Satisfaction of households in surrounding communities of protected areas with economic compensation for wildlife accidents: a case study of Xishuangbanna National Nature Reserve in China

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Abstract

Purpose – This study aims to investigate the satisfaction of farmers with the compensation policy for wildlife-caused damages and its influencing factors, analyze the current situation of satisfaction with the compensation policy among farmers, identify factors significantly affecting satisfaction, and explore ways to optimize the compensation policy and improve the satisfaction of farmers based on the effects of various influencing factors.

Design/methodology/approach – The Xishuangbanna National Nature Reserve in Yunnan Province, China, is selected as the research area for the study. Through field interviews, 370 valid questionnaires were collected to obtain relevant data on farmers' satisfaction with the compensation policy for wildlife-caused

damages. The Oprobit model is utilized to explore the factors influencing farmer satisfaction and to analyze their underlying reasons.

Findings – The study reveals that farmers in the communities surrounding the Xishuangbanna National Nature Reserve generally experience low satisfaction with the compensation policy, particularly concerning satisfaction with compensation amounts, which tends to be dissatisfied on average. Satisfaction with the compensation policy is significantly influenced by individual characteristics and household labor structure, while the degree of human-wildlife conflict, wildlife conservation attitudes and household income structure have insignificant impact. Among individual characteristics, gender, education level, health status, and ethnicity are highly significant. In household labor structure, the number of agricultural laborers, non-agricultural laborers, and household agricultural labor time are highly significant.

Originality/value – Building on the overall satisfaction of farmers with the compensation policy, this study further decomposes policy satisfaction into satisfaction with compensation amounts, coverage, and procedures. It provides more targeted recommendations for enhancing satisfaction with the compensation policy, which can help effectively mitigate human-wildlife conflicts and achieve harmonious coexistence between humans and nature.

Keywords Human-wildlife conflict, Wildlife-caused damages compensation, Policy satisfaction

Paper type Research paper

1. Introduction

Species balance plays a crucial role in achieving ecosystem functionality (Viswanathan *et al.*, 2024). Loss of biodiversity will have negative impacts on ecosystem functionality (Huang *et al.*, 2024). Therefore, exploring how to mitigate the global biodiversity crisis and maintain ecosystem functionality is a current research hotspot. Tropical rainforests are vital terrestrial ecosystems that make significant contributions to biodiversity and also hold substantial economic value, serving as an important source of income for many households (Yang *et al.*, 2023). Xishuangbanna Dai Autonomous Prefecture in Yunnan Province, China, is home to the largest area of tropical rainforest in China and is also an important rubber-producing region. Driven by the lucrative profits of rubber production, the area of rubber plantations in Xishuangbanna has expanded rapidly (Yi *et al.*, 2014), leading to severe deforestation of natural forests and causing a sharp decline in the ecological functions and biodiversity of tropical rainforests (Guo *et al.*, 2002). China is one of the earliest signatories and ratifiers of the Convention on Biological Diversity and attaches great importance to biodiversity conservation. With the emergence of the biodiversity crisis, the Chinese government has gradually strengthened its efforts in ecological protection. Guided by the concept of sustainable development and the harmonious coexistence of humans and nature, Xishuangbanna has implemented ecological restoration and biodiversity conservation measures, enhancing the construction and protection of nature reserves. With the formulation, implementation, and improvement of policies and regulations related to ecological protection, the forest coverage area in Xishuangbanna has expanded, reaching 80% forest coverage, and biodiversity has significantly recovered, effectively protecting various rare wildlife species [1].

The recovery and increase in the population of wildlife species have led to the continuous expansion of their habitat, inevitably overlapping with human activity areas, resulting in widespread human-wildlife conflicts, particularly in rural areas within nature reserves, where such conflicts are frequent (Fang *et al.*, 2021). These conflicts have severely damaged the lives and properties of local farmers. Previous studies have typically classified human-wildlife conflicts into four categories. The first category involves damage to crops, with much large herbivorous wildlife feeding on crops, causing significant losses (Mauri *et al.*, 2020). The second category pertains to harm inflicted on livestock, with some carnivorous wildlife preying on poultry and livestock. The third category involves threats to human safety, especially from large and venomous wildlife, endangering human lives (Li *et al.*, 2018). The fourth category involves damage to other properties, such as vehicles and houses (Nezval and Bíl, 2020; Feng *et al.*, 2023). In China, human-elephant conflicts are the most severe type of human-wildlife

conflict (Li *et al.*, 2018), predominantly occurring in Xishuangbanna Dai Autonomous Prefecture (Chen *et al.*, 2016). Over the past few decades, conservation measures for Asian elephants in Xishuangbanna have yielded significant results, leading to an increase in the elephant population (Chen *et al.*, 2016). Meanwhile, the increasing population of Asian elephants has resulted in relative scarcity of food and habitat (Feng *et al.*, 2023). In search of abundant food and suitable habitats, Asian elephants have continually expanded their range into human activity areas, resulting in incidents where elephants damage crops, attack humans, and even cause casualties (Bandara and Tisdell, 2003). While biodiversity conservation is undeniably crucial for maintaining ecosystem stability and has positive implications for regional and national sustainable development, local farmers have suffered significant losses to their private property and safety due to threats from wildlife (Bhushal *et al.*, 2024; Karanth *et al.*, 2018). Ma *et al.* (2023) studied the costs of human-wildlife conflicts in the Giant Panda National Park and found that the explicit costs of conflicts were as high as $952.6 per capita, accounting for 7.2% of per capita net income. Considering the implicit costs, the actual costs of human-wildlife conflicts far exceed the estimates. Poudel *et al.* (2022) investigated human-wildlife conflicts in the Himalayas and found that the average household loss caused by wildlife predation was $422.5, equivalent to 23.28% of annual income for some families. Barua *et al.* (2013) studied the hidden costs of human-wildlife conflicts in low-income countries and found that major hidden costs included declines in mental health, production interruptions, and food insecurity.

There are typically two methods to reduce losses for farmers (Fang *et al.*, 2021). The first method involves implementing crop protection measures, which aim to protect farmers' assets by repelling or preventing wildlife from damaging crops. Karanth *et al.* (2013) studied 7,449 households within a 1,972 kilometers area of the Western Ghats protected area in India and found common protective measures such as night patrols, fencing, and deterrent devices. The second method is to provide economic compensation to farmers. Compensation plays a crucial role in ecologically sustainable protection by alleviating the economic burden on farmers after wildlife damage and increasing farmers' tolerance towards the offending wildlife. Lack of compensation for human-wildlife conflicts may lead to extensive killing of wildlife (Bulte and Rondeau, 2007; Karanth *et al.*, 2018). In India, from 1994 to 2006, many elephants were poisoned by farmers due to crop damage (Bulte and Rondeau, 2007). Therefore, establishing a robust wildlife incident compensation policy and effectively implementing compensation measures are crucial for wildlife protection.

To alleviate human-wildlife conflicts, many countries and regions have implemented economic compensation policies for wildlife incidents. In India, the initial purpose of wildlife incident compensation was to protect rare wildlife such as tigers and elephants. Compensation effectively alleviated residents' hostile sentiments towards these rare wildlife species and increased residents' tolerance towards wildlife (Nkansah, 2023). Specifically, the autonomy of wildlife management policies in Indian states is relatively strong, and relevant departments in each state can formulate compensation plans based on their specific circumstances within the framework of national policies (Karanth *et al.*, 2018). In Nepal, to protect large wildlife and mitigate losses for farmers, a compensation policy was introduced in 1999 and subsequently revised in 2009, 2015, and 2017, gradually expanding the scope of compensation and increasing compensation amounts (Bhushal *et al.*, 2024). However, many regions still have imperfect wildlife damage compensation systems. Research by Karanth *et al.* (2013) in the Western Ghats of India found that only 31% of households received compensation, with most farmers relying solely on protective measures to prevent wildlife incidents. The compensation system suffers from information asymmetry issues and may be inefficient due to factors such as government corruption and moral hazard behavior among farmers, leading to difficulties in obtaining compensation, long processing times, and inadequate compensation levels (Maclennan *et al.*, 2009; Dobšinská *et al.*, 2024). Therefore, it is necessary to study farmers' satisfaction with compensation policies to assess

the perceived effectiveness of wildlife incident compensation policies. This study investigates farmers' satisfaction with compensation for wildlife incidents and aims to: (1) evaluate the satisfaction of residents in communities surrounding nature reserves with economic compensation policies for wildlife incidents; (2) analyze the factors influencing farmers' compensation satisfaction; and (3) propose recommendations for optimizing compensation policies.

2. Study area and methods

2.1 Study area

Xishuangbanna Dai Autonomous Prefecture is one of the eight autonomous prefectures in Yunnan Province, China. It is located between 21°10′ to 22°40′ north latitude and 99°55′ to 101°50′ east longitude, situated on the northern edge of the tropics. The climate is warm and humid throughout the year, with distinct dry and wet seasons. Covering an area of 19,096 square kilometers, it has a border length of 966.29 kilometers. The highest point is 2,429 meters above sea level, while the lowest point is 477 meters above sea level. The total permanent population of the prefecture is 1,308,000, with 794,200 belonging to ethnic minorities, including the Dai, Han, Hani, Yi, and Lahu ethnic groups [2].

Xishuangbanna Dai Autonomous Prefecture has a forest area of 1,555,000 hectares, with two national nature reserves, Xishuangbanna and Naban River Basin, distributed within its territory. The Xishuangbanna National Nature Reserve, located in the southern part of Yunnan Province, spans Jinghong City, Menghai County, and Mengla County, covering a total area of 2,425 square kilometers, which accounts for 12.68% of the prefecture's land area. It is the region with the largest tropical forest area, the most intact ecosystem, and the widest distribution of Asian elephant populations in China. The Xishuangbanna National Nature Reserve was also one of the first natural reserves established in China and joined the UNESCO Man and the Biosphere Programme in 1993. The prefecture is home to many rare and endangered wildlife species, including Asian elephants, sambar deer, Indian bison, and white-cheeked gibbons (endangered), totaling 183 species, with 40 species classified as national first-level protected wildlife. It also protects numerous plant species, including the hopea tree and Xishuangbanna green plum, with over 3,829 species, including 116 nationally protected species and six first-level protected species [3].

Xishuangbanna Prefecture attaches great importance to ecological conservation and has also focused on improving measures for compensating for wildlife damage. In 2009, it took the lead in incorporating wildlife incident insurance into commercial insurance payouts, providing a model experience for further promoting public liability insurance for wildlife incidents in China. The Forestry and Grassland Bureau of Xishuangbanna Prefecture has specified the compensation standards for wildlife public liability insurance in 2023, including standards for compensation for personal injury, crops, economic crops, livestock, poultry, fish, and house damage [4]. In 2023, Xishuangbanna Prefecture allocated a total of 34,650,000 yuan for wildlife public liability insurance and completed compensation for 14,502 wildlife incidents, including 11,986 incidents involving Asian elephants, with a total compensation amount of 27,198,000 yuan. These efforts have played a role in alleviating human-wildlife conflicts and promoting harmonious coexistence between humans and nature [5].

2.2 Data and methods

2.2.1 Data source and questionnaire. This study selected the Xishuangbanna National Nature Reserve as the research area and collected data on the satisfaction of farmers with compensation for wildlife incidents and related influencing factors through household surveys. The research findings are expected to be representative. The household survey

questionnaire included various aspects such as individual characteristics, family labor characteristics, family income, characteristics of wildlife incidents and economic losses, compensation amounts, satisfaction with compensation policies, and farmers' support for wildlife conservation. The questionnaire design adhered to principles of scientific rigor and simplicity. Specifically, for individual characteristics, data were collected on age, gender, education level, homeowner status, marital status, physical health status, political affiliation, ethnicity, and whether the respondent served as a village cadre. For family labor characteristics, data were collected on the number of agricultural laborers, non-agricultural laborers, and agricultural labor time. Regarding family income, data were collected on net operating income, net property income, net transfer income, and wage income. Information on wildlife incident characteristics included the frequency of wildlife incidents, total economic losses, compensation amounts, and support for wildlife conservation. The process of collecting the questionnaire followed principles of authenticity and effectiveness. Through a one-month field survey, a total of 370 valid household questionnaires were obtained from the Xishuangbanna National Nature Reserve.

2.2.2 Measurement. The research focuses on exploring various factors influencing the satisfaction of farmers with compensation for wildlife incidents. Previous studies on ecological compensation satisfaction have indicated that the level of understanding of compensation policies, satisfaction with compensation amounts, and policy implementation efficiency are important factors influencing satisfaction (Pang *et al.*, 2022; Tan *et al.*, 2020). Pang *et al.* (2022) studied the satisfaction of farmers with ecological compensation in the Poyang Lake Wetland in Jiangxi Province, China, and found that farmers' subjective perceptions, income factors, and family labor structure significantly influence satisfaction. Xiao *et al.* (2019) conducted research on the satisfaction of farmers with compensation policies for cultivated land in Chengdu, Sichuan Province, China, and demonstrated that farmers' understanding of the value of compensation objects significantly affects satisfaction. Similarly, Klebl *et al.* (2024) found in their study that farmers' values play a crucial role in biodiversity conservation. Farmers' understanding and values regarding biodiversity significantly influence their behavior and may lead them to support wildlife conservation by sacrificing their own interests. Regarding the impact of subjective cognitive factors on compensation satisfaction, Canova *et al.* (2019) found that political ideology also influences farmers' satisfaction. Additionally, individual characteristics such as gender, age, education level, and employment status, as well as family characteristics, also influence compensation satisfaction (Komura *et al.*, 2023).

In summary, this study categorizes the factors influencing the satisfaction of compensation for wildlife-related incidents among farmers into five categories, including individual characteristics, degree of human-wildlife conflict, wildlife conservation attitudes, family labor structure, and family income structure.

Individual characteristics include variables such as age, gender, education level (Komura *et al.*, 2023), household head status, marital status, health status, ethnicity (Tan *et al.*, 2020), whether holding village cadres positions, and political affiliation (Canova *et al.*, 2019). The degree of human-wildlife conflict includes variables such as the frequency of wildlife-related incidents, total economic losses (Xiao *et al.*, 2019), and compensation amounts for wildlife-related incidents (Tang and Wang, 2023). Wildlife conservation attitudes include the variable of support for wildlife conservation (Klebl *et al.*, 2024). Family labor structure includes variables such as the number of agricultural workers, non-agricultural laborers, and time spent on agricultural labor (Pang *et al.*, 2022). Family income structure includes variables such as net operating income, net property income, net transfer income, and wage income (Pang *et al.*, 2022).

2.2.3 Specification of the model. To explore the factors influencing farmers' satisfaction with compensation for wildlife-related accidents, this study adopts the research methodology

referenced from existing literature ([Pang *et al.*, 2022](#); [Poudel *et al.*, 2022](#)) and constructs an Ordered Probit (Oprobit) model for regression analysis. The basic principle of the Oprobit model is to use the latent variable approach to derive maximum likelihood estimates for analyzing ordered discrete variables. The analysis of factors influencing satisfaction in this study meets the conditions for using this model, hence the adoption of the Oprobit model. Assumptions:

$$Satis_j^* = Indicharac_{kj}^{'}\beta_1 + HWC_{lj}^{'}\beta_2 + Consciou_{mj}^{'}\beta_3 + Labor_{nj}^{'}\beta_4 + Income_{oj}^{'}\beta_5 + \varepsilon$$

Where the dependent variable $Satis_j^*$ represents farmers' satisfaction, with, j ($j = 1, 2, 3, 4$) denoting the types of satisfaction including overall satisfaction with compensation policy $Satis_1$, satisfaction with compensation amount $Satis_2$, satisfaction with compensation scope $Satis_3$ and satisfaction with compensation procedure $Satis_4$. The explanatory variables $Indicharac_{ij}$ represent individual characteristic factors that may affect farmers' satisfaction $Satis_j$, including age, gender, level of education, and other individual characteristics of farmers; HWC_{kj} represents the degree of human-wildlife conflict factors that may influence farmers' satisfaction $Satis_j$, including the frequency of wildlife-related accidents, total economic losses, and compensation amounts for wildlife-related accidents; $Consciou_{lj}$ represents factors of farmers' consciousness of wildlife protection that may affect farmers' satisfaction; $Labor_{mj}$, including the number of agricultural laborers, non-agricultural laborers, and agricultural labor time; $Income_{nj}$, represents factors of family income structure that may affect farmers' satisfaction $Satis_j$, including net operating income, net property income, net transfer income, and wage income. β is the parameter to be estimated, with its positive or negative sign indicating the direction of the influence of the independent variable on the probability of changes in the dependent variable. The estimated value of β has no economic significance, and its value does not represent the marginal effect of the variables; ε is the random error term. Let:

$$Satis_j = \left\{ 1, if\ Satis_j^* \le c_{1j}\ \ 2, if\ c_{1j} < Satis_j^* \le c_{2j}\ \ 3, if\ c_{2j} < Satis_j^* \le c_{3j}\ \ 4, if\ c_{3j} \right.$$
$$< Satis_j^* \le c_{4j}\ \ 5, if\ Satis_j^* > c_{4j}$$

Where $Satis_j$ takes values 1, 2, 3, 4, 5, representing degrees of satisfaction as "Very Dissatisfied, Dissatisfied, Neutral, Satisfied, and Completely Satisfied", respectively; $c_{pj}(p = 1, 2, 3, 4, 5)$ represents "cut-off points," which are the probability thresholds estimated by the model. Assuming the random error term ε follows a standard normal distribution, let:

$$X_{ij}^{'}\beta = Indicharac_{kj}^{'}\beta_1 + HWC_{lj}^{'}\beta_2 + Consciou_{mj}^{'}\beta_3 + Labor_{nj}^{'}\beta_4 + Income_{oj}^{'}\beta_5$$

$$P(x) = P(x) = \Phi\left(c_{1j} - X_{ij}^{'}\beta\right)$$

$$P(x) = P(x) = \Phi\left(c_{2j} - X_{ij}^{'}\beta\right) - \Phi\left(c_{1j} - X_{ij}^{'}\beta\right)$$

$$\vdots$$

$$P(x) = P(x) = 1 - \Phi\left(c_{4j} - X_{ij}^{'}\beta\right)$$

analyzing which variables significantly affect the probability of satisfaction selection, and determine the degree of influence by calculating the marginal effects.

3. Results and discussion

3.1 Descriptive statistics results

The descriptive statistics results for the explanatory variables of the model are presented in Table 1. The descriptive statistics of farmers' individual characteristics indicate that the average age of the respondents is relatively high at 54.34 years, with the oldest respondent being 82 years old and the youngest being 21 years old, suggesting that the surveyed population consists mainly of middle-aged and elderly individuals. The average level of education is 2.85, indicating a relatively low level of education among the respondents, below the junior high school level. The mean value for gender is 1.31, indicating a higher proportion of males among the surveyed population. The average health status of the farmers is 2.06, implying good health conditions among the surveyed population. The mean value for ethnicity is 1.31, indicating a higher proportion of Han ethnicity among the respondents. The mean value for whether they serve as village cadres is 0.20, indicating that most respondents are ordinary villagers. In terms of political affiliation, the vast majority of the surveyed population identifies as ordinary citizens.

The descriptive statistics for human-wildlife conflict and compensation level indicate that the average frequency of wildlife incidents is 3.99, suggesting that most farmers perceive an increase in the frequency of wildlife incidents. The average compensation amount for incidents is 300 yuan, with the highest being 35,000 yuan and the lowest being 0 yuan. The average total economic loss from wildlife incidents is 2,800 yuan, with the highest loss being 60,000 yuan and the lowest being 0 yuan. The difference between the average compensation amount and the average total economic loss is 2,500 yuan.

Regarding wildlife conservation attitudes, the mean value for farmers' support for wildlife protection is 3.58, ranging between 3 and 4, indicating general support for wildlife protection among residents. In terms of family labor structure, the average number of family agricultural laborers and non-agricultural laborers is 1.57 and 1.42, respectively, with the average number of agricultural laborers exceeding that of non-agricultural laborers, indicating that there are more individuals engaged in agricultural labor in the surveyed families. The average duration of agricultural labor per household is 6.42 months, indicating that agricultural labor is conducted for over half of the year. In the descriptive statistics analysis of family income structure, the mean net operating income is 14,000 yuan, with the highest reaching 670,000 yuan and the lowest being −800,000 yuan. The mean net property income is −5,600 yuan, with the highest being 43,000 yuan and the lowest being −342,000 yuan. The mean net transfer income is 2,400 yuan, with the highest being 89,820 yuan and the lowest being −99,870 yuan. The mean wage income is 23,000 yuan, with the highest income being 180,000 yuan and the lowest being 0 yuan.

Based on the analysis results of farmers' compensation acquisition in Table 2, it is evident that 58.66% of the surveyed farmers have obtained wildlife damage insurance. This indicates that the wildlife damage compensation insurance in Xishuangbanna Prefecture has been widely promoted.

The descriptive statistics results for farmers' compensation satisfaction in Table 3 indicate that the mean values for all satisfaction levels range between 2 and 3. The mean value for compensation amount satisfaction is 2.05, while for compensation procedure satisfaction, it is 2.85. The mean value for compensation scope satisfaction is 2.72, and for overall compensation satisfaction, it is 2.73. The maximum value for compensation amount satisfaction is 4, indicating that no respondents selected "Completely Satisfied."

Observing the probability distribution of farmers' compensation satisfaction in Table 4, it is evident that the probability of selecting "Very Dissatisfied" for compensation amount satisfaction is the highest, reaching 39.74%. The probabilities of selecting "Neutral" for overall satisfaction, scope satisfaction, and procedure satisfaction are the highest, at 37.83%, 32.24%, and 30.59%, respectively. Overall, the probability of selecting dissatisfaction is greater than the proportion of selecting satisfaction.

Variable	Code/Unit	Sample size	Mean	Standard deviation	Minimum	Maximum
Age	years	369	54.34	12.46	21	82
Gender	1 = Male 2 = Female	370	1.31	0.46	1	2
Education Level	1 = Illiterate 2 = Primary School 3 = Junior High School 4 = High School 5 = Vocational School and Above (including Vocational School, College, Undergraduate) 6 = Graduate School	369	2.85	0.96	1	5
Whether the Head of Household	1 = Yes 0 = No	370	0.68	0.47	0	1
Marital Status	1 = Married 2 = Unmarried 3 = Divorced 4 = Widowed	368	1.28	0.81	1	4
Physical Health Status	1 = Healthy 2 = Good 3 = Fair 4 = Poor 5 = Disabled	369	2.06	1.18	1	5
Political Affiliation	1 = Masses 2 = Communist Party Member	368	1.17	0.43	1	2
Ethnicity	1 = Han 2 = Minority Ethnicity	368	1.31	0.48	1	2
Whether Serving as Village Cadre	1 = Yes 0 = No	369	0.20	0.40	0	1
Frequency of Wildlife Accidents	1 = Greatly Reduced 2 = Slightly Reduced 3 = Basically Unchanged 4 = Slightly Increased 5 = Greatly Increased	343	3.99	1.05	1	5
Total Economic Loss	10,000 yuan	303	0.28	0.71	0	6
Compensation Amount for Wildlife Accidents	10,000 yuan	368	0.03	0.20	0	3.5
Degree of Support for Wildlife Protection	1 = Extremely Opposed 2 = Opposed 3 = Neutral 4 = Supportive 5 = Strongly Supportive	360	3.58	1.12	1	5
Number of Agricultural Laborers	people	366	1.57	1.24	0	6
Number of Non-Agricultural Laborers	people	366	1.42	1.25	0	6
Time Spent on Agricultural Labor	months	338	6.42	5.34	0	12
Net Operating Income	10,000 yuan	370	1.40	6.34	−80	67
Net Property Income	10,000 yuan	370	−0.56	2.79	−34.2	4.3
Net Transfer Income	10,000 yuan	370	0.24	1.23	−9.987	8.982
Wage Income	10,000 yuan	370	2.30	3.09	0	18

Source(s): Based on authors' design and calculations

3.2 Variance inflation factor

In order to test whether the model suffers from multicollinearity issues, this study calculated the Variance Inflation Factor (VIF) of the explanatory variables before conducting model regression. A VIF closer to 1 indicates weaker multicollinearity, while values greater than 10 suggest severe multicollinearity. The test results are presented in Table 5, where all explanatory variables have VIF values ranging from 1.09 to 1.79, implying a good selection of explanatory variables in the model.

3.3 Analysis of factors affecting farmers' satisfaction

The analysis of factors influencing farmers' satisfaction is conducted using the Oprobit model, with insignificant variables gradually removed through stepwise regression. The regression results are shown in Table 6. Among the various influencing factors, the impact of family income structure is consistently insignificant. Further analysis reveals a significant correlation between family income and agricultural labor numbers, prompting the removal of income variables.

| | Whether you are compensated for wildlife accidents | | |
	Yes	No	Total
Count	210	148	358
%	58.66%	41.34%	100%
Source(s): Based on authors' design and calculations			

Table 2.
Compensation status of farmers

Satisfaction types	Sample size	Mean	Standard deviation	Minimum	Maximum
Compensation Amount Satisfaction	156	2.05	1.06	1	4
Compensation Scope Satisfaction	304	2.72	1.05	1	5
Compensation Procedure Satisfaction	304	2.85	1.09	1	5
Overall Compensation Satisfaction	304	2.73	0.96	1	5
Source(s): Based on authors' design and calculations					

Table 3.
Farmers' compensation satisfaction status

| Satisfaction type | | Satisfaction with compensation for wildlife accidents | | | | | |
		Very dissatisfied	Dissatisfied	Neutral	Satisfied	Completely satisfied	Total
Compensation	Count	62	46	26	22	0	156
Amount Satisfaction	%	39.74%	29.49%	16.67%	14.10%	0%	100%
Compensation Scope	Count	36	98	98	58	14	304
Satisfaction	%	11.84%	32.24%	32.24%	19.08%	4.61%	100%
Compensation	Count	34	86	93	74	17	304
Procedure	%	11.18%	28.29%	30.59%	24.34%	5.59%	100%
Satisfaction							
Overall	Count	32	90	115	62	5	304
Compensation	%	10.53%	29.61%	37.83%	20.39%	1.64%	100%
Policy Satisfaction							
Source(s): Based on authors' design and calculations							

Table 4.
Probability distribution of farmers' compensation satisfaction

Regarding individual characteristics, variables such as age, household head status, marital status, political affiliation, and serving as village cadres are all found to be insignificant and thus are removed from the model. After eliminating insignificant variables, the regression results become more precise. Additionally, this study analyzes the marginal effects of significant factors influencing farmers' satisfaction, including individual characteristics and household labor structure factors on satisfaction probability, as shown in Table 7.

3.3.1 Individual characteristics. From the regression results, it is evident that gender influences farmers' overall satisfaction with compensation policies and satisfaction with compensation procedures. Specifically, the effect on overall satisfaction is significant at the 10% level, while the effect on satisfaction with compensation procedures is significant at the 5% level. Marginal analysis reveals that gender has a positive marginal effect on overall satisfaction at the 10% significance level and a significant positive marginal effect on satisfaction with compensation procedures at the 5% level, indicating that females are more likely to feel satisfied with compensation, particularly regarding satisfaction with compensation procedures, possibly due to their greater patience in dealing with compensation procedures.

Education level significantly affects satisfaction with compensation policies overall, compensation amount, compensation scope, and compensation procedures, with significance levels of 5%, 10%, 10%, and 5%, respectively. The marginal analysis shows positive marginal effects of education level on all types of satisfaction, particularly significant at the 5% level for overall satisfaction and satisfaction with compensation procedures, and at the 10% level for satisfaction with compensation amount and scope. This suggests that higher education levels increase the probability of farmers choosing satisfaction, especially regarding satisfaction with compensation procedures, likely because higher education levels enable better understanding of compensation procedures and the rationale behind policy amounts and scopes.

Physical health affects overall satisfaction with compensation policies, satisfaction with compensation scope, and satisfaction with compensation procedures at significance levels of 1%, 1%, and 10%, respectively. The marginal analysis indicates that physically healthy

Variable	VIF	1/VIF
Whether the head of household	1.79	0.559873
Education level	1.77	0.565209
Gender	1.71	0.58397
Age	1.70	0.58746
Number of agricultural laborers	1.66	0.601596
Ethnicity	1.58	0.631832
Time spent on agricultural labor	1.56	0.640989
Wage income	1.55	0.646355
Number of non-agricultural laborers	1.52	0.657467
Whether serving as village cadre	1.52	0.657943
Political affiliation	1.46	0.684868
Physical health status	1.39	0.721404
Total economic loss	1.26	0.791487
Net operating income	1.24	0.804392
Frequency of wildlife accidents	1.17	0.857108
Marital status	1.16	0.864829
Compensation amount for wildlife accidents	1.13	0.885119
Net transfer income	1.13	0.885799
Degree of support for wildlife protection	1.12	0.896535
Net property income	1.09	0.915655
Source(s): Based on authors' design and calculations		

Table 5.
Variance inflation
factors (VIF)

Influencing factors	Variable	Overall compensation policy satisfaction	Compensation amount satisfaction	Compensation scope satisfaction	Compensation procedure satisfaction
Individual Characteristics	Gender	0.280* (0.158)			0.337** (0.146)
	Education Level	0.195** (0.0902)	0.218* (0.119)	0.133* (0.0745)	0.196** (0.0787)
	Physical Health Status	0.175*** (0.0661)		0.179*** (0.0576)	0.108* (0.0579)
	Ethnicity	0.591*** (0.158)	0.650*** (0.193)		0.358** (0.141)
Human-Wildlife Conflict and Compensation Degree	Frequency of Wildlife Accidents	−0.120 (0.0798)		−0.247*** (0.0687)	−0.118* (0.0687)
	Total Economic Loss	−0.0713 (0.0943)	−0.298** (0.151)		
	Compensation Amount for Wildlife Accidents	0.135 (0.294)			0.519* (0.293)
Wildlife Protection Concept	Degree of Support for Wildlife Protection	0.0351 (0.0670)	0.138 (0.0966)		
Family Labor Structure	Number of Agricultural Laborers	−0.180** (0.0744)	−0.163 (0.111)	−0.115* (0.0621)	−0.123* (0.0627)
	Number of Non-Agricultural Laborers	0.171** (0.0687)	0.0420* (0.0252)	0.188*** (0.0593)	0.124** (0.0598)
	Time Spent on Agricultural Labor	0.0643*** (0.0171)	0.227** (0.103)	0.0420*** (0.0148)	0.0384*** (0.0148)

Note(s): (1) *** is significant at 1%, ** is significant at 5%, * is significant at 10%; (2) Standard error in parentheses
Source(s): Model results based on authors' work

Table 6.
Results of the Oprobit model regression

individuals tend to choose satisfaction with compensation scope and procedures, with significant positive marginal effects at the 5% level for overall satisfaction and satisfaction with compensation scope, and at the 10% level for satisfaction with compensation procedures. Overall, individuals with good physical health are more inclined to be satisfied with compensation scope and procedures, possibly due to their greater ability to withstand the risks of wildlife-caused damages.

Ethnicity has an impact on the selection of satisfaction with compensation policies, with significant effects on overall satisfaction, satisfaction with compensation amount, and satisfaction with compensation procedures at least at the 5% level. The marginal analysis shows positive effects of ethnicity on satisfaction with compensation policies, with marginal effects passing the significance test at the 1% level for overall satisfaction and satisfaction with compensation amount, and at the 5% level for satisfaction with compensation procedures. These results indicate that ethnicity influences satisfaction with compensation policies, with minority ethnic groups possibly having traditional values regarding wildlife conservation and being more willing to compromise some benefits in human-wildlife

Influencing factors	Variable	Overall compensation policy satisfaction	Compensation amount satisfaction	Compensation scope satisfaction	Compensation procedure satisfaction
Individual Characteristics	Gender	0.0356* (0.0209)			0.0625** (0.0279)
	Education Level	0.0247** (0.0121)	0.0816* (0.0446)	0.0254* (0.0145)	0.0365** (0.0150)
	Physical Health Status	0.0222** (0.00900)		0.0344*** (0.0115)	0.0201* (0.0109)
	Ethnicity	0.0750*** (0.0232)	0.244*** (0.0727)		0.0666** (0.0269)
Human-Wildlife Conflict and Compensation Degree	Frequency of Wildlife Accidents	−0.0152 (0.0103)		−0.0475*** (0.0139)	−0.0219* (0.0129)
	Total Economic Loss	−0.00904 (0.0120)	−0.112** (0.0571)		
	Compensation Amount for Wildlife Accidents	0.0171 (0.0373)			0.0965* (0.0553)
Wildlife Protection Concept	Degree of Support for Wildlife Protection	0.00446 (0.00855)	0.0518 (0.0363)		
Family Labor Structure	Number of Agricultural Laborers	−0.0228** (0.0101)	−0.0612 (0.0416)	−0.0221* (0.0121)	−0.0228* (0.0119)
	Number of Non-Agricultural Laborers	0.0217** (0.00928)	0.0853** (0.0388)	0.0361*** (0.0118)	0.0231** (0.0113)
	Time Spent on Agricultural Labor	0.00815*** (0.00252)	0.0157* (0.00948)	0.00805*** (0.00293)	0.00713** (0.00284)

Note(s): (1) *** is significant at 1%, ** is significant at 5%, * is significant at 10%; (2) Standard error in parentheses
Source(s): Model results based on authors' work

Table 7.
Results of significant
variable marginal
effects

conflicts, thus having lower demands for compensation amount and procedures and being more easily satisfied.

3.3.2 Household labor structure. The family labor structure has an impact on satisfaction, with agricultural labor numbers significantly affecting overall satisfaction, satisfaction with compensation scope, and satisfaction with compensation procedures at least at the 10% significance level. The number of non-agricultural laborers significantly affects overall satisfaction, satisfaction with compensation amount, satisfaction with compensation scope, and satisfaction with compensation procedures at the 5%, 10%, 1%, and 5% statistical levels, respectively. Household agricultural labor time significantly affects overall satisfaction, satisfaction with compensation amount, satisfaction with compensation scope, and satisfaction with compensation procedures at least at the 5% significance level.

The marginal analysis results indicate that the marginal effect of agricultural labor numbers is negative, with negative marginal impacts on overall satisfaction, satisfaction with compensation scope, and satisfaction with compensation procedures significant at least at

the 10% statistical level. The marginal effect of non-agricultural labor numbers is positive, indicating a positive impact on overall satisfaction, satisfaction with compensation amount, satisfaction with compensation scope, and satisfaction with compensation procedures, with marginal effects significant at the 5%, 5%, 1%, and 5% statistical levels, respectively. The marginal effect of household agricultural labor time is positive, with significant levels of marginal effects on overall satisfaction, satisfaction with compensation amount, satisfaction with compensation scope, and satisfaction with compensation procedures selection probabilities at 1%, 10%, 1%, and 5%, respectively.

Regarding overall satisfaction with policies, the negative marginal effect of agricultural labor numbers is smaller than the positive marginal effect of non-agricultural labor numbers. This indicates that for the same household, increasing both agricultural and non-agricultural labor numbers simultaneously still increases the probability of individuals choosing satisfaction. The family agricultural labor structure reflects family income, asset structure, and labor force composition to some extent. The more the family relies on agricultural employment, the lower the probability of satisfaction with compensation; conversely, the more the family relies on non-agricultural employment, the higher the probability of satisfaction with compensation. This suggests that if a family mainly relies on agriculture for livelihood, the probability and severity of encountering wildlife-caused damages will be higher than for families relying more on non-agricultural livelihoods. The regression results of household agricultural labor time reflect the potential economic costs and risks of human-wildlife conflicts. The longer the agricultural labor time, the lower the opportunity costs faced by farmers, allowing them to engage safely in agricultural work. The level of opportunity costs affects their expectations regarding compensation amount, scope, and procedures, leading to a higher probability of choosing satisfaction with compensation policies.

3.4 Discussions

This study aims to analyze the satisfaction of farmers living around the Xishuangbanna National Nature Reserve with wildlife-caused damages compensation policies and their influencing factors. Moreover, the study not only examines the overall satisfaction of farmers with compensation policies but also provides a detailed analysis of the factors influencing satisfaction with compensation amount, scope, and procedures, thereby refining the study of satisfaction with compensation policies. Compared with existing research, this study has drawn some novel conclusions.

Pang et al. (2022) found that education level influences overall satisfaction, a conclusion further corroborated in this study. However, while their research suggests gender has no significant impact and family income affects satisfaction, this study identifies gender as a significant factor affecting satisfaction and finds no significant impact of family income. Additionally, this study pays more attention to the influence of ethnicity on policy satisfaction, showing that minority ethnic groups tend to be more satisfied.

Some literature has explored the impact of land structure (Feng et al., 2023) and land transfer situations (Pang et al., 2022) on policy satisfaction. Although these factors are not considered in this study due to minimal changes in land structure or transfer around the research area, agricultural labor time is a significant variable reflecting the frequency of wildlife-caused damages and farmers' livelihood strategies in the face of human-wildlife conflicts.

Barua et al. (2013) studied the hidden costs of human-wildlife conflicts, suggesting opportunity costs are one of the hidden costs. This study uses household agricultural labor time as a proxy for opportunity costs and finds a positive impact of farming time on satisfaction with compensation policies, indicating lower opportunity costs reduce farmers' expectations of compensation and thus increase satisfaction, confirming their findings.

The study particularly focuses on the influence of farmers' wildlife conservation attitudes on satisfaction, but finds no significant impact, possibly due to sample selection. The study area, focusing on human-elephant conflicts, involves potentially substantial economic losses for farmers, increasing their demand for compensation and making it harder for them to be satisfied with existing compensation policies. Moreover, the older age and lower education level of the sampled farmers in the region may contribute to the insignificance of the impact of wildlife conservation attitudes. Additionally, the study's indicator construction and questionnaire design are more detailed than in other studies, enabling a more precise understanding of the factors affecting farmers' satisfaction. Finally, the study's focus on the Xishuangbanna National Nature Reserve, where human-wildlife conflicts are most pronounced in China, enhances the representativeness and urgency of the findings regarding compensation policy satisfaction in this region compared to other areas in China.

4. Conclusions and implications

4.1 Key findings

This study, based on field survey data and utilizing the Oprobit regression model, investigated farmers' satisfaction with and influencing factors of wildlife-caused damages compensation policies. The main conclusions drawn are as follows:

Overall, farmers in the Xishuangbanna National Nature Reserve show a relatively low level of satisfaction with wildlife-caused damages compensation policies, with an average satisfaction level ranging between "Neutral" and "Dissatisfied." The average satisfaction with the compensation amount is 2.05, leaning towards "Dissatisfied," while satisfaction with the compensation scope and procedures tends towards "Neutral".

Individual characteristics are significant factors influencing farmers' satisfaction with compensation policies. Among these, education level and ethnicity have the most significant impact. The higher the education level, the higher the probability that farmers will be satisfied with the compensation policies, and minority ethnic groups are notably more likely to be satisfied compared to the Han ethnicity. Improving farmers' education levels and providing more effective compensation policies tailored to different ethnic groups can significantly enhance farmers' satisfaction with compensation policies.

Family labor structure significantly affects farmers' satisfaction with compensation policies. Specifically, the fewer the number of agricultural laborers in the family, the more non-agricultural laborers, and the longer the agricultural labor time, the greater the probability that farmers will be satisfied. Providing more non-agricultural employment opportunities for farmers' families can significantly improve satisfaction with wildlife-caused damages compensation.

Additionally, the impact of human-wildlife conflicts and compensation levels, as well as wildlife conservation attitudes, on the probability of farmers' satisfaction with compensation policies, is not significant. Family income structure also does not significantly influence satisfaction levels.

4.2 Policy implications

Based on the research findings, the following policy implications are proposed:

Increase the compensation for wildlife-caused damages in Xishuangbanna Prefecture. Under the current compensation standards, the amount is insufficient to fully compensate farmers for the economic losses incurred in human-wildlife conflicts. The overall satisfaction of farmers with the compensation policy falls between "Dissatisfied" and "Neutral", while the satisfaction with the compensation amount is generally dissatisfied, indicating that the inadequate compensation amount is the most important reason for farmers' dissatisfaction. Therefore, efforts should be made to strengthen the compensation.

Expand the scope of compensation for wildlife-caused damages in Xishuangbanna Prefecture. The average satisfaction with the compensation scope is also lower than the average overall satisfaction, indicating that farmers are dissatisfied with the scope of compensation for wildlife-caused damages. Therefore, the compensation scope should be further refined. The government should organize research teams to conduct comprehensive investigations into the potential losses caused by wildlife-caused damages in the prefecture, understand the demands of local farmers, and expand the types of losses covered by compensation.

Simplify the compensation procedures for wildlife-caused damages. Although the satisfaction with the compensation procedures in Xishuangbanna Prefecture is better than the other two aspects of satisfaction, its average satisfaction level is still at a "general" level or below. Therefore, finding more effective, simple, and scientific ways to determine losses, simplifying the compensation procedures, and providing farmers with a more convenient process for obtaining compensation should be prioritized.

Strengthen publicity and education to further enhance farmers' ecological values. Efforts should be made to strengthen publicity on ecological protection, biodiversity conservation, etc., firmly establishing the concept of harmonious coexistence between humans and nature. Relevant departments should actively carry out ecological civilization education, cultivate farmers' ecological values, and strengthen ecological civilization construction.

Notes

1. https://www.xsbn.gov.cn/zrbhq/112828.news.detail.dhtml?news_id=2866700

2. https://www.xsbn.gov.cn/tjj/67469.news.detail.dhtml?news_id=2912057

3. https://www.xsbn.gov.cn/zrbhq/112818.news.detail.dhtml?news_id=1855867

4. https://www.xsbn.gov.cn/lyj/81753.news.detail.dhtml?news_id=2900108

5. https://www.bndaily.com/p1/yw/20240319/430922.html

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