative to expensive chemical fertilizers. On average, 11% of respondents across all locations anticipated no change in their food security status.

In terms of natural resource use, 46% of participants expected an increase in reliance on forest and other resources. This was linked to both economic necessities, due to rising living costs, reduced agricultural output, and declining alternative livelihoods. However, 37% of respondents anticipated no change in resource use, stating that their current dependency levels would remain constant. Notably, 17% expected a decrease in natural resource use, especially in close-unfenced areas, citing the implementation of stricter penalties and enhanced security around the national park, from which many currently extract resources illegally. One female respondent from unfenced-close shared: "*We used to go into the park, but now they have tightened the rules. You can be arrested even for collecting firewood*".

Regarding relations with the national park, a majority of respondents in fenced-close, fenced-distant, and unfenced-distant areas (over 80%) anticipated no change. However, in the unfenced-close area, 84% expected deterioration in relations, pointing to increased human–wildlife conflict, stricter enforcement and penalties by park authorities, and ongoing disputes over fence construction and land boundaries following recent wildlife translocations.

Despite the challenges, 63% of respondents across locations believed their wellbeing would improve under the BAU scenario, noting positive early results from adaptation strategies such as income diversification and organic fertilizer use. Meanwhile, 22% anticipated no change, and 15% expected their wellbeing to worsen, often due to deepening poverty or loss of livelihoods. "*Unless things change, I don't see our life improving. Prices are high, rains are poor, and animals destroy crops*," said an elderly woman from the unfenced-close area. Reflecting this tension, 54% of participants perceived the BAU scenario as unfair, linking it to persistent or worsening poverty and food insecurity.

3.3 | Predicted impact of scenarios on food security, resource use, park relations and wellbeing

3.3.1 | Food security

Predicted impacts of scenarios on food security varied considerably (Figure 2). For example, compared to business as usual, the farm-input price increase scenario was expected to significantly decrease food security in all four study locations ($p < .01$, 95% CI: −2.32; −0.77). Respondents anticipated reduced access to inorganic fertilizers, which they consider essential for maintaining crop yields. Many were skeptical that organic fertilizers could offset this reduction, citing limited production capacity: "*Many*

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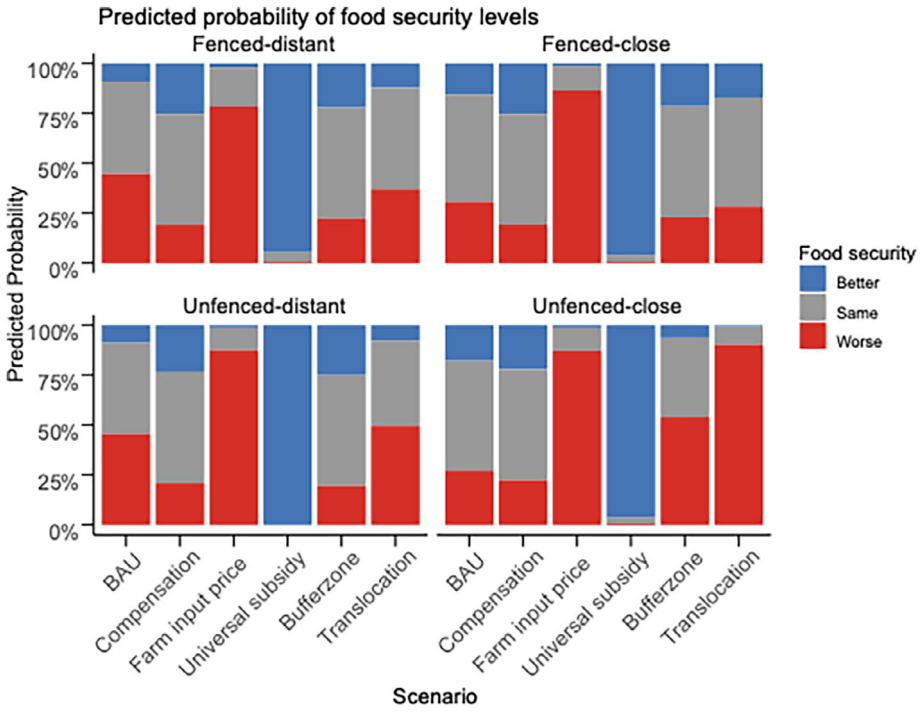

FIGURE 2 Predicted probabilities of perceived food security outcomes under different conservation and livelihood scenarios, disaggregated by household location. Bars represent the categorized responses as worse (red), the same (gray), or better (blue).

of us will have little or no access to inorganic fertilizer, which will lower crop yield, especially for maize. This will mean less food to eat or sell" (male, unfenced-distant).

Under the universal input subsidy scenario, respondents anticipated significant improvements in food security compared to business as usual ($p < .01$, 95% CI: 4.07; 6.38). Better access to farm inputs was expected to increase crop yields and strengthen household food supplies across all locations. The wildlife compensation scenario was also expected to improve food security as it would help household recover from crop losses ($p < .01$, 95% CI: 0.53; 1.90).

There were two scenarios in which location had a substantial influence on perceived outcomes, particularly for respondents in unfenced-close areas, where exposure to wildlife and conservation restrictions is most acute. In both cases, these scenarios involved conservation interventions. The wildlife translocation scenario was expected to worsen food security outcomes in unfenced-close locations ($p < .01$, 95% CI: −4.73; −2.39), as was the buffer zone restoration scenario ($p < .01$, 95% CI: −3.19; −1.24). Respondents in these areas anticipated that translocation would increase crop losses. Meanwhile, the buffer zone scenario was seen as likely to restrict access to farmland, as communities expected conservation restoration activities to displace smallholder agriculture around the park.

3.3.2 | Natural resource use

In most locations, respondents anticipated minimal changes in natural resource use across scenarios (Figure 3). However, in unfenced-close areas, the BAU scenario was associated with a significantly higher likelihood of improved resource use (i.e., reduced extraction pressures and more sustainable practices) ($p < .01$, 95% CI: 0.82; 2.20), while the buffer zone restoration ($p < .01$, 95% CI: −2.38; −0.57), universal subsidy ($p < .01$, 95% CI: −2.72; −0.80), and compensation scenarios ($p < .01$, 95% CI: −2.48; −0.66) were associated with less sustainable or intensified resource use.

These results reflect respondents' perceptions that stricter park enforcement under the BAU scenario encourages more sustainable and responsible use of natural resources, whereas interventions such as buffer zone restoration were perceived to restrict access to forest resources altogether.

3.3.3 | People–park relations

Expectations about changes in people–park relations were also strongly influenced by scenario and location (Figure 4). While participants expected their relationships to generally remain the same, they also expected that the universal input subsidy and compensation scenarios would significantly improve people's relationship with the park [$p < .01$, 95% CI: 0.99; 2.51 and $p < .01$, 95% CI: 0.66; 2.20], respectively. Respondents viewed these scenarios as a fair and inclusive policy compared to BAU, particularly those living close to the park ($p < .01$, 95% CI: 1.54; 3.15): "*Compensation will show the government cares as much for us as for animals*" (woman, fenced-close).

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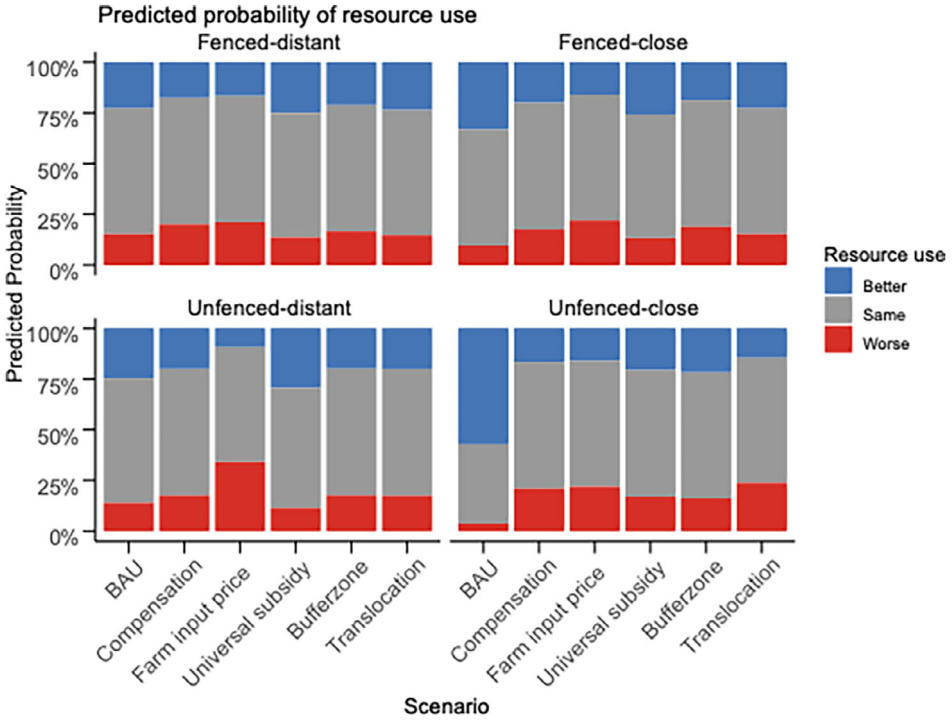

FIGURE 3 Predicted probabilities of perceived resource use under different scenarios, by location. Bars represent the categorized responses as worse (red), the same (gray), or better (blue).

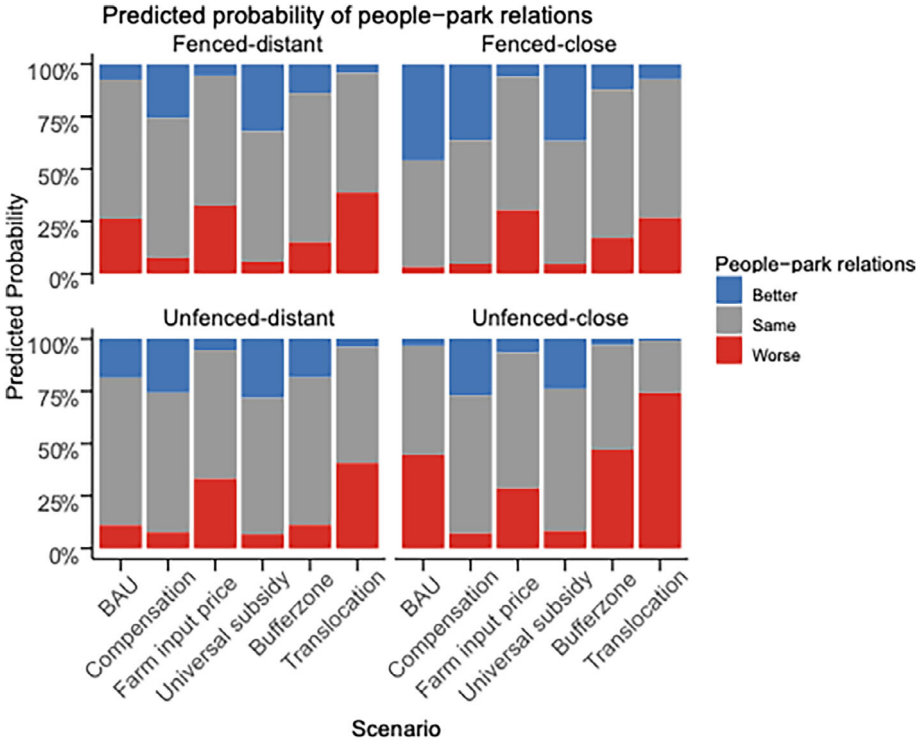

FIGURE 4 Predicted probabilities of people-park relationship under different scenarios, by location. Bars represent the categorized responses as worse (red), the same (gray), or better (blue).

However, respondents also raised concerns about anticipated corruption and underpayment in the compensation scenario: "*Even if I support this compensation, how are these going to be calculated and how will they compensate life*?" (man, unfenced-close).

The buffer zone restoration scenario was expected to significantly worsen the people-park relationship, particularly by those close to the national park ($p < .01$, 95% CI: −3.56; −1.46), where it was perceived as the loss of community land without addressing wildlife damage: "*It's just a way for the park to take land without stopping animals from eating our crops*" (woman, close, unfenced). "*We also want to restore the buffer zone, but where will we live and farm?*" (man, unfenced-close).

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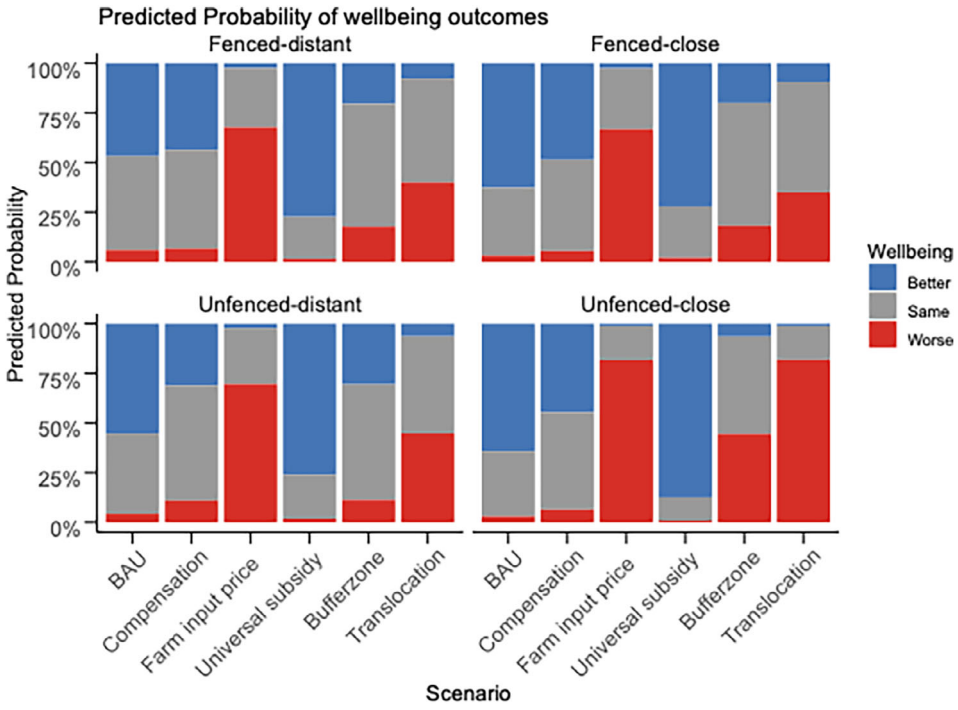

FIGURE 5 Predicted probabilities of people's wellbeing under different scenarios, by location. Bars represent the categorized responses as worse (red), the same (gray), or better (blue). Results highlight universal input subsidy was anticipated to improve people's wellbeing across all locations while increase in farm input subsidy, translocation and buffer zone scenarios would have the opposite effect.

The same trend was seen under the wildlife translocation scenario, where participants from both close and distant areas expected the scenario to worsen the people–park relationship ($p = .10$, 95% CI: −1.38; 0.11), as respondents feared further loss of lives and property.

3.3.4 | People's wellbeing

Regardless of the location, study participants expected their wellbeing to improve under the universal subsidy ($p < .01$, 95% CI: 0.62; 2.09) (Figure 5). By easing access to farm inputs, participants expected the universal subsidy to enable them to achieve higher crop yields, thereby enhancing their livelihoods through income from their crop produce.

In contrast, participants in all locations anticipated that buffer zone restoration ($p < .01$, 95% CI: −1.89; −0.57), translocation ($p < .01$, 95% CI: −3.03; −1.68) and increases in farm input price ($p < .01$, 95% CI: −4.23; −2.80) scenarios would significantly worsen their wellbeing. Although these scenarios were anticipated to directly impact residents in the unfenced-close part of the national parks, people living in the other areas nonetheless thought they would also be indirectly affected, as some of the people living in that area are their relatives.

Overall, unfenced-close communities were consistently the most negatively affected across scenarios, reporting reduced food security, worsened relations between people and parks, and a decline in overall wellbeing. Fenced and distant communities generally reported fewer negative impacts, particularly for buffer zone restoration and translocation, considering that they would be less affected.

3.4 | Perceptions of fairness of scenarios

Overall, the universal input subsidy and wildlife compensation scenarios were perceived as fairer than BAU (Figure 6). In contrast, farm-input price increases, buffer zone restoration, and translocation were viewed as unfair, especially by communities in unfenced areas. While these general patterns were consistent across the four geographical groups, the rationale behind responses varied subtly by proximity and fencing status, as well as by age and gender.

The universal subsidy scenario was viewed as significantly fairer than BAU across all locations ($p < .01$, 95% CI: 1.73; 3.18). Respondents saw this as a major improvement over the existing subsidy program, which they criticized for being prone to input shortages, delayed implementation, and inequitable distribution: "*The current subsidy program sometimes registers people with no place to farm, and they end up selling the coupons to traders. In other cases, one household can have five people receiving coupons, including children, while other households have none, and this causes a lot of inequality and misunderstanding in the communities*" (woman, unfenced-distant).

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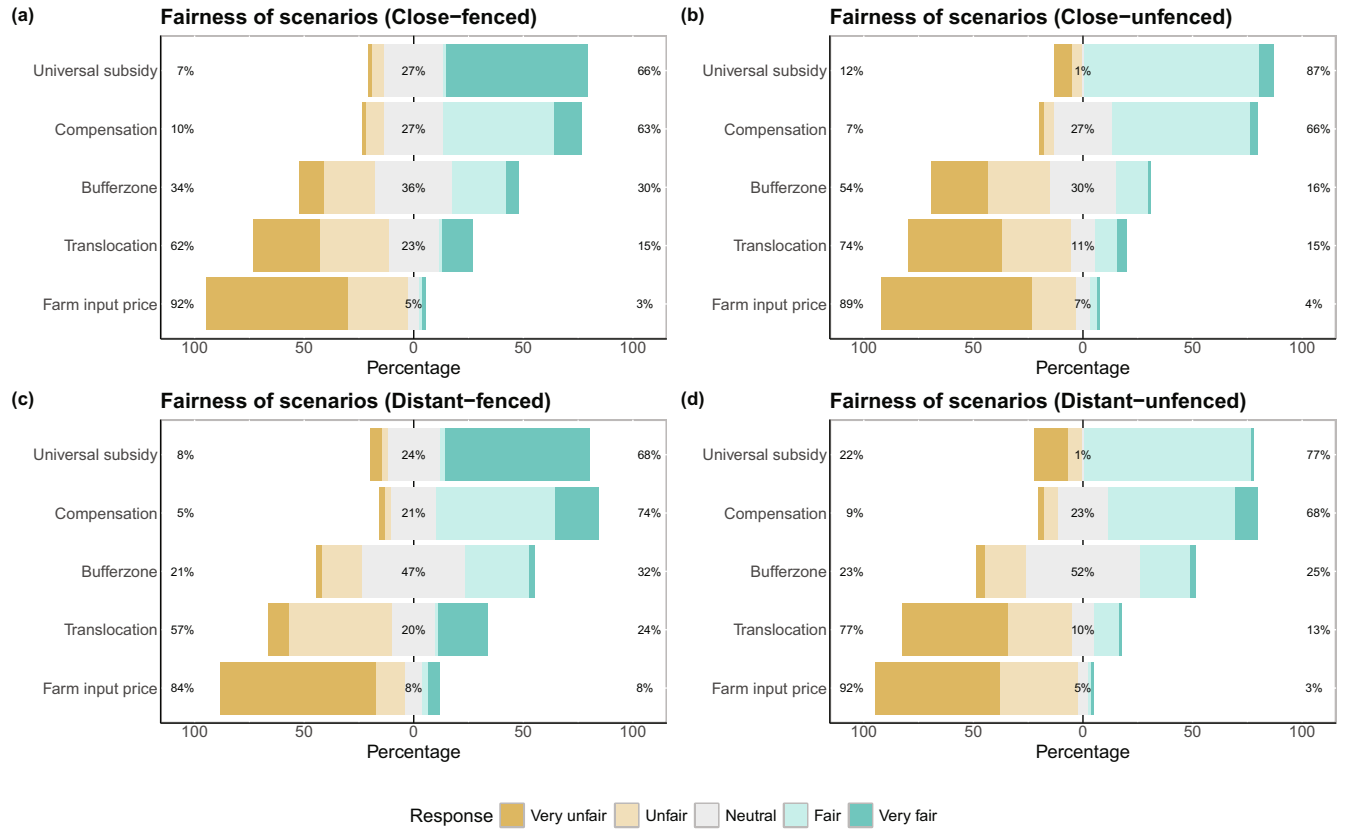

FIGURE 6 Respondents' perspectives on the fairness of scenarios, compared to BAU. While an increase in farm input prices and wildlife translocation scenarios were deemed unfair in all locations, the implementation of universal subsidies and wildlife compensation was seen as fair. The universal subsidy was perceived as particularly fair (compared to the BAU) by those in the fenced area. Perspectives on the fairness of buffer zone restoration varied based on location; respondents close to the park on the unfenced side found it much less fair than those further away or in the fenced area.

Many participants also expressed frustration with the timing of input distributions and the lack of transparency in the selection process, which disproportionately affected low-income and land-dependent households. Although most participants perceived universal subsidy as fair, a minority questioned its feasibility, noting that it would still be unfair if fertilizer was unavailable in local markets due to monopoly by large scale farmers: "*We have seen programs that promise inputs for everyone, but when the time comes, there is no fertilizer in the shops. Farmers with estates buy large amounts from the markets to resell later*" (man, fenced-distant).

The compensation scenario was also seen as significantly fairer than BAU ($p < .01$, 95% CI: 0.78; 2.01). Respondents felt it could promote coexistence by easing the economic burden of human-wildlife conflict and recognizing the community's losses: "*Compensation will show the government cares as much for us as for animals*" (woman, fenced-close).

Despite concerns about corruption, exaggeration of damage, and underpayment, the compensation scenario was still generally preferred over BAU as it was seen to provide tangible financial relief and official acknowledgment of livelihood impacts.

However, several participants also challenged its fairness, arguing than no payment could replace human life and that compensation might encourage people to cultivate close to the park boundary, expecting to be reimbursed: "*You can't compensate life, and if people know they will be paid they will not stop farming near the park*" (man, unfenced-close).

Both the translocation and farm-input price increase scenarios were perceived as unfair across all locations: translocation was deemed unfair by a majority ($p < .01$, 95% CI: −1.78; −0.57), especially on the unfenced side of the park, where 74% of close-unfenced and 77% of distant-unfenced respondents viewed it negatively: "*Another translocation would show the government values animals more than us, especially since the park is failing to*

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manage animals, and people have died from the last translocation" (man, unfenced-distant).

For the farm-input price increase scenario, over 70% of respondents across all locations rated it as unfair ($p <$ .01, 95% CI: −4.99; −2.78), largely due to current struggles affording inorganic fertilizers. This scenario was seen as worsening inequality by limiting access to essential agricultural inputs and increasing food insecurity. Nonetheless, a few respondents perceived potential benefits, suggesting that higher fertilizer prices might encourage adoption of organic manure and more sustainable farming, illustrating diverse ways of reasoning about fairness: "*If fertilizer becomes too expensive, maybe people will go back to using manure, which is better for the soil. It is these inorganic fertilizers that has destroyed the land*" (woman, fenced-distant).

Perceptions of fairness of the buffer zone restoration scenario varied significantly by geography. While 54% of respondents from unfenced-close areas perceived it as unfair, citing the loss of farmland without guarantees of resettlement or compensation, respondents from fenced and distant areas were neutral (e.g., 47% of distant-fenced and 52% of distant-unfenced remained neutral), recognizing the conservation value of the buffer zone: "*This scenario assumes that only park people know the importance of conservation, and we don't, which is untrue. We also want to restore the buffer zone, but where will we live and farm is the question*" (man, unfenced-close).

While some agreed the buffer zone could reduce dangerous encounters with wildlife, concerns over displacement, lack of alternatives, and exclusion from decision-making shaped perceptions of unfairness. A few participants also expressed conditional support, suggesting that if restoration efforts included compensation, they could be viewed as fair. "*If they restore the buffer zone but also give us another place to farm, then it would be fair*" (woman, unfenced-close).

These contrasting perspectives show that while place-based conditions influenced interpretations, shared experiences of vulnerability and mistrust toward conservation interventions often led to convergence in responses across groups.

In terms of demographic factors, older individuals were significantly more likely to perceive scenarios as unfair (Estimate = −0.01, p = .01, 95% CI: −0.02; 0.00). This may reflect accumulated experiences with unmet policy promises or vulnerability to change. Gender also influenced people's responses to scenarios; men were more likely to perceive scenarios as fair, although the effect was only marginally significant (p = .07, 95% CI: −0.02; 0.48), suggesting subtle gendered dynamics in policy perceptions.

3.5 | People's behavioral changes in response to scenarios of change

When asked how they would respond to each scenario (Figure 7), diversifying income was the most common strategy across all villages, particularly under the BAU scenario where 305 out of 317 participants (across all four locations) said that they are expecting to seek alternative income sources. Participants explained that this would include reducing maize farming in favor of crops requiring less inorganic fertilizer (e.g., soy and groundnuts) or engaging in petty trade and labor to supplement income. Crop diversification also emerged as a key strategy under BAU, with many respondents (125/317) noting a shift toward drought-tolerant crops, such as cassava and early maturing maize, as a means to cope with increasingly erratic rainfall and ongoing wildlife depredation.

The comparatively wide range of behavioral responses reported under BAU reflects the fact that this scenario represents a continuation of existing pressures without targeted external support or intervention. In this context, households anticipated relying on multiple, self-initiated coping and adaptation strategies simultaneously, rather than responding to a single dominant driver of change.

In contrast, responses under the alternative scenarios were more targeted.

Farm expansion was the dominant response under the universal subsidy scenario (288/317), where participants said they would expand land under cultivation to maximize yields if fertilizer became more affordable. Making manure was the dominant response under the farm input price increase scenario (237/317), with respondents noting this as a necessary adaptation in the face of rising input costs.

Migration and shifting farmland emerged as more location-specific strategies, particularly in close and unfenced villages which border the national park, and were most pronounced under the wildlife translocation and buffer zone restoration scenarios. Chi-squared analysis (Table C6 in Appendix S3) confirmed that shifting farmland ($\chi^2(3) = 126.38$, $p < .01$) and migration ($\chi^2(3) = 23.20$, $p < .01$) were significantly more common in close and unfenced locations. Other behavioral responses included irrigation farming, food budgeting, family planning, and planting trees.

4 | DISCUSSION

4.1 | Scenario impacts on food security, resource use, park relations and wellbeing

Our findings highlight the complex and sometimes contradictory ways in which conservation and development

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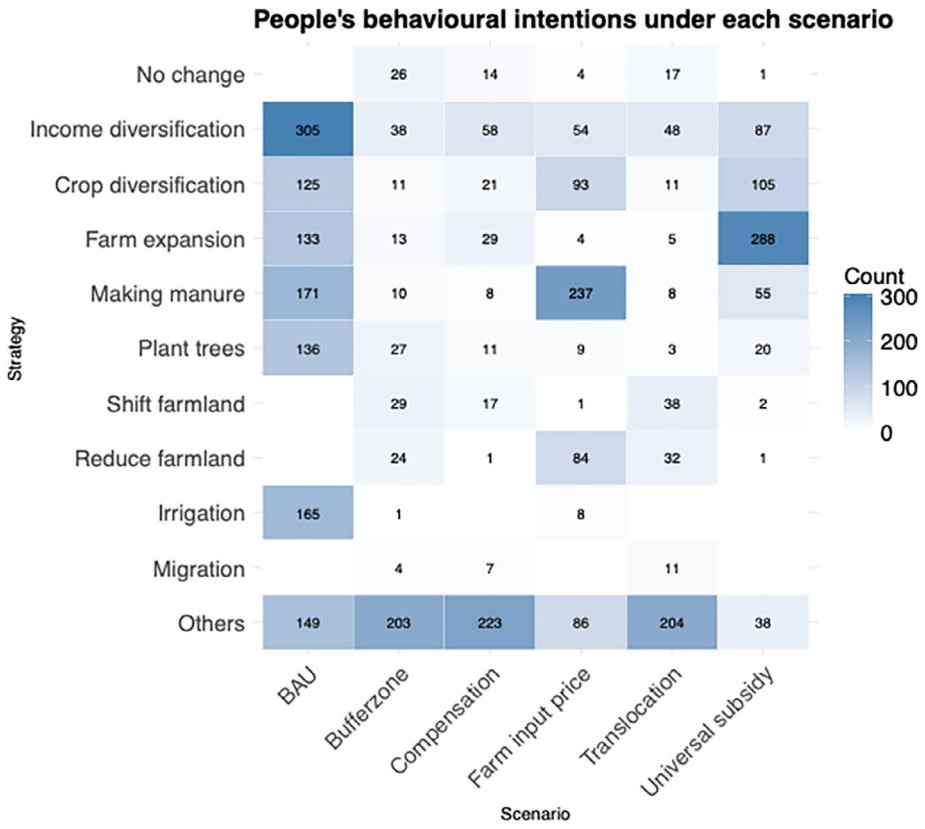

FIGURE 7 Heatmap of behavioral intentions in response to six land-use scenarios across all four locations ($n = 317$). Darker shades indicate higher uptake of specific strategies under each scenario. While income diversification, making manure, and farm expansion were common across all locations under BAU, input price increases and universal subsidy scenarios, strategies such as shifting farmland and migration were particularly concentrated in close unfenced areas under the translocation and buffer zone restoration scenarios.

intervention can shape food security, natural resource use, people-park relations, and wellbeing. Among the scenarios tested, the farm input price increase scenario demonstrated the most detrimental effects compared to the BAU baseline. This scenario was associated with both declines in both food security and wellbeing across all four study locations. Respondents attributed these effects to the anticipated inaccessibility of inorganic fertilizers, already viewed as prohibitively expensive under prevailing production constraints. These concerns resonate with wider evidence across sub-Saharan Africa, where rising input costs have been shown to erode smallholder resilience, deepen inequalities, and increase reliance on subsistence strategies, undermine household resilience and adaptive capacity (Pangapanga-Phiri et al., 2025; Wunder et al., 2014).

Although input price increase did not alter overall levels of natural resource use, communities adjacent to unfenced park boundaries anticipated increased extraction, suggesting a compensatory reliance on natural resources to buffer farm-level losses. This coping strategy reflects the role of forests and parklands as critical safety nets during agrarian stress, a phenomenon widely documented in Malawi and beyond (Kamanga et al., 2009; Salerno et al., 2021; Vallin et al., 2025). Similar dynamics have been observed in South Africa, Botswana, and Mozambique, where households intensify reliance on wild foods, fuelwood, or timber when agricultural productivity falters (De Boer & Baquete, 1998; Thondhlana et al., 2012; Twyman, 2001). Importantly, respondents also linked this scenario to heightened tensions with the park, highlighting the ways that agrarian distress and wildlife-induced losses can interact to fuel human–wildlife conflict (Mandoloma et al., 2025; Salerno et al., 2021). Such interactions highlight the complex impacts that broader exogenous changes, such as agrarian and market dynamics, can have due to the interrelationship between conservation and food security outcomes.

In contrast, the universal farm input subsidy scenario was widely seen as transformative, with respondents anticipating significant improvements in food security due to expansion of their farmlands, wellbeing, and park relations. Beyond material benefits, the scenario was valued for its perceived fairness, particularly in comparison to Malawi's current targeted subsidy program, which is often criticized for exclusion, corruption, and inefficiency. This emphasis on fairness echoes findings that distributive justice and transparency often matter as much as material benefits in shaping perceptions of interventions (McDermott et al., 2013; Reed et al., 2009). Yet, broader evidence also suggests that universal subsidies can lock smallholders into input-intensive production systems, driving agricultural expansion and threatening

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habitats (Ceddia et al., 2014; Meyfroidt, 2018). These tensions highlight a recurring dilemma where policies that secure short-term food security may inadvertently deepen long-term trade-offs with conservation.

Compensation for wildlife-induced losses scenario was also viewed positively, particularly for its potential to alleviate conflict and symbolically acknowledge the burdens that local communities bear on behalf of broader conservation goals. Respondents indicated that compensation represented an important recognition of justice, responsibility, and reciprocity. Similar findings have previously been reported where compensation schemes reshaped community attitudes by recognizing conservation-related risks (Braczkowski et al., 2023; Kansky et al., 2021). Yet skepticism about corruption, underpayment, and bureaucratic inefficiencies tempered enthusiasm. These concerns are not unique to Malawi; globally, compensation schemes have often been criticized for poor governance and limited sustainability (Kalenga et al., 2024; Rondeau & Bulte, 2007). As such, while compensation can reduce immediate tensions, it is unlikely to serve as a standalone solution without broader reforms in governance and accountability.

The elephant translocation scenario generated strong and widespread opposition. Respondents cited recent experiences of translocations that were associated with crop losses, livestock depredation, and heightened risks to human safety. For many, this intervention represented the prioritization of wildlife over human lives, reinforcing perceptions of unfairness and neglect. Such responses mirror findings from southern Africa where elephant movements, whether natural or human-facilitated, have intensified conflict and eroded community trust (Hoare, 2015; Mutanga et al., 2015; Songhurst et al., 2016). These concerns underscore the risks of conservation-led interventions that externalize costs onto local people without robust mechanisms for risk-sharing (Büscher & Thakholi, 2024).

The buffer zone restoration scenario produced more varied and spatially differentiated responses. In some locations, respondents expected ecological benefits such as stabilized rainfall, improved soil fertility, and enhanced agricultural resilience, reflecting broader evidence that ecological restoration can generate co-benefits for agriculture (Fedele et al., 2021; Lemenih & Kassa, 2014). For example, for participants from the fenced side close to the park, the existing barrier between the park and their farms meant that buffer zone restoration was unlikely to directly affect their land. Some even saw it as beneficial, helping to limit wildlife incursions and protect crops. In contrast, unfenced–close respondents live and farm within what is formally designated as the buffer zone, so its restoration would entail direct loss of farmland and restricted access to resources.

This distinction helps explain why the unfenced–close group viewed the scenario as particularly unfair and threatening, while other groups were more neutral or supportive. In the unfenced-close area, restoration was seen as undermining both food security and wellbeing, primarily due to anticipated restrictions on farmland and the absence of credible measures to address wildlife conflict, leaving households doubly exposed. Such divergent perceptions reflect the uneven distribution of conservation costs and benefits, well-documented in African land-use interventions (Meyfroidt et al., 2022; van Velden et al., 2020). For communities already marginalized by proximity to unfenced park boundaries, restoration was not perceived as resilience-building but as an extension of exclusion. These findings strengthen arguments for participatory approaches to restoration that explicitly address equity, fairness, and accountability (L'Roe et al., 2023; Salerno et al., 2021).

4.2 | Location and demographic influences

Geographic location strongly shaped scenario perceptions, with close-unfenced communities consistently reporting greater vulnerability. These households anticipated more negative impacts on food security, resource use, and fairness, reflecting the compounded pressures of limited land access, heightened exposure to wildlife, and fewer livelihood alternatives. Such patterns are consistent with research across southern Africa showing that communities adjacent to protected areas often shoulder disproportionate burdens from conservation interventions while receiving limited benefits (Merz et al., 2023; Mogomotsi et al., 2020). In contrast, distant or fenced communities were more optimistic about interventions such as buffer zones, benefitting from ecological spillovers without direct exposure to risks. This divergence underscores the importance of recognizing conservation landscapes as socially differentiated, where location fundamentally structures opportunities and vulnerabilities (König et al., 2021; Pailler, 2018).

Demographic factors also influenced perceptions. Older respondents were more likely to view interventions as unfair, potentially reflecting accumulated experiences with failed or inequitable projects, a trend also documented in other landscapes including in Zimbabwe and South Africa (Mutanga et al., 2015; Shackleton & Shackleton, 2006). Gender differences were subtler but suggestive: men were marginally more likely to perceive scenarios as fairer, potentially reflecting differential exposure to risks (e.g., crop protection, resource collection) as well as greater involvement in, or access to, local

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decision-making forums where conservation interventions are discussed and negotiated. Previous studies have also shown that women's perspectives on conservation interventions are shaped by their central role in household food security and resource collection, which makes them particularly sensitive to restrictions on land and resource access (Kiptot et al., 2014; Vasquez & Sunderland, 2023; Westerman, 2021). These findings point to the need for inclusive and intersectional approaches that avoid treating "the community" as homogenous, recognizing instead how age, gender, and location interact to shape perceptions and vulnerabilities (Axelrod et al., 2022; Erwin et al., 2021).

Across scenarios, however, behavioral and attitudinal responses were broadly consistent among the four location-based groups, with only limited variation between fenced and unfenced or close and distant communities. This convergence likely reflects shared livelihood dependencies, similar exposure to national agricultural and conservation policies, and dense social and economic connections across villages. These common experiences appear to shape people's priorities for reconciling food security and conservation more strongly than geographical or boundary differences alone. Where differences did emerge—most notably the stronger opposition to buffer zone restoration among unfenced–close respondents—they were rooted in direct exposure to land and resource restrictions rather than fundamentally divergent values or attitudes. The diversity of behavioral responses observed under the BAU scenario reflects a form of adaptive capacity rooted in flexibility and self-reliance, whereby households anticipate combining multiple low-regret strategies in the absence of targeted policy support.

4.3 | Implications for policy and practice

The findings highlight a central challenge: no intervention provides a panacea for simultaneously advancing food security, wellbeing, and biodiversity conservation (Estrada-Carmona et al., 2024). Interventions that deliver livelihood benefits, such as subsidies or compensation, risk creating ecological trade-offs, while interventions designed primarily for conservation, such as translocations or buffer zones, can erode legitimacy if their social costs fall unevenly on vulnerable groups. This tension is not unique to Malawi. Across Africa, from community-based natural resource management in Namibia, Botswana and Zimbabwe (Dressler et al., 2010; Foyet, 2024; Kansky, 2022), to payment for ecosystem services in Uganda (Jayachandran et al., 2017), interventions succeed when they embed fairness and fail when they ignore inequities.

Policy responses must therefore move beyond simplistic binaries of "conservation versus development." Integrated strategies that explicitly navigate trade-offs and seek synergies are needed, guided by principles of equity, participation, and local ownership (Estrada-Carmona et al., 2024; Fischer et al., 2017; König et al., 2021). Evidence from Kenya and Tanzania shows that interventions co-designed with communities foster trust, enhance legitimacy, and improve both conservation and livelihood outcomes (Matiku et al., 2013; Pas et al., 2023; Sambu, 2025). Such findings underscore the importance of developing scenarios and strategies in partnership with local communities, rather than imposing them externally, with shared responsibility for implementation and evaluation.

This imperative is amplified by global agendas such as the "30 by 30" target (Convention on Biological Diversity [CBD], 2022). While ambitious, these goals will falter if pursued through exclusionary models that replicate the injustices of earlier conservation paradigms (Ghoddousi et al., 2022; Langhammer et al., 2019). Their durability will depend on the social contracts that underpin them (Sandbrook et al., 2023; Sibanda et al., 2025). Embedding fairness, both procedural and distributive, into conservation policy is thus not optional but fundamental.

4.4 | Limitations and future research directions

There are several limitations in this study that we acknowledge and offer important directions for the future. First, spatial proximity to the park may interact with other unmeasured factors, such as land tenure status or local governance dynamics. Perceptions are likely to be affected by previous exposure to the scenario elements, such as previous wildlife conflicts or interactions with park staff. These underlying structural and historical differences are likely to affect responses but are not captured by our explanatory variables. While we captured some of this complexity through focus groups and key informant interviews, future research could explore more deeply how these lived experiences shape expectations, particularly among those living in the close-unfenced areas, where differences were most pronounced.

Second, while the use of ordinal outcome variables (e.g., "worse", "same", "better") offered an interpretable structure for capturing perceptions, it may have constrained the nuance of participant views. Some respondents may have found these categories too coarse to express complex or ambivalent opinions, especially regarding trade-offs between ecosystem protection and livelihood outcomes. Additionally, the models were confined to main effects due to sample size issues, and we

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had to focus on a few simple scenarios to keep cognitive load to acceptable levels. This meant we could not capture interactions between explanatory variables, or between scenarios. However, we balanced this quantitative simplicity by asking participants to explain why they made the choices they did, providing deeper understanding into their rationale and mechanisms underlying responses. By combining quantitative scenarios with qualitative explanations of why people responded as they did, in a mixed-methods approach, we were able to generate a robust foundation for understanding how people see the future and how different external factors may shape social and ecological outcomes for the area.

5 | CONCLUSION

This study highlights the importance of basing conservation and development strategies on local realities. Community perspectives in Kasungu reveal that interventions, whether aimed at improving food security, addressing human-wildlife conflict, or expanding conservation efforts, carry varied and sometimes unequal impacts across social and spatial lines. Scenarios such as universal input subsidies and wildlife compensation were widely perceived as fair and beneficial to food security and wellbeing. In contrast, others, like translocation and buffer zone restoration, were viewed as unjust, particularly by those in more vulnerable locations.

Effectively navigating the trade-offs between biodiversity conservation and human wellbeing requires more than technical solutions. It calls for participatory policy design that centers equity, recognizes historical grievances, and respects local livelihoods. Conservation initiatives, particularly those involving land-use restrictions or wildlife management, must be implemented with mechanisms to mitigate livelihood losses and ensure community support. Similarly, external actors seeking to implement conservation efforts, such as translocations or buffer zone restoration, should consider and mitigate potential negative impacts on local livelihoods and perceptions of fairness.

This study emphasizes integrating local perspectives in policymaking. Understanding community values and trade-offs is key to designing effective, context-specific interventions. Sustainable agriculture and conservation-friendly incentives must align food security with biodiversity goals. Involving communities in decision-making ensures policies reflect local needs. Ultimately, balancing food security and biodiversity conservation in Kasungu and similar contexts requires collaborative efforts from policymakers, local stakeholders, and conservation practitioners to navigate trade-offs and promote sustainable development.

AUTHOR CONTRIBUTIONS

LM, MC, KH, LC, and EJMG conceptualized ideas and designed the study. LM collected the data. LM and HT carried out the analysis, and all authors discussed the results. LM led the writing of the manuscript with input from all authors.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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DATA AVAILABILITY STATEMENT

Anonymized data may be made available upon request to the corresponding author.

ETHICS STATEMENT

The Oxford University Research Ethics Committee (CUREC) (R79246/RE002) approved the study. The Malawi Department of National Parks and Wildlife issued a research permit (Ref: DNPW 10/10/14).

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