Using the Extended Theory of Planned Behaviour to Evaluate Farmers' Intentions to Participate in the Management of Rocky Desertification

[1*] Fu Linjiang , [2*] Zeng Yizhou

[1,2] *Rattanakosin International College of Creative Entrepreneurship, Rajamangala University of Technology Rattanakosin*
**Corresponding Author: fu.linjiang@rmutr.ac.th, zeng.yizhou@rmutr.ac.th*

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ABSTRACT

This investigation focuses on the efforts to combat the pervasive issue of desertification in Bijie City, Guizhou Province, China. From the standpoint of social psychology, it looks into what influences farmers' behavior and desire to take part in desertification control. The study introduces an additional variable, risk perception, based on the Theory of Planned Behavior, to understand the complex interplay among these factors. A thorough research model was constructed to examine farmers' involvement in controlling desertification in the context of Bijie City. 438 respondents were used to gather data, and the results offer interesting new insights. Key variables such as environmental risk perception (RP), attitudes (AT), subjective norms (SN), and perceived behavioral control (PBC) significantly enhance farmers' willingness and actual participation in managing rocky desertification. Moreover, the intention to prevent stony desertification acts as a mediating factor linking environmental risk perceptions, attitudes, subjective norms, perceived behavioral control, and behavior towards stony desertification control. This study presents robust evidence supporting initiatives to enhance farmers' motivation to engage in rocky desertification control. The results suggest that the department responsible for rocky desertification control should implement proactive strategies to elevate farmers' awareness and drive their participation in combating this environmental challenge.

1. Research Background

Despite its extraordinary trajectory of economic expansion, China is facing serious ecological issues, including severe water pollution, declining air quality, and destruction of grasslands (Li, 2020; Liu & Diamond, 2005). Among the most pressing ecological issues globally is karst rocky desertification, which poses a significant obstacle to China's sustainable development. Karst rocky desertification leads to reduced arable land, soil erosion, decreased land productivity (Dan et al., 2018), and heightened frequency of natural disasters like floods, landslides, and droughts, exacerbating economic hardship among local farmers (Qin et al., 2006). China's poverty alleviation efforts primarily target areas impacted by ecological and economic poverty resulting from karst rocky desertification (Shen et al., 2022).

However, the foundation of these strategies largely relies on engineering and technological research. Despite farmers being the primary contributors to karst rocky desertification, little is known about the psychological factors influencing their participation in control initiatives (Adesina & Chianu, 2002; Bekele & Drake, 2003; Chianu & Tsujii, 2004). China's southwest karst regions are experiencing severe soil erosion, rocky desertification, and flora deterioration due to unsustainable human activities (Zhang, 2015). According to Yu (2015), a key factor in determining the effectiveness of control measures is farmers' passion and desire to participate in rocky desertification management. Perception of risk emerges as a critical predictor of personal pro-environmental behavior, significantly influencing farmers' intentions to engage in environmental activities such as safe fertilizer usage (Savari & Gharechaee, 2020).. Similarly, integrating perceived climatic hazards into the theory positively impacts farmers' engagement in agricultural conservation (Tama et al., 2021b).

In summary, China faces significant ecological challenges, including water pollution, air quality deterioration, and grassland degradation, amidst its impressive economic growth. Karst rocky desertification emerges as a global ecological concern, hindering China's sustainable development by reducing arable land, causing soil erosion, and increasing the frequency of natural disasters. Guizhou Province bears the brunt of this issue, with Bijie City, Qiannan Prefecture, and Qianxi Prefecture being most affected. Strategies to combat desertification involve restructuring rural

industries, promoting ecological migration, and implementing restoration measures, relying heavily on engineering and technological research. Farmers have a major role in desertification, but little is known about the psychological aspects of their involvement in efforts to stop it. Perception of risk emerges as a key predictor of farmers' pro-environmental behavior, influencing their engagement in environmental activities. However, research on how risk perception affects farmers' involvement in desertification management remains limited. The study's focal point is Bijie City in Guizhou Province, which is the part of China most negatively affected by rocky desertification. Given the success of rocky desertification control in Qianxi County, the study concentrates on farmers there as micro-level subjects. Using social psychology and the Theory of Planned Behavior as a lens, the study aims to provide light on how risk perception affects farmers' pro-environmental behavior and willingness to participate in rocky desertification management. This research endeavor fills a critical gap in the field.

2. Literature Review

2.1 Farmers' Pro-Environmental Behavior and Rocky Desertification Control

A farmer's voluntary participation in environmental conservation throughout the agricultural production cycle is an example of pro-environmental behavior, which is driven by profit. This includes maximizing production parameters during the agricultural product harvesting process with the goal of reducing environmental degradation and increasing agricultural profitability (Kollmuss & Agyeman, 2002). Research on the mechanisms underlying rocky desertification formation suggests that it arises from a combination of human activity and natural causes rather than a singular factor (Chen, 2022). Thus, effective prevention of rocky desertification necessitates raising awareness among farmers in affected areas regarding behavioral modifications. Motivating farmers to proactively engage in rocky desertification management and carefully assess the outcomes of their efforts are crucial steps toward successful control (Li & Wang, 2005). Individual pro-environmental behavior is influenced by various factors including upbringing, routines, attitudes, and external influences (Stern, 2000; Gifford, 2014). Elements such as knowledge, personality, responsibility, attitudes, and norms play significant roles in shaping pro-environmental behavior (Gifford, 2014). Pro-environmental land use behavior among farmers is influenced by a multitude of factors including behavioral costs, psychological cognition, social constraints, and regulatory frameworks (Sheng et al., 2020).

The above contents highlight the multifaceted nature of pro-environmental behavior among farmers, particularly in the context of rocky desertification control. Farmers engage in environmental conservation throughout the agricultural production cycle driven by profit motives. This involves optimizing production parameters to enhance agricultural profitability while minimizing environmental degradation. To stop the rocky desertification process, pro-environmental actions including afforestation, grass cultivation, and vegetation management are part of routine agricultural practices. Additionally, artificial intervention measures like tree planting and land conversion further contribute to reducing the impact of desertification. Research indicates that rocky desertification arises from a combination of human activity and natural causes, emphasizing the importance of raising awareness among farmers in affected areas to facilitate effective prevention through behavioral modifications. A person's pro-environmental conduct is shaped by a multitude of factors, including upbringing, routines, attitudes, and outside influences. Knowledge, personality, responsibility, and conventions all play important roles. Additionally, social restrictions, psychological cognition, behavioral costs, and regulatory frameworks influence pro-environmental land use behavior. The study aims to explore the factors influencing farmers' behavior and willingness to participate in rocky desertification control, encompassing both external and intrinsic psychological aspects. It underscores the importance of understanding individual psychological factors, such as attitudes and perceived behavioral control, as well as external factors like social norms and education, in determining pro-environmental behavior among farmers. This comprehensive analysis provides valuable insights into the complexities of promoting environmental conservation efforts within agricultural practices, particularly in addressing challenges related to rocky desertification.

2.2 Perceived Risk of Rocky Desertification

Environmental risk perception, stemming from studies on individual pro-environmental behavior, forms the basis of understanding farmers' attitudes towards environmental conservation. Agricultural practices involving the heavy use

of herbicides, fertilizers, and plastic mulch have been identified as contributors to environmental degradation. In response, farmers are motivated to adopt pro-environmental behaviors to mitigate the perceived risks associated with these practices. Five variables were used by Wang and Zhou (2020) to categorize risk perception: subjective health risk perception, physiological health risk perception, psychological health risk perception, and perception of work behavior and quality of life. Studies have shown that farmers' intentions to protect the environment, use fertilizers safely, preserve farm biodiversity, and engage in ecological agriculture protection are positively influenced by their perception of environmental risk (Su et al., 2021a; Savari & Gharechaee, 2020; Hamideh & Marzieh, 2019; Tama et al., 2021a). One of China's most delicate ecological systems is karst rocky desertification, which severely hinders regional sustainable development (Wang et al., 2018; Xu et al., 2013). Within the southwest region, it stands out as the most pressing ecological challenge (Xu et al., 2013).

The above contents underscore the pivotal role of environmental risk perception in shaping farmers' attitudes towards environmental conservation. Agricultural practices utilizing herbicides, fertilizers, and plastic mulch are recognized as contributors to environmental degradation, prompting farmers to adopt pro-environmental behaviors to mitigate associated risks. Some scholars categorized risk perception into subjective health, physiological health, psychological health, and opinions of living quality as well as conduct at work, emphasizing its complex character. Their study revealed a strong correlation between haze risk perception and public environmental behavior, illustrating the significance of risk perception in influencing environmental actions. Researchers have extended the Theory of Planned Behavior to explore the relationship between pro-environmental intentions and environmental risk perception. According to studies, farmers' perceptions of environmental risk have a favorable impact on their intents to practice ecological agriculture, safeguard safe fertilizer usage, maintain biodiversity, and protect the environment. This underscores the importance of considering risk perception in promoting pro-environmental behavior among farmers. Karst rocky desertification emerges as a significant ecological challenge in China, particularly in the southwest region, where it poses a threat to local sustainable development. Rocky desertification is an ecological problem that requires immediate attention due to its vulnerability to both natural and human-caused factors. Drawing upon the concept of environmental risk perception, the study focuses on understanding farmers' perceptions of environmental risk associated with rocky desertification. By investigating the mechanisms influencing farmers' intentions and actions related to rocky desertification control, the study aims to deepen our understanding of the interplay between risk perception and pro-environmental behavior. Such insights are crucial for developing effective strategies to manage rocky desertification and promote sustainable agricultural practices. In summary, the analysis underscores the significance of environmental risk perception in influencing farmers' attitudes and behaviors towards environmental conservation, particularly in the context of addressing rocky desertification. By incorporating risk perception into research and policy interventions, it is possible to foster pro-environmental behavior among farmers and mitigate the environmental impact of agricultural practices.

2.3 Related Research

Water scarcity, soil depletion, and challenging vegetation restoration contribute to the fragility of the karst rocky desert ecosystem. Rocky desertification, a manifestation of unsustainable human exploitation coupled with fragile ecological environments, not only hinders economic and social development but also leads to regional economic stagnation. Therefore, focusing on water retention, soil conservation, and vegetation restoration is crucial for rocky desertification management in the karst region, with the goal of driving rural revitalization. However, solely relying on single technical measures results in a simplistic vegetation structure, lacking stability and sustainability, thus failing to achieve comprehensive management. Even well-managed areas face degradation risks due to inadequate post-treatment maintenance. Over years of exploration, various composite models for rocky desertification management have been developed, transitioning from "green water and green mountains" to "golden mountains and silver mountains". These include: 1. Forest and grassland vegetation restoration driving agricultural and forestry industry development models, such as Guangdong Province's Daluo Ridge model and Zuling model, which integrate vegetation restoration with water resource development to promote organic integration of agricultural and forestry industries. 2. Soil and water conservation models, implementing terrace engineering through land improvement and soil

amelioration to increase effective arable land area, intercept sediment, and guarantee effective irrigation. 3. Ecological migration models, relocating populations from severely desertified areas to areas with proper ecological balance, complemented by forestation and afforestation measures. 4. Ecotourism models, promoting the establishment of desertification parks to develop local ecotourism industries, such as Yunnan Province's Xichou County Desertification National Park and Mihou Mountain Desertification Park. 5. Integrated management models, addressing different degrees of desertification through comprehensive watershed management, including mountain, water, field, forest, and road governance strategies (Zheng, Cha & Feng, 2022).

Overall, rocky desertification has been successfully stopped from spreading further in the karst region due to extensive ecological conservation and development, which has improved the environment over time. However, challenges such as governance effectiveness consolidation, poor sustainability, lack of regional-specific governance technologies, and unstable vegetation communities persist, highlighting the need to enhance ecosystem diversity, stability, and sustainability in rocky desertification management. To address these challenges, it is essential to continue researching water retention, soil conservation, and vegetation restoration, integrate regional realities, and develop rational rocky desertification management models, focusing on adjusting agricultural structures and nurturing ecological industries. Moreover, emphasis should be placed on integrated protection and systematic management, exploring integrated solutions for rocky desertification management. Research on the rocky desertification management standard system and improvement of ecological monitoring and evaluation standards are necessary. Given the high costs of rocky desertification management and the substantial post-treatment maintenance expenses, exploring diversified investment, and financing mechanisms and encouraging social capital participation are essential. Finally, preventative measures should be integrated to strengthen research on ecosystem degradation mechanisms and reduce the occurrence of desertification in non-desertified areas (Xiao, Xiong & Zhang, 2014; Luo, 2019).

The distribution of karst landforms and their impact on desertification is a complex and challenging issue. Karst landforms occupy an important position globally due to their unique geological features, but their interaction with human activities varies significantly across different regions. In the regions of carbonate rocks in the eastern United States and southern Europe, the characteristics of karst landforms mitigate the problem of desertification to some extent. The high porosity and good water retention of carbonate rocks in these areas help slow down the development of desertification. Meanwhile, the relatively low population density and less land pressure mean less exploitation of land, allowing traditional farming and animal husbandry practices to maintain the natural state of the landforms to some degree. Consequently, there are relatively fewer governance efforts targeting desertification in these areas, resulting in less prominent socio-economic issues and a lack of experiences to draw upon. However, in other karst regions, especially those with dense populations and high land pressure like southwestern China, the challenges are greater. Here, the combination of dense population and uneven economic development leads to excessive exploitation of karst landforms, exacerbating the problem of desertification. Massive desertification not only severely affects the local ecological environment but also directly threatens the livelihoods and social stability of local residents. Therefore, addressing the issue of desertification in karst regions requires comprehensive consideration of geological, ecological, and economic factors to develop targeted governance measures. This includes, but is not limited to, strengthening land use management, promoting sustainable agricultural and animal husbandry practices, and conducting ecological restoration and vegetation protection. Additionally, enhanced international cooperation and communication are needed to collectively address the challenge of desertification in karst regions, contributing positively to the development of the Earth's ecological civilization (Zheng, 2023).

The governance of karst desertification has greatly promoted the development of Guizhou Province, reduced the likelihood and extent of various natural disasters and economic losses while improved people's living standards. However, there are still prominent issues that affect the effective integration between the rural revitalization strategy and the governance of karst desertification. Firstly, the level of financial support for the governance of karst desertification is insufficient. The amount of financial support does not match the actual situation of karst desertification governance, resulting in fluctuations in the actual completion area of karst desertification governance, which is not conducive to the deep advancement of the rural revitalization strategy and the governance of karst

desertification. It has been reported that, up to now, there has been no determination of the amount of financial support for the governance of karst desertification at the national level, nor has a unified and clear calculation standard been formally established. This makes it difficult for some karst desertification governance projects to be effectively implemented, leading to fluctuations in the actual completion area of karst desertification governance, which affects the development process of the rural revitalization strategy. Secondly, the ecological environment of karst areas is extremely fragile, and the economic and social development level in this region is relatively backward. The potential area of land prone to karst desertification is large, which easily leads to ecological environmental problems such as soil erosion, and these problems occur frequently, persist for a long time, and cause significant damage. This has greatly negative impacts on the development of agricultural processing industry, the cultivation of characteristic industries, the development of rural e-commerce, and the construction of forestry economy, making the governance of karst desertification and the implementation of the rural revitalization strategy more difficult. Thirdly, the industrial or product radiation driving force of the areas where karst desertification is governed is not strong, and the added value is relatively low. The impact of karst desertification governance on the development of agricultural processing industry and characteristic industries varies, mainly because the added value of such industries or products is not high and their radiation driving force is weak. Furthermore, they are readily impacted by the delicate karst ecological environment, which makes it harder for the people who have already been lifted out of poverty in the area to design a strategy for rural rehabilitation and karst desertification governance without incident. Fourthly, the concept of ecological civilization has not yet fully penetrated into people's hearts. The understanding of the importance of ecological civilization construction among local residents is relatively low, mainly due to the low education and cultural level of local residents, and insufficient exploration of the traditional culture of ecological environment protection among ethnic minorities. This is not conducive to creating a good public opinion atmosphere for the governance of karst desertification under the background of the rural revitalization strategy (Hong, Yang & Song, 2023).

2.4 Theory of Planned Behavior

Turaga et al. (2010) claim that the Theory of Planned Behavior (TPB) is one of the best models for predicting pro-environmental behavior since it can be applied to a wide range of environmental circumstances. Studies by Ho et al. (2015) and De Leeuw et al. (2015) have applied TPB to investigate environmental conservation behavior among teenagers and anticipated pro-environmental conduct within Singaporean society. Currently, numerous researchers utilize the extended TPB to explore pro-environmental behavior in diverse contexts, such as organic food purchasing, household waste management, farm protection, green technology adoption (Dalvi et al., 2020), biodiversity conservation (Hamideh & Keshavarz, 2019), contributions to assist sustainable development in rural areas (Pérez & Egea, 2019), and sorting of residential garbage (Wang et al., 2021). These studies have yielded promising predictive outcomes across various domains. Despite its popularity, the TPB model has been criticized for its overemphasis on individual traits while neglecting environmental influences on behavioral intentions (Hoyos et al., 2009). Consequently, there is a recognized need for further refinement and strengthening of the model. Some researchers argue that the conventional TPB model inadequately explains pro-environmental behavior and advocate for the incorporation of additional elements to enhance its explanatory power (Cooke et al., 2007; Donald et al., 2014; Fu et al., 2019). In response, in order to better fit various study contexts, academics have expanded the TPB in a number of ways, including by adding new variables, expanding its dimensions, and rearranging its links. The aim is to investigate how external situational circumstances, and internal psychological factors influence farmers' behaviors and intentions regarding rocky desertification governance. Through the integration of various theoretical frameworks, the research aims to offer a thorough comprehension of the elements motivating farmers to participate in efforts to limit rocky desertification.

2.5 Research Hypotheses

Environmental risk perception significantly influences individuals' engagement in environmentally friendly practices, such as avoiding chemical pesticides (Sabzehei et al., 2016). Similarly, farmers' pro-environmental behavior is encouraged by their perception of soil risk (Zhou et al., 2020b), and their willingness to participate in ecological agricultural preservation is positively affected by their perception of risk (Tama et al., 2021a). Moreover, the willingness to protect the biodiversity of farms and apply fertilizers responsibly is positively influenced by risk

perception (Hamideh & Keshavarz, 2019; Savari & Gharechaee, 2020). Overall, the body of research suggests that environmental risk perception is a significant determinant of both individual and farmer behavior in environmental conservation efforts. It underscores the importance of raising awareness about environmental risks and promoting proactive measures to address them. So, the following hypotheses are proposed:

- H1a: Farmers' perceptions of the risk connected with rocky desertification have a favorable impact on their participation in management activities aimed at mitigating the effects of desertification
- H1b: Farmers' willingness to assist in its control is positively impacted by their assessment of the risk associated with rocky desertification.

A person's decision to participate in a certain action is based on a number of factors, including the influence of important people, such as friends and family, according to the Theory of Planned behavior (TPB). These people's social pressure may cause behavioral intentions to shift (Xu, 2021). Thus, this study posits that farmers' attitudes and beliefs regarding desertification control, influenced by friends and family, impact their willingness to participate. Specifically, farmers' intentions to engage in desertification control increase with the strength of their subjective norm perception regarding the issue. Therefore, the following hypothesis is proposed:

- H2: Subjective norms have a favorable effect on farmers' intentions to take part in desertification management.

Positive or negative behavioral attitude is a person's subjective assessment of a certain activity (Ajzen, 1991). It is widely accepted that individuals are more likely to engage in behaviors they hold positive attitudes toward. Research findings indicate that attitudes toward environmental behavior strongly influence the likelihood of engaging in such actions (Bamberg et al., 2003; Kaiser & Gutscher, 2003). Consequently, the following hypothesis is put forth:

- H3: Farmers' attitudes have a favorable impact on their readiness to take part in the control of desertification.

Perceived behavioral control measures an individual's perceived ability to control a particular behavior (Ajzen, 1991). Empirical evidence supports a direct correlation between behavioral intention and perceived behavioral control (Ajzen & Madden, 1986). People are more likely to take action if they believe they have control over their behavior and can mobilize resources to support it (Leeuw et al., 2015). Based on the Theory of Planned Behavior, individuals' willingness to participate in environmental conservation is positively influenced by their perception of behavioral control (Zhang et al., 2018). Consequently, the following hypothesis is put forth:

- H4a: Perceived behavioral control has a favorable impact on Participation of farmers in the management of desertification
- H4b: Farmers' engagement in programs aimed at slowing down desertification is positively impacted by their perception of behavioral control.

Behavioral intention, defined as an individual's inclination toward adopting a specific behavior, plays a crucial role in determining whether that behavior will be enacted. Chen and Xie (2021) identified a significant relationship between willingness and action in the context of desertification control. Therefore, it is hypothesized:

- H5: The determination to stop desertification has a favorable impact on the actions made to manage it.

The risk perception theory states that people's perceptions of environmental dangers have a direct impact on their willingness to take pro-environmental actions that reduce such risks. (Zhou et al., 2020; Tama et al., 2021a). Additionally, behavioral intention partially modifies the association between behavior and risk perception (Ajzen, 1991; Knauder & Koschmieder, 2019). According to Ajzen's (1991) Theory of Planned Behavior, behavioral intentions are influenced by subjective standards, perceived behavioral control, and attitudes toward the behavior. Based on these theories, it is hypothesized:

- H6a: People's attitudes toward desertification and their attempts to manage it are mediated and moderated by their willingness to control it.
- H6b: Between people's actions in controlling desertification and their subjective norms about it, willingness to regulate serves as a moderator and mediator.

- H6c: The willingness to regulate the process serves as a partial moderator and mediator between people's perceived behavioral control over desertification and their real efforts in regulating it.
- H6d: The willingness of individuals to control desertification acts as a partial mediator and moderator in the relationship between their perceptions of the risk and their efforts to manage it.

3. Research Methodology

The research methodology of this study involves two key components: research sampling and questionnaire design. 1) Sampling of the Research: The study targets families in the Bijie area of Guizhou Province, China, and focuses on examining factors impacting farmers' engagement in rocky desertification control. 2) Questionnaire Design: A 5-point Likert scale is used in a quantitative research approach to evaluate the factors that have been found.

3.1 Research Sampling

The study aims to investigate the factors influencing farmers' engagement in rocky desertification control. Targeting households in the Bijie area of Guizhou Province, China, was determined based on the widespread occurrence of rocky desertification in the region and the active involvement of farmers in its management. Information from China's Seventh National Population Census (Data from the Census of Population of China) shows that as of November 1, 2020, In Bijie City, Guizhou Province, there were 3.9933 million households. Among them, Qiannan District, housing 361,700 households, was identified for its significant impact on desertification control and substantial reduction in rocky desertification (Statistical Yearbook of Bijie City 2021). Thus, the 361,700 permanent families in Qiannan District, Bijie City, Guizhou Province, are the study's target population. The sample size was estimated at 399 individuals using Yamane's condensed method for sample size calculation (1973), with an additional 10% increase to account for potential questionnaire invalidity (Israel, 1992), resulting in 438 people as the sample size in total.

3.2 Questionnaire Design

The research design used in the study is quantitative, and it evaluates the factors found using a 5-point Likert scale. Considering every object on the scale, respondents are presented with five alternative responses that represent different degrees of agreement, ranging from "strongly disagree" to "strongly agree," or values ranging from 1 to 5. The survey is divided into two portions. Demographic data, such as age, gender, household income, and educational attainment, are gathered in the first section. The details of the findings are illustrated in Figure 1. In the second part of the questionnaire, the factors influencing farmers' willingness and actions to stop rocky desertification are assessed. These variables include behavioral control perception, attitude, subjective norms, perception of rocky desertification danger, and individual norms. Figure 2 provides measurement questions related to the scale.

4. Data Analysis

This study's results were carefully analyzed utilizing sophisticated statistical software. First, the data from the questionnaire was sorted and examined by the researchers to remove any irregularities. Descriptive statistical analysis was then performed on the sample, utilizing frequencies and percentages. Thirdly, tests for validity and reliability were used to evaluate the results of the questionnaire. Fourth, an assessment was made of the research model's goodness of fit and the research hypotheses' validity. Ultimately, the correlations between the research variables were examined by computing Pearson correlation coefficients.

4.1 Descriptive Statistical Analysis

The descriptive statistical results about the fundamental attributes of the research participants are displayed in Table 1. The data reveals a relatively balanced gender distribution, with 50.2% of the participants being male and 49.8% female. Regarding age distribution, 12.8% of participants are under 18, 19.2% fall between 18 and 30, 15.3% between 31 and 40, 16.4% between 41 and 50, 18.3% between 51 and 60, and 18% are over 60 years old. In terms of education, 85% of participants have attained education up to or below junior high school level. Furthermore, the majority of households (85.4%) report a monthly income of below 5,000 yuan.

Table 1 The research sample's descriptive statistics

		n	Percentage（%）
Gender	Male	220	50.2
	Female	218	49.8
Age	Under 18	56	12.8
	18-30	84	19.2
	31-40	67	15.3
	41-50	72	16.4
	51-60	80	18.3
	Over 60	79	18
Education Background	Primary school and below	210	47.9
	Junior high school	143	32.6
	High school	67	15.3
	Bachelor's degree or higher	18	4.1
Monthly Income	1,000 yuan or below	102	23.3
	1,001 to 3,000 yuan	150	34.2
	3,001 to 5,000 yuan	122	27.9
	5001 to 7000yuan	37	8.4
	7001 to 9000yuan	20	4.6
	9,001 yuan and above	7	1.6

4.2 Reliability and Validity Analysis

4.2.1 Reliability Analysis

Validity and reliability analysis were conducted to evaluate the dependability of the questionnaire data in this study, as suggested by Guan (2009) and Zhang et al. (2018). The Cronbach's α coefficient was utilized to evaluate the dependability of the survey items. Generally, Cronbach's α coefficients below 0.65 are considered unreliable, while values between 0.65 and 0.70 are minimally acceptable, those between 0.70 and 0.80 are relatively excellent, and values between 0.80 and 0.90 are deemed very good (Zhang & Li, 2017). Table 2 presents the results of the questionnaire, indicating that all questions have scores averaging around 3.1, except for the perceived behavior control variable, which has an average value exceeding 3.5. Additionally, the questionnaire's total Cronbach's Alpha rating of 0.946 indicates good reliability. The Cronbach's Alpha values for the dimensions of Rocky Desertification Perception (RP), Subjective Norm (SN), Attitude (AT), Perceived Behavioral Control (PBC), Behavioral Intention (BI), and Control of Soil Desertification (CSD) are 0.968, 0.918, 0.869, 0.847, 0.902, and 0.938, respectively. The questionnaire demonstrates high reliability across these dimensions, meeting the reliability criterion without further investigation. Additionally, Table 2 shows that Every variable's average value is more than 3.5., with the perceived behavior control variable having the lowest mean value of 3.3685 and attitude exhibiting the highest mean value. A higher mean value indicates greater endorsement, with the average values ranging from 3.5485 to 3.9254 for the different dimensions.

Table 2 Questionnaire Measurement Items: Average Scores and Cronbach's Alpha Coefficients

Variables	**Average Score**	**Cronbach's Alpha Coefficient**
Rocky Desertification Perception (RP)	3.5485	0.968
Subjective Norm (SN)	3.5647	0.918
Attitude (AT)	3.9254	0.869
Perceived Behavioral Control (PBC)	3.3685	0.847

Behavioral Intention (BI)	3.8615	0.902
Control of Soil Desertification (CSD)	3.8370	0.938

These results demonstrate the average scores and reliability of the questionnaire items across different dimensions.

4.2.2 Validity Analysis

1) Model Convergence Validity Analysis

The researcher used an advanced software, known for its robust analytical capabilities, was employed to meticulously estimate the model's parameters. Table 3 presents the outcomes of this estimation process, wherein each indicator's standardized factor loading coefficient surpasses the threshold of 0.7. This indicates that each indicator effectively contributes to its respective latent construct, demonstrating satisfactory coefficients that lend credibility to the model's validity. Moreover, the examination extended to the Composite Reliability (CR) and Average Variance Extracted (AVE) indices further reinforces the model's robustness. Each individual indicator element's AVE value is noticeably over 0.5, meaning that the relevant indicators account for a significant amount of the variance in each construct. Additionally, the composite reliability values exceed 0.7, suggesting high internal consistency among the indicators within each construct. These findings collectively affirm the model's strong convergence validity, indicating that the data accurately reflect the underlying theoretical constructs and are suitable for subsequent analysis and interpretation.

Table 3 The Convergence Validity Outcomes

Factor	Question	Std. Estimate	AVE	CR
RP	RFP1	0.896	0.77	0.968
RP	RCP3	0.814		
RP	RCP2	0.887		
RP	RCP1	0.885		
RP	RLP3	0.929		
RP	RLP1	0.868		
RP	RLP2	0.91		
RP	RFP3	0.778		
RP	RFP2	0.919		
AT	AT1	0.845	0.692	0.87
AT	AT3	0.787		
AT	AT2	0.861		
SN	SN1	0.885	0.791	0.919
SN	SN3	0.864		
SN	SN2	0.919		
PBC	PBC1	0.82	0.532	0.849
PBC	PBC5	0.686		
PBC	PBC4	0.673		
PBC	PBC2	0.788		
PBC	PBC3	0.664		
BI	BI1	0.854	0.754	0.939
BI	BI5	0.873		
BI	BI4	0.891		
BI	BI3	0.875		

BI	BI2	0.848		
CSD	CSD1	0.784	0.739	0.894
CSD	CSD3	0.902		
CSD	CSD2	0.888		

2) Discriminant Validity Analysis

Table 4 displays the results of the discriminant validity analysis, which is a comparison between the factor correlations and the square root of the Average Variance Extracted (AVE). The results indicate that the square root of the AVE for each factor exceeds the maximum correlation between this element together with any other element. This comparison confirms that the questionnaire exhibits robust discriminant validity. In essence, discriminant validity ensures that each construct in the model is distinct from others and measures a unique aspect of the phenomenon under investigation. The findings from this analysis suggest that the questionnaire effectively distinguishes between different constructs, as the variance captured by each construct's indicators is greater than the shared variance between constructs. Consequently, researchers can have confidence that the questionnaire accurately captures the unique characteristics of each construct and avoids redundancy or overlap between them. Overall, the strong discriminant validity observed in the analysis enhances the credibility and reliability of the questionnaire. It provides assurance that the measured constructs are indeed distinct and contribute uniquely to the understanding of the phenomenon being studied. This validation is crucial for ensuring the accuracy and integrity of subsequent analyses and interpretations based on the questionnaire data.

Table 4 Analysis of Discriminant Validity

	RP	**AT**	**SN**	**PBC**	**BI**	**CSD**
RP	0.877					
AT	0.39**	0.832**				
SN	0.37**	0.449**	0.89			
PBC	0.162**	0.191**	0.261**	0.729		
BI	0.398**	0.435**	0.477**	0.393**	0.869	
CSD	0.451**	0.595**	0.577**	0.35**	0.536**	0.86

*** At the 0.01 level, correlation is significant(2-tailed).*

4.3 Correlation Analysis

In this analysis, the associations between numerous variables were investigated through an exploratory study that made use of Pearson correlation analysis. All of the variables show high connections with one another at a 99% confidence level, according to the data shown in Table 5. There is a constant and substantial positive connection ($r > 0$) shown by the correlation coefficients (r) between the variables. This correlation analysis provides valuable insights into the interrelationships among the variables under investigation. By examining the strength and direction of these correlations, researchers can gain a deeper understanding of how different factors influence one another within the context of the study. The significant positive correlations observed indicate that as one variable increases, the other variables tend to increase as well, and vice versa. These findings highlight the interconnected nature of the factors influencing environmental risk perception and pro-environmental behavior among farmers. Understanding these correlations is essential for developing effective strategies and interventions aimed at promoting sustainable agricultural practices and environmental conservation efforts. Moreover, the robust correlations observed underscore the reliability and validity of the research model and the questionnaire used to collect data. The consistency of the correlations strengthens the confidence in the relationships identified and enhances the credibility of the study's findings. Overall, the correlation analysis serves as a valuable tool for uncovering patterns and relationships within the

data, providing valuable insights that can inform future research and decision-making in the field of environmental management and agricultural sustainability.

Table 5 Correlation Evaluation

	BI	CSD	RP	SN	AT	PBC
BI	1					
CSD	0.536**	1				
RP	0.398**	0.451**	1			
SN	0.477**	0.577**	0.370**	1		
AT	0.435**	0.595**	0.390**	0.449**	1	
PBC	0.393**	0.350**	0.162**	0.261**	0.191**	1

** *At the 0.01 level, the correlation is significant (2-tailed).*

4.4 Model Fit Test

According to Table 5's fit test findings, the model's fit indicators satisfy the necessary requirements. To be more precise, the model meets the following criteria for a decent fit: CMIN/DF = 2.223 (less than 5), RMSEA = 0.053 (less than 0.08), GFI = 0.894, TLI = 0.986, CFI = 0.961, and NFI = 0.933. The questionnaire survey's fit indices are generally great, according to these results, and the study's overall fit is considered good.

Table 6 Test of Model Fit

Indicators of Observation	Indicators of Evaluation		Model Value
	Adequate	good	
RMESA	<0.08	<0.05	0.053
CMIN/DF	<5.00	<3	2.223
CFI	[0.7, 0.9]	>0.9	0.961
GFI	[0.7, 0.9]	>0.9	0.894
NFI	[0.7, 0.9]	>0.9	0.933

4.5 Hypothesis Testing

All route coefficients between the latent variables are positive and $p < 0.05$ in Table 7, indicating a statistically significant positive influence among the variables. Consequently, all direct hypotheses of the investigation are validated. Assuming multivariate normality, the study used the free bootstrapping technique to confirm, at a 95% confidence level, the relevance of the indirect impacts of the final route model. Therefore, all indirect hypotheses derived from the study model are confirmed.

Table 7 Results of Research Hypotheses

Variable	Relationship		SE	CR	p	Std. Estimate
RP	→	BI	0.040	4.144	0.000	0.189
RP	→	CSD	.028	3.390	.001	.138
AT	→	BI	.057	4.042	.000	.213
AT	→	CSD	.043	7.748	.000	.388
SN	→	BI	.046	4.923	.000	.250
SN	→	CSD	.033	5.784	.000	.270

Variable	Relationship		SE	CR	p	Std. Estimate
PBC	→	BI	.051	6.268	.000	.288
PBC	→	CSD	.037	3.117	.002	.131
BI	→	CSD	.038	3.097	.002	.151

4.8 Intermediate Effect Testing

Under the premise of a multivariate normal distribution, the study used the free bootstrapping method to confirm, at 95% confidence intervals, the importance of the indirect consequences of the final route model.Table 8 illustrates the validity of all indirect assumptions used in the research model.

Table 8 Effects of Mediation Results

Route	Calculate	SE	Lower	Upper	P
AT→BI→CSD	.062	.03	.016	.136	.001
SN→BI→CSD	.054	.022	.018	.103	.001
PBC→BI→CSD	.097	.031	.043	.165	.001
RP→BI→CSD	.036	.016	.01	.071	.004

5. Discussion And Conclusion

This study introduces a critical variable, risk perception, into a study model concerning farmers' involvement in the remediation of rocky desertification in the Bijie region of Guizhou province, grounded in the Theory of Planned Behavior. While prior research has mainly concentrated on the engineering and technical facets of karst rocky desertification management, there remains a gap in comprehending the psychological factors influencing farmers' involvement in its governance. Thus, this study fills that void. Supported by the Theory of Planned Behavior, renowned for its robust predictive capacity in personal actions that support the environment, our findings further bolster its theoretical underpinnings and predictive efficacy in this domain. The results affirm earlier research, illustrating the direct impact of individual environmental risk perception, attitude, subjective norms, and perceived behavior control on pro-environmental behavior intention. Furthermore, pro-environmental behavior, perceived behavioral control, attitude, subjective norms, and environmental risk perception are all mediated by behavioral intention. Additionally, policy interventions can be informed by taking into account farmers perceived behavioral control as a partially mediating variable impacting their behavior and willingness to participate in the governance process. Initiatives such as providing ecological compensation to farmers, improving the ecological compensation mechanism, and reducing operating costs for pro-environmental activities can foster regional sustainable development. Aligned with the Theory of Planned Behavior, proactive government initiatives are pivotal in cultivating farmers' eagerness and readiness to engage in rocky desertification governance and cultivate personal standards for engagement. Despite the study's accurate predictions regarding farmers' inclinations and actions in rocky desertification governance, limitations exist. The sole reliance on quantitative research methods restricts the exploration of qualitative aspects, underscoring the necessity for mixed methods approaches in future studies. Additionally, expanding the focus beyond farmers to encompass decision-makers and planners in relevant organizations and validating findings across diverse geographical contexts are recommended for a comprehensive understanding and broader applicability.

In summary, this investigate examines the factors influencing farmers' participation in rocky desertification treatment, introducing risk perception into the research model grounded in the Theory of Planned Behaviour. While previous research focused on technical aspects, this study explores psychological factors affecting farmers' involvement in desertification governance, strengthening the theory's predictive capacity. Findings confirm the impact of risk perception, attitude, subjective norms, and perceived behaviour control on pro-environmental behaviour intention, mediated by behavioural intention. Recognizing risk perception's role is crucial, guiding targeted training programs and policy interventions for sustainable development. Proactive government initiatives are essential, aligned with the

Theory of Planned Behaviour. However, limitations exist, suggesting the need for mixed methods approaches and broader validation for comprehensive understanding.

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