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Smallholder farmers' behavioral preferences under the impact of climate change: A comparative analysis of two agricultural areas in China

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Farmers' behaviors to deal with climate change can be divided into two categories: mitigation and adaptation. Mitigation behaviors can reduce the rate of climate change, while adaptation behaviors can reduce the vulnerability to climate change. In this study, we focused on the factors influencing farmers' behavioral preferences and explored the differences in their behaviors in response to climate change in different types of regions. A structural equation model was constructed to describe the relationship between trust, risk perception, psychological distance and risk severity, and farmer behaviors. The results indicate that the factors affecting climate adaptation vary greatly in different regions. In agricultural areas, risk salience, psychological distance and mitigation behaviors had an important influence on farmer adaptation behavior, while risk perception only affects farmers' mitigation behaviors. Trust can not only predict farmers' adaptability, but also explain farmers' choice of mitigation behaviors. For farmers in farming and pastoral areas, belief, risk severity level and trust have positive driving effects on both adaptation and mitigation behaviors. The findings provide suggestions for the development of public policy and risk management approaches to deal with climate change, which could encourage active behavior among farmers.

KEYWORDS
climate change, agriculture, adaptation behavior, mitigation behavior, farmers

1 Introduction

In recent years, the public has gradually become aware of global warming. Global climate change has become an objective reality faced by humankind and a major global issue of universal concern to the international community (Liu et al., 2018). China is one of the most sensitive areas of global climate change, with the rate of the temperature rise exceeding the global average during the recent period. ""The Blue Book on China's

Climate " indicates that from 1901 to 2017, China's average annual surface temperature rose by 0.24°C every 10 years. At the same time, extreme weather events, such as high temperatures, severe rainfall, and waterlogging, have also increased due to climate warming. Climate change is likely to cause widespread, serious, and even irreversible impacts on ecosystems and human society (IPCC, 2014). In this case, whether managers and agricultural producers can respond to climate change and its impact is the key to mitigating the negative impacts of climate change and to achieve profitability.

Climate change has brought about major changes in agricultural production and industrial structure, which has increased the uncertainty of farming incomes, threatened the food security of China and the rest of the world (Huang, 2016). Agricultural production is closely related to climatic conditions, climate change will bring essential risks to the agriculture sector. Agriculture is the sector that bears the brunt of climate change, it faces many of the major risks of climate change. Meanwhile, Climate change will increase the risks to agricultural production. It is predicted that climate change will have a serious impact on global food security by the middle of the 21st century (Dubey et al., 2016). The impact of climate change on agriculture has attracted much attention from all parts of society. How best to deal with climate change is not only a major environmental issue, but also a major issue related to people's livelihoods and economic development.

Agricultural production is an interwoven process of natural and economic activity, which is highly vulnerable to climate change. The effects of global warming have reduced the yield of some of the world's major food crops over the past 25 years. Due to their low level of adaptation, developing countries have been particularly adversely affected by the negative effects of climate-induced events (Zilli et al., 2020). As a major agricultural country with a large population, China is substantially affected by climate change, which has become one of the world's most vulnerable and sensitive countries. While the world is committed to mitigating climate change, the adaptation of farmers to climate change is not only the focus of the international community, but also the focus of the Chinese government's sustainable development strategy. Farmers are the basic unit of agricultural production. To improve the ability of the agricultural sector to respond to climate change, China must focus on micro-farmers. Researching farmers' adaptive behaviors to climate change has important practical value.

When faced with climate change, farmers first recognize changes through their subjective perception, and then take corresponding countermeasures. Farmers' recognition of climate change will directly affect their behavior. Human behavior under climate change is closely related to people's cognition, understanding, and behavioral patterns. With the deepening of farmers' understanding of climate, an increasing number of farmers are willing to take initiatives to achieve the sustainable development of agriculture. Therefore, improving farmers' understanding of climate change will help to formulate effective strategies for agricultural adaptation to climate change. Improving farmers' understanding of climate change can lead to effective adaptations to climate change. A large number of empirical studies in social psychology and behavioral psychology have shown that there is a significant positive correlation between the public's understanding of environmental changes and their adaptive behaviors (Abid et al., 2015). However, there are both individual and regional differences in understanding among farmers (Mc Guinness and Taylor, 2014). Studying the understanding of climate change in different regions and its influencing factors will assist farmers to correctly understand climate change and take reasonable measures to adapt to its impacts.

Farmer behavior is the basis of the agricultural sector's adaptation strategy to climate change, and it is the key to adapt to climate change generally. Human behavior is greatly affected by climate change. From this perspective, regardless of how much progress we have made in adopting technology to mitigate climate change, the ultimate and most effective measure is human behavior. Both adaptation and mitigation strategies have gradually emerged in recent years to cope with the pressure of global climate change (Yazdanpanah et al., 2014; Mase et al., 2017). Because climate change is already happening, adaptation has become the primary strategy in response to climate change. Adaptation can greatly reduce farmers' vulnerability to climate change. Research has shown that adaptive behavior is almost the same in different regions (Mwaseba et al., 2014; Asrat and Simane, 2017; Du et al., 2021). However, the factors that influence adaptive behavior are different in different areas, and their effects are also different. Adaptation to climate change varies over time and space, with variations in factors such as cultivation time, cultivation methods, crop types, and climate types (Deressa et al., 2009; Yazdanpanah et al., 2014; Asrat and Belay Simane, 2017; Asrat and Simane, 2017; Liu et al., 2018; Rezaei et al., 2018). It is also commonly believed that farmers' ability to adapt to climate change is positively related to their income. For plantation farming, the larger the proportion of the total income of peasant households, the more attention the household will give to climate change (Arshad et al., 2009; Liu et al., 2018; Ullah et al., 2018).

Mitigation aims to reduce the impact of human activities on climate change, while adaptation aims to improve the adaptability of human society. Mitigation is an intervention aimed at controlling the causes of climate change, such as reducing emissions of greenhouse gases into the atmosphere (Asrat and Simane, 2017). Without effective mitigation, adaptive strategies will become ineffective in the face of increasing climate change (Deressa et al., 2009). To fully understand the basic challenges faced by farmers, it is necessary to define and compare the concept of the mitigation and adaptation modes, to identify the internal relationships and conflicts between them, and provide a theoretical basis for the rational analysis of the two modes.

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In this study, we considered different agricultural production areas in China. Some were agricultural areas, while others were agricultural and animal husbandry areas. We investigated the climate adaptation behaviors of farmers in these different regions. In the paper, we introduce the synergistic and complementary effects between mitigation and adaptation behavior to study the behavior of different farmer groups. The study makes an important contribution to the literature on farmers' mitigation and adaptation behavior, and overcomes the limitations of previous studies.

The aims of this study were as follows: 1) to explore the perception of different groups of farmers to climate change based on their individual perspectives; 2) to investigate the actions taken by different groups of farmers toward climate adaptation or mitigation behavior; 3) to determine the key factors that affect or hinder farmers' choices with regard to extreme climate behavior, and evaluate the effectiveness of their behavior. This study will not only improve our understanding of the micro-mechanisms of extreme climate change behavior, but will also help the government to identify different target groups and understand the micro mechanisms of different actors in their adaptation to extreme climate events.

The rest of the paper is organized as follows. Section 2 describes the theoretical model, while Section 3 formulates the empirical model. Then, Section 4 presents the results and a discussion, followed by the conclusions and policy implications of the paper in Section 5.

2 Theoretical model

The study was based on the theoretical analysis of trust, climate change beliefs, risk perception, and adaptation (Arbuckle et al., 2013; Eggers et al., 2015; Leiserowitz, 2005). The methodological framework followed the "value-beliefs-norms" (VBN) approach, which has been applied to the study of human behavior by many scholars (Asrat and Belay Simane, 2017). The VBN theoretical framework originates from a psychosocial perspective, which contains four variables: values, beliefs, norms, and behavior. Although the framework has already produced valuable results, with the addition of further variables, such as risk salience and psychological distance, the ability to predict farmer behavior will increase. Previous studies have found that one of the unique characteristics of climate change risks is that they are often seen as a distant psychological risk (Habiba U, Shaw R, Takeuchi Y. F, 2012). Researchers believe that perceiving climate change through so-called psychological distance may reduce the possibility of accepting the reality and impact of climate change, and thus it is possible to neglect support for mitigation action and even adaptation behavior. However, there is little published research on how the above issues affect the behavioral choices of Chinese farmers. This study attempted to fill this gap and make a contribution to the literature.

The main motivator of the adaptation response is the perception of climate change. Risk perceptions are beliefs about potential harm or the possibility of a loss. This is a subjective judgment that people make about the characteristics and severity of a risk. In the study, risk perception was considered to be a subjective judgment made by farmers regarding the characteristics and severity of the risks brought about by climate change. Risk perception can also be an important indicator of the psychological state of farmers. As an important part of the risk management process, risk perception has become a hot topic in sociology, psychology, disaster science, and other research fields. However, there have been few studies of farmers' behavior regarding climate risk perception.

Trust is one determinant of farmers' behaviors under climate change (Azadi et al., 2019). From a sociological perspective, trust is an important dimension of social relationships and an indispensable part of social capital. Many previous studies have shown that trust in institutions is moderately correlated with public behavior and farmers' perception, and adaptation to climate change relies on experts, authoritative institutions, and media discourse, which will improve the quantity and quality of information regarding climate change and adaptation technology available to farmers (Deressa et al., 2009). Successful mitigation and adaptation to climate change depends on the public's trust in experts and institutions. Generally, when farmers obtain timely and accurate information, their understanding of climate change will be deeper and their adaptation behavior will also be more effective. In this study, we measured farmers' trust in government agencies, experts, and risk management institutions, and discuss the implications of these findings for government. We also considered how experts can potentially increase trust levels to foster engagement in climate-friendly behaviours.

Beliefs refer to the existence and characteristics of a natural hazard. Climate change belief or awareness is an important predictor of farmer behavior. Previous studies have confirmed there is a strong correlation between belief and adaptive measures (Arbuckle et al., 2013; Mc Guinness and Taylor, 2014; Liu et al., 2018; Mase et al.,2015). Farmers who believe that climate change does occur have a higher overall perceived risk, and are more inclined to take mitigation measures. Liu et al. (2018) and Ullah et al. (2018) revealed that these beliefs have a negative impact on climate change measures. In contrast Hasibuan et al. (2019) and Mwaseba et al. (2014) proposed that an awareness of climate change was positively correlated with mitigation measures. Belief in climate change is manifested by an awareness of climate change-related phenomena, and is a measure of the extent to which farmers believe in the occurrence and influence of climate change. Studies of different populations may therefore yield different results. Studying how the public perceives risks can help policymakers better understand whether a target population thinks a hazard should be addressed.

Traditionally, it was believed that climate change risks would only affect the interests of other people or countries, and future generations (Hendrickx and Nicolaij, 2004). But now, an increasing number of studies support the general view that psychological distance plays a role in accepting the reality of climate change. Among them, the psychological distance model (CLT) proposed by Liberman and Trope summarizes the four key dimensions of psychological distance: spatial distance, temporal distance, distance between a perceiver and a social target (i.e., another person or group), and uncertainty (for example, the degree of certainty that an event will occur). Currently, the literature on CLT in the field of climate change is relatively limited. Existing research shows that climate change is most likely to affect geographically distant people and regions, as well as the interests of future generations. In fact, more scholars believe that the effects of climate change are likely to be more severe in developing countries, especially those geographically located in the south. In addition to this, there appears to be a general spatial bias in which people tend to perceive environmental degradation to be more severe at the global level than at the local level. In current research, spatial distance has still been confused with social distance. To summarize, an individual's experience of weather and climate change-related events can spur them into action. Recent research shows that the experience of flood disasters (attributed to climate change) is significantly related to the way individuals perceive climate change and the extent to which they are prepared to take action on climate change. It means that an individual's experience with weather and climate change-related events can motivate them to take action. If we design more effective behavioral interventions, we must consider the psychological distance of climate change and examine the impact of distance on a series of mitigation and adaptation actions. This will ensure that government can establish the best behavioral framework.

To sum up, there are few literatures that analyze the behavioral research of farmers' psychological distance in detail and systematically, and there also have few of relevant literature to investigate the relationship between different aspects of psychological distance, concern about climate change and willingness to take action. Therefore, there is a need to better understand farmers' perceptions of the relationship between the three in order to develop effective measures to facilitate farmers' efforts to address climate risks. For China, agriculture is generally dominated by either agricultural production areas or agricultural and animal husbandry production areas. Farmer behavior can be subdivided into adaptive behaviors and mitigation behaviors, which are adopted by different groups. Exploring the relationships between the different behaviors is crucial for enabling farmers to adapt to climate change. Based on the behavior change framework VBN and CLT theory, this study attempts to establish a behavioral framework model that can be widely used by comparing and analyzing the characteristics of farmers in different regions. This model can more effectively explain the predictive ability of climate change mitigation and adaptation behaviors in agricultural production, thereby providing a knowledge system for environmental protection behaviors in agricultural production environments. The theoretical framework of the research is shown in Figure 1.

3 Empirical analysis

We selected Henan and Inner Mongolia as empirical survey areas. Henan is a major agricultural region in 2021, Henan's total grain output was 130,884 million tons, ranking second in China. Wheat production in Henan accounts for more than 40% of the total national wheat output, which has given Henan the reputation of being the Central Plains Granary. The other area we selected was Inner Mongolia, which is one of the three major producing areas of small grains and the largest pastoral area in China. In agricultural terms, Inner Mongolia is located in the Northern Hemisphere's golden corn belt, and is one of the country's main production provinces. In terms of animal husbandry, Inner Mongolia is located in the "golden milk source zone" of the Northern Hemisphere, and is the largest producer of dairy products in China. We selected these two different regions to compare the impact of climate change on China's agriculture.

Over the past 50 years, the temperature in Henan Province has increased by 0.73°C. The temperature difference between winter and summer has decreased significantly, and the temperature difference between day and night has also tended to decrease. The average annual precipitation of the whole province has fluctuated, and the average annual precipitation days have shown a decreasing trend. Provincial meteorological data indicates that extreme drought events have increased significantly, with frequent heavy rainfall, snow disasters, frost, cold, and other disasters worsening. The overall change of precipitation in Inner Mongolia over the same period is not significant, with the change of summer precipitation being more severe than the interannual change. The frequency of extreme precipitation events, such as rainstorms, may be increasing due to the influence of climate warming. As shown above, both areas are vulnerable to climate change.

According to the principle of optimal sample selection (Marcoulides et al., 2020), the study sample size was 600 and 500 farmers in Henan and Inner Mongolia, respectively. We used a multi-stage stratified random sampling method to select samples of farmers from the study area. A face-to-face survey was conducted in the fall of 2021. We collected data through structured questionnaires. A five-point Likert scale was used for beliefs, psychological distance, trust, risk salience and risk perception, and farmer behavior.

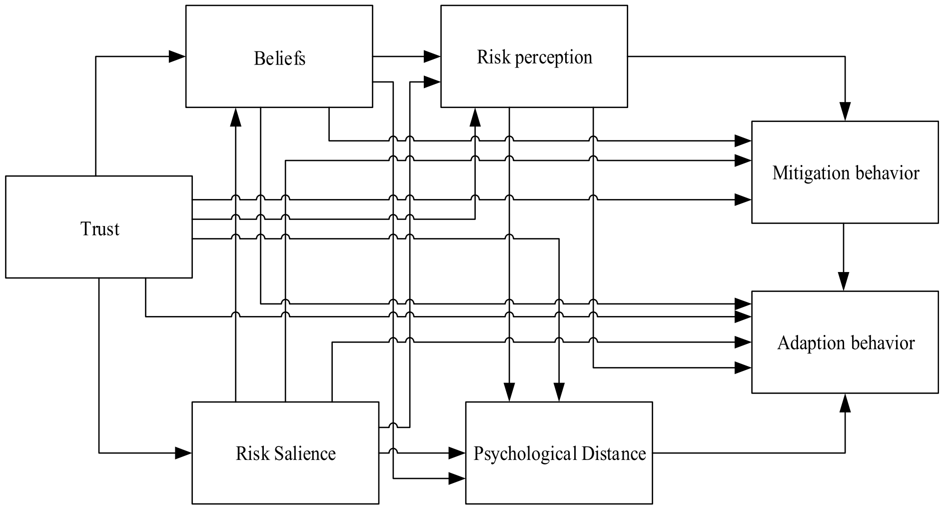

FIGURE 1
| Research framework.

4 Results

4.1 Descriptive statistics

In Henan Province, we collected 812 samples, of which 630 were considered valid. Among them, 44% were female, 28.7% were graduates from junior high school, and 42% had a high school degree or above. In Henan, approximately 30% of farmers had incomes lower than the national average level. The mean score for climate change belief was 4.1, while the risk perception score was 4, which indicated that farmers were well aware of the reality of climate change, and were highly sensitive to its impacts. The mean score of the mitigation behavior was 3.7, while for adaptive behavior it was 3.8. The results suggest that the farmers were inclined toward adaptive behavior.

In Inner Mongolia, we collected 500 samples, of which 370 were considered valid. Among them, 21.5% were female, 28.7% were graduates from junior high school, and 73% had a high school degree or above. In Inner Mongolia, approximately 30% of farmers had incomes lower than the national average level (7,919 yuan). The mean score for climate change belief was 4.01, while the risk perception score was 3.8. The results showed that they were highly sensitive to the impact of climate change. However, compared with the farmers in Henan, the farmers in Inner Mongolia had a weaker perception of climate change risk. Through investigation, it was found that farmers were not sensitive to no-till farming, and therefore this agricultural practice was deleted from the model.

Table 1 shows examples of climate change questionnaire items, with the results in brackets representing the calculation results for Inner Mongolia. The validity of the questionnaire was approved by experts. Before we started the research, we selected pilot samples. Through pilot experiments, we removed the factors of hypothetical distance and social distance, due to their Cronbach's alpha values being less than 0.6, and then combined temporal distance and spatial distance as they were unifying factors. Then, we conducted a second questionnaire survey. The final results are shown in Table 1. The validity of the questionnaire was recognized by experts. All questionnaires were checked to ensure that the answers were complete. The value of Cronbach's alpha reliability coefficient was generally 0.6 to 0.9 (Table 1). All remaining impact factors were tested for compliance in strict accordance with the requirements of the AMOS 20 software.

4.2 Analysis of the model fit

Before conducting structural equation modeling (SEM), we tested all of the data for collinearity. The results showed that the variance inflation factor of variables was less than 10, indicating that there was no multicollinearity. We then applied a series of indicators that were calculated to test our model fit. The indicators included the root mean square error of approximation (RMSEA), goodness-of-fix index (GFI), normed fit index (NFI), Chi square, and minimum discrepancy per degree of freedom (CMIN/DF).

TABLE 1 Summary of questionnaire results.

Dimension	Questionnaire	Mean	SD
Climate Change Beliefs α=0.88, M=4.1, SD=0.8 (α=0.87, M=4.01, SD=0.86)	I believe that weather conditions have changed (precipitation and temperature) compared to the past	4.12(4.1)	0.8(0.86)
	I believe there has been a decrease in snow and rain compared to the past	4.15(4.1)	0.8(0.86)
	I believe that more drought, dust, and other unusual weather events have occurred in recent years	4.04(3.9)	0.9(0.9)
	I believe that the dry season in recent years comes sooner than in the past	4.05(3.9)	0.8(0.9)
	I believe that winter here is not as cold as it was in the past	4.21(4.3)	0.7(0.9)
	I believe that winds are particularly strong in summer and stir up dust	3.85(3.8)	0.9(0.9)
	It seems that this area is likely to be affected by climate change	4.17(4.1)	0.7(0.75)
hypothetical distance α=0.8, M=3.4, SD=1 (α=0.73, M=3.13, SD=0.9)	Climate change will mainly affect areas that are far away from here	3.14(3)	1(0.9)
	Climate change likely affects cities more than rural areas	3.3(3.1)	1.1(0.9)
	Climate change will not affect current generations, but it will affect the lives of future generations	3.41(3.1)	1.3(0.9)
	I haven't noticed the effects of climate change, but I think the effects of climate change will be observed in the next 50 years	3.61(3.3)	1(0.9)
Risk Perceptions α=0.91, M=4, SD=0.8 (α=0.89, M=3.8, SD=0.88)	I think that climate change will cause decreasing soil fertility	3.81(3.5)	0.79(0.9)
	I believe that climate change will lead to reduced forage and livestock waste	3.57(3.2)	0.87(0.9)
	I believe that climate change will have a negative impact on agriculture in the Kermanshah province	4.02(3.7)	0.71(0.89)
	I believe that climate change has a negative impact on wheat production in the Kermanshah province	4.07(3.6)	0.73(0.88)
	I think that the amount of milk and meat cattle will decrease due to climate change	3.74(3.4)	0.83(0.9)
	I believe that diseases and pests will increase due to climate change	4.05(3.9)	0.77(0.9)
	I believe that climate change will lead to biodiversity depletion	3.88(3.7)	0.8(0.9)
	Considering any potential effects of climate change there could be for society in general, how concerned are you about climate change?	4.2(4.5)	0.73(0.64)
	It seems to me that there have been increased rates of disease due to climate change	4.07(3.9)	0.75(0.9)
	How concerned, if at all, are you about the effects of climate change, sometimes referred to as 'global warming,' on human health?	4.23(4.5)	0.7(0.7)
Risks Salience α=0.83, M=4, SD=0.78 (α=0.8, M=4, SD=0.9)	I have personally experienced the effects of global warming	3.81(3.8)	0.81(0.79)
	I have seen reduced waters (rivers and wells, springs) due to climate change	4.14(4.1)	0.74(0.96)
	I have seen a decrease in the quality of my crops due to climate change	4.03(3.8)	0.8(0.96)
	The recent drought in the country is due to climate change	4.01(3.9)	0.78(0.85)
Trust α=0.93, M=4, SD=0.78 (α=0.9, M=3.9, SD=0.91)	Government agencies can provide the best available information on climate risks	3.81(3.8)	0.81(0.8)
	Government agencies can provide me with enough information to decide what actions I should take regarding climate risks	4.14(4.1)	0.74(0.9)
	Government agencies can provide me with truthful information about climate risks	4.03(3.8)	0.79(0.9)
	Government agencies can provide me with timely information about climate risks	4.01(3.9)	0.78(0.8)
Adaptation Behaviors α=0.7, M=3.8, SD=0.97 (α=0.6, M=3.8, SD=0.94)	In order to reduce the potential impact of climate change, will you increase the use of pesticides and fertilizers in order to reduce the adverse effects of climate change	3.7(3.3)	0.96(1.1)
	In order to reduce the potential impact of climate change, will you increase the frequency of irrigation in order to reduce the adverse effects of climate change	4(3.75)	0.86(1.1)
	In order to reduce the potential impact of climate change, will you change crop varieties to reduce the adverse effects of climate change	3.72(3.87)	0.94(0.8)
	In order to reduce the potential impact of climate change, will you buy agricultural insurance to reduce the adverse effects of climate change	3.7(4.2)	1.12(0.72)
Migration Behaviors α=0.8, M=3.7, SD=0.96 (α=0.6, M=4, SD=0.81)	In order to reduce the potential impact of climate change, will you use no-till machine to sow directly in order to reduce the adverse effects of climate change	3.53	1.1
	In order to reduce the potential impact of climate change, will you change the planting structure to reduce the adverse effects of climate change	3.64(3.9)	0.97(0.77)
	In order to reduce the potential impact of climate change, will you use organic fertilizer to reduce the adverse effects of climate change	3.8(3.7)	0.86(0.9)
	In order to reduce the potential impact of climate change, do you use crop rotation (crop rotation) to reduce the adverse effects of climate change	3.8(4.1)	0.93(0.7)

TABLE 2 The model fit summary.

Model	CMIN/DF	GFI	NFI	RMSEA
Henan	2.4	0.9	0.9	0.05
Inner Mongolia	1.9	0.9	0.9	0.05

MacCallum (1996) proposed the cut-points of the RMSEA, with the model fit being good when the RMSEA was 0.08–0.1. For the GFI, the general criterion is that the GFI value should be greater than 0.9, which would indicate that the model path map fitted the actual data well. The NFI can be used to compare the chi square difference between a proposed model and a nihility model, producing a ratio relative to the chi square value of the nihility model. The closer the value is to 1, the better the fitness of the model. A CMIN/DF value between 1 and 3, indicates that the degree of fit between the hypothesized model and the sample data is acceptable (Rezaei et al., 2018). The results are shown in Table 2. In summary, our data indicated that the model was acceptable from an empirical perspective.

4.3 Farmers' behavioral preferences under climate change in Henan

The structural equation results were as follows. The calculation results revealed the coefficients of each path in Figure 2. The results indicated that trust had a positive impact on risk salience, adaptive behavior, mitigation behavior and risk perception, with scores of 0.61 ($p<0.1$), 0.57 ($p<0.1$), 0.61 ($p<0.1$), and 0.59 ($p<0.1$), respectively. However, there was no relationship between trust and hypothetical distance. Belief had positive effects on the hypothetical distance (0.14, $p<$ 0.001) and risk perception (0.1, $p<$ 0.001). There were positive effects of risk salience on risk perception (0.87, $p<0.001$) and adaptation behavior (0.56, p < 0.001). The risk severity had a positive influence on belief (0.71, p <0.001), and risk perception

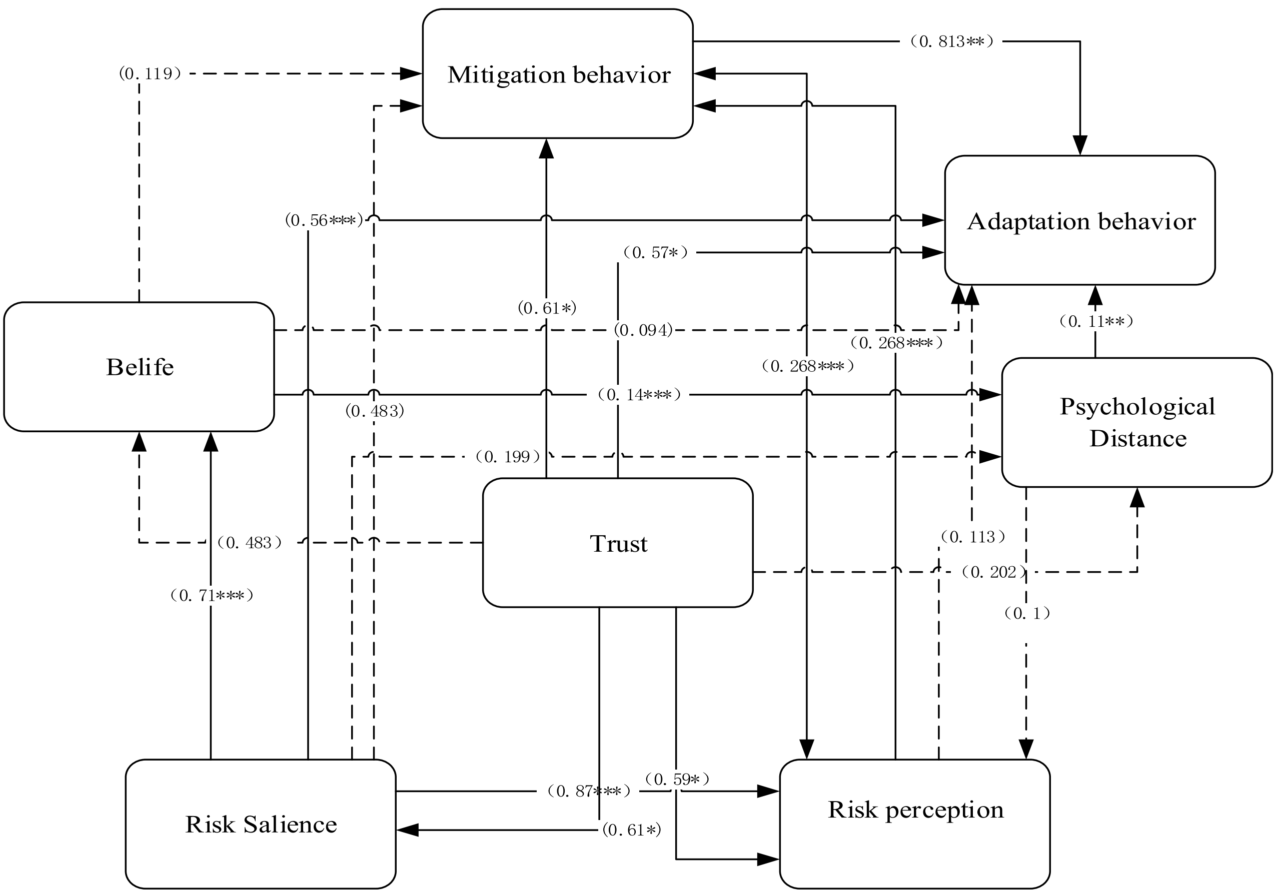

FIGURE 2
Structural equations modeling and path coefficients between variables in Henan. Note: non-significant (***$p<0.001$, **$p<0.05$, *$p<0.1$).

TABLE 3 The Standardized effects of the variables in Henan.

Standardized total effects	Trust	Risks salience	Belief	Hypothetical distance	Perception	Mitigation	Adaptation
Risks Salience	0.608	0	0	0	0	0	0
Belief	0.483	0.71	0	0	0	0	0
Hypothetical distance	0.202	0.199	0.137	0	0	0	0
Perception	0.591	0.867	0.11	0.092	0	0	0
Adaptation	0.576	0.565	0.094	0.107	0.113	0	0
Mitigation	0.611	0.458	0.119	0.102	0.268	0.813	0
Standardized Direct Effects	Trust	Risks Salience	Belief	Hypothetical distance	Perception	Mitigation	Adaptation
Risks Salience	0.608	0	0	0	0	0	0
Belief	0.052	0.71	0	0	0	0	0
Hypothetical distance	0.073	0.102	0.137	0	0	0	0
Perception	0.052	0.779	0.098	0.092	0	0	0
Adaptation	0.214	0.399	0.068	0.097	0.113	0	0
Mitigation	0.131	-0.17	0.023	-0.001	0.176	0.813	0
Standardized Indirect Effects	Trust	Risks Salience	Belief	Hypothetical distance	Perception	Mitigation	Adaptation
Risks Salience	0	0	0	0	0	0	0
Belief	0.432	0	0	0	0	0	0
Hypothetical distance	0.128	0.098	0	0	0	0	0
Perception	0.54	0.088	0.013	0	0	0	0
Adaptation	0.362	0.166	0.026	0.01	0	0	0
Mitigation	0.48	0.628	0.096	0.103	0.092	0	0

had a positive influence on farmers' mitigation behavior (0.268, p <0.001), The hypothetical distance had a positive effect on adaptation behavior (0.11, p<0.05). The results further revealed that adaptation behavior had a positive effect on mitigation behavior, with a score of 0.8(p<0.05).

Refer to Azadi et al. (2019) for the analysis of the indirect influence path of adaptive behavior. The indirect effects among the variables calculated in this paper are shown in Table 3. The results show that trust is transmitted through risk perception (β=0.48), risk severity level is transmitted through adaptive behavior (β=0.628), belief is transmitted through risk perception (β=0.1), and psychological distance is transmitted through adaptive behavior (β=0.103), risk perception is through adaptive behavior (β=0.1), which can have an indirect impact on farmers' mitigation behavior.

In summary, the variables of trust and risk salience jointly predicted 84% of the variance in risk perceptions. Belief directly and indirectly predicted 7% of the variance in hypothetical distance. Risk salience directly predicted 55% of the variance in belief. The variables of trust, risk salience, risk perceptions, hypothetical distance and belief jointly predicted 58% of the variance in adaptive behavior. The variables of trust, adaptive behavior, hypothetical distance, risk salience, risk perceptions and belief jointly predicted 83% of the variance in mitigation behaviors.

4.4 Farmers' behavioral preferences under climate change in inner Mongolia

The following results for Inner Mongolia are based on the model described above. According to the model fit and through appropriate adjustments, the structural equation results were as follows. The calculation results revealed the coefficients of each path in Figure 3. The results indicated that trust had a positive impact on belief, risk salience, hypothetical distance, adaptive behavior, and mitigation behavior, with scores of 0.33, 0.33,0.33, 0.2, 0.3, and 0.4, at the significance level of 1%, respectively. Belief had positive effects on risk perception (0.3, p<0.1) and mitigation behavior (0.1, p<0.001), and negative effects on mitigation behavior (−0.124, p<0.001). Risk salience had positive effects on risk perception (0.88, p<0.001), adaptation behavior (0.55, p<0.05), and adaptive behavior (0.43, p<0.01). The results did not confirm the relationship between the hypothetical distance and farmer behavior.

The indirect effects between variables are shown in Table 4. For the indirect effects of mitigation behaviors, the following results were obtained for trust through belief (β=0.16), trust through risk perception (β=-0.36), hypothetical distance through risk perception (β=-0.019), which can indirectly affect farmers' climate mitigation behavior. For the indirect effects of adaptive behavior, the following results were obtained for trust through hypothetical distance (β=−0.36), trust through risk perception (β= 0.13), risk salience through risk perception (β=0.004), and

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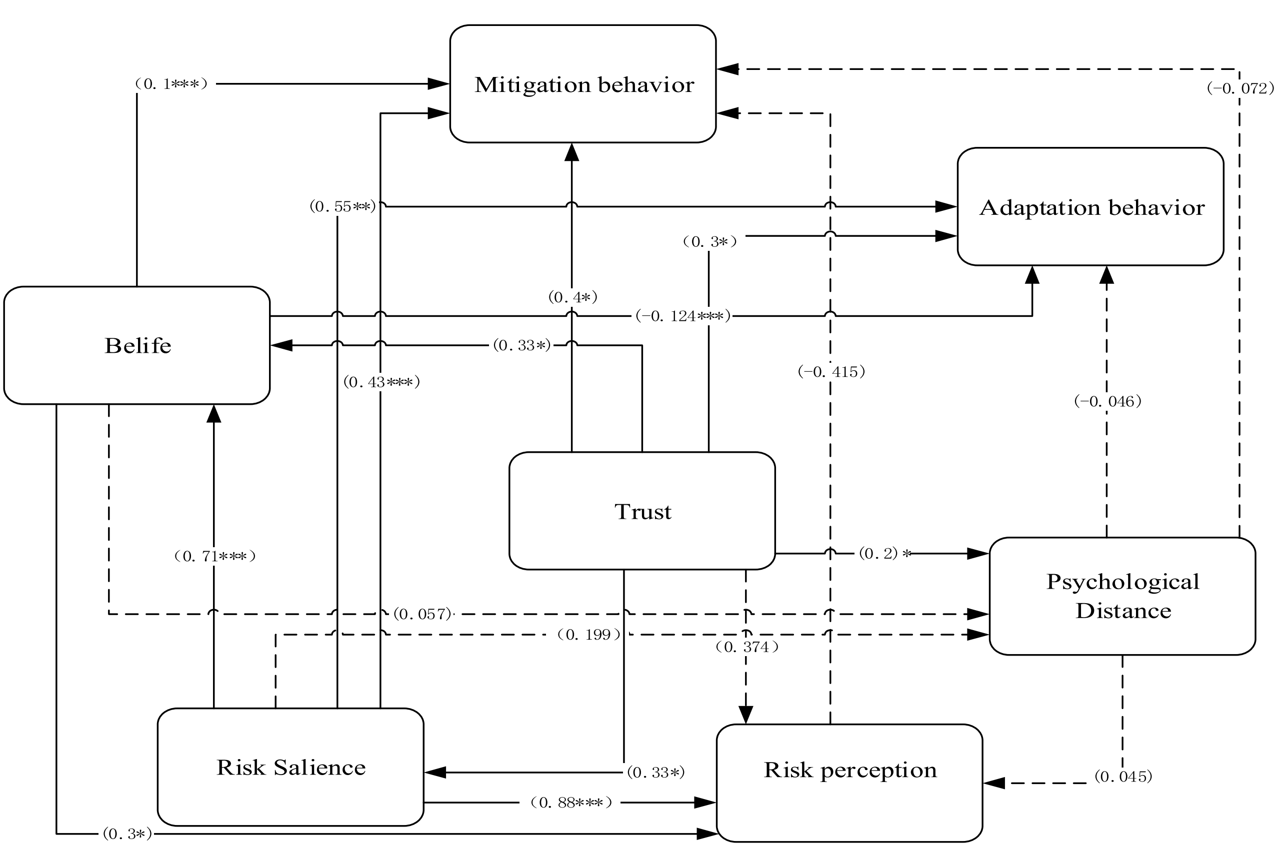

FIGURE 3
Structural equations modeling and path coefficients between variables in Inner Mongolia. Note: non-significant (****p*<0.001, ***p*<0.05, **p*<0.1).

belief through risk perception (β=−0.003), which can indirectly affect farmers' climate adaptive behavior.

In summary, the variables of risk salience and belief jointly predicted 90% of the variance in risk perception. Belief, trust, hypothetical distance and risk salience directly and indirectly predicted 37% of the variance in adaptive behaviors undertaken by farmers. Trust, belief, risk perception, risk salience, and hypothetical distance jointly predicted 41% of the variance in mitigation behavior undertaken by farmers.

5 Discussion

Mitigation and adaptation to climate change requires changes in human production systems and lifestyles. Public awareness of climate change is the first step toward these changes. A large number of empirical studies have shown that there is a significant positive correlation between the public's perception of environmental change and their adaptive behavior, in social psychology and behavioral psychology. Our conclusions have confirmed the importance of this for different types of farmers. Based on this information, we should be able to accurately evaluate farmers' understanding of climate change, the factors influencing their level of understanding, and the different behavioral measures they adopt. It is important for the government to formulate relevant policies to improve the ability of agriculture to adapt to climate change.

In China, agriculture can be divided into either agriculture or agriculture and animal husbandry. Agriculture is mainly concentrated in plain areas. Agriculture and animal husbandry is mainly concentrated in the four major pastoral areas of China. The Inner Mongolia Pastoral Area is the largest pastoral area in China. On the basis of the different climate change strategies (mitigation and adaption), this study conducted an in-depth analysis of the psychological variables regarding climate change between different types of farmers, and attempted to develop a unified social-psychological model to examine the decisions regarding adaptation and mitigation behaviors.

5.1 The SEM model in Henan

Through the SEM model, in agricultural areas such as Henan our analysis showed that risk salience was the greatest predictor

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TABLE 4 The Standardized effects of the variables in Inner Mongolia.

Standardized total effects	Trust	Risks salience	Belief	Hypothetical distance	Perception	Mitigation	Adaptation
Risks Salience	0.325	0	0	0	0	0	0
Belief	0.326	0	0	0	0	0	0
Hypothetical distance	0.202	−0.089	0.057	0	0	0	0
Perception	0.374	0.871	0.288	0.045	0	0	0
Adaptation	0.341	0.555	−0.124	−0.046	0	0	0
Mitigation	0.416	0.435	0.093	−0.072	−0.415	0	0
Standardized Direct Effects	Trust	Risks Salience	Belief	Hypothetical distance	Perception	Mitigation	Adaptation
Risks Salience	0.325	0	0	0	0	0	0
Belief	0.326	0	0	0	0	0	0
Hypothetical distance	0.212	−0.089	0.057	0	0	0	0
Perception	−0.013	0.875	0.285	0.045	0	0	0
Adaptation	0.211	0.551	−0.122	−0.046	0	0	0
Mitigation	0.255	0.792	0.215	−0.053	−0.415	0	0
Standardized Indirect Effects	Trust	Risks Salience	Belief	Hypothetical distance	Perception	Mitigation	Adaptation
Risks Salience	0	0	0	0	0	0	0
Belief	0	0	0	0	0	0	0
Hypothetical distance	−0.011	0	0	0	0	0	0
Perception	0.386	−0.004	0.003	0	0	0	0
Mitigation	0.13	0.004	−0.003	0	0	0	0
Adaptation	0.162	−0.357	−0.122	−0.019	0	0	0

of belief and the inclination to adopt adaptation behavior. When farmers directly experience the effects of climate change, they become aware of its consequences and will adopt more active adaptation behaviors. The findings also revealed that hypothetical distance played a central role in the structural model and was a significant predictor of adaptation behavior. The hypothetical distance can positively affect farmers' adaptation behavior. We found that the perception of psychological distance may have different effects on attention and action, which was similar to the results reported by (McDonald et al., 2015). When the impacts of climate change occur in remote places and potentially affect the future life of farmers, such farmers are more willing to adopt an adaptive strategy to prevent harm. Thirdly, farmers' mitigation behavior can positively influence adaptation behavior, which depends on the increase of farmers' risk awareness. Farmers who actively adopt mitigation behaviors are more likely to adopt positive adaptation behaviors due to their stronger awareness of climate change. At the same time, the model results that risk perception is a significant predictor of mitigation behavior, which meaning that when farmers are told that climate change is negatively affecting their farms, property, health and other related issues, they will act to prevent its impact.

Finally, the findings suggest that trust is not only a predictor of adaptive behavior, but also an important factor influencing mitigation behavior. In the context of climate change, social trust can be difficult to define and study. Following a pilot test, this study refers to a specific definition of trust (i.e., government management of climate change risks, providing information on climate change risks, etc.), and based on several questions of Vaske (Vaske et al., 2007) the social trust dimension is measured. The questions were designed to assess respondents' trust in "government officials" to effectively manage climate change risks. Research has found that in agriculture, social trust may require specific links between risk management and government agencies for government to exert influence. Our research underscores the importance of farmers' trust in government, which may enhance farmers' environmental behavior. Menapace et al. (2015) and Spence et al. (2012) have revealed the relationship between trust, risk saliency and risk perception, which has been confirmed in other confirmed in other studies. However, our study did not examine the relationship between trust and belief, suggesting that it is difficult to link social trust with climate risk perception. Climate-related risks are multifactorial in nature and are not the explicit responsibility of any particular local or government agency. Given this fact, the specific functioning of social trust may not account for the diversity of climate-related risks that differ in risk perceptions. Different from the results of Kellstedt et al. (2008), this study shows that trust does not promote farmers' understanding of climate change.

Although numerous studies have confirmed the relationship between beliefs and behaviors, this relationship has not been confirmed in an analysis of farmer behavior in rural areas, which is similar to the findings of a study of farmers in Iowa, which found that it was possible for farmers to undertake adaptation behaviors without engaging their belief systems about climate causality. Trust in the government not only has a direct effect on farmer behavior, but also functions as a mediating variable in the positive relationships between risk salience, risk perception, and mitigation and adaptation behavior. Carlton and Jacobson (2013) and Slovic (2000) revealed the relationships between trust, risk salience, and risk perception, which were then confirmed in other studies (Stern, 2000; Carlton and Jacobson, 2013). Although the relationship between trust and belief was not tested in our study, we found that trust cannot promote farmers' understanding of climate change, which differed from the results of Kellstedt (Kellstedt et al., 2008).

Finally, we found that the hypothetical distance can affect risk perception and adaptation behavior. Although a large number of studies have confirmed the relationship between belief and behavior, our analysis did not confirm the relationship. Very few studies have produced similar findings, although there has been one example from a study of farmers in Iowa, which found that it was possible for farmers to undertake adaptation behaviors without engaging their belief systems about climate causality (Arbuckle, 2013).

5.2 The SEM model in inner Mongolia

For Inner Mongolia, our analysis revealed that risk salience was the greatest predictor of risk perception and behavior strategies. In other words, for farmers in agricultural and pastoral areas, farmers' awareness of climate change will actively improve their response. The other important factors in farmers' behavior were trust and belief. The results showed that trust can affect belief, risk salience, adaptation behavior, and hypothetical distance. This conclusion reveals the high correlation between farmers' belief in climate change and government trust, and climate change beliefs are crucial to farmers' agricultural risk perceptions.

The model validates the correlation between beliefs and farmers' behavior in agro-pastoral areas. Climate change beliefs refer to the extent to which farmers believe climate change will occur and impact or their awareness of climate change-related phenomena. This study demonstrates that farmers in agro-pastoral areas who in the existence of climate change are more likely to adopt behavioral strategies, a finding consistent with Menapace (Menapace L et al., 2015). Farmers' perceptions of climate change are critical to their assessment of adaptation measures. At the same time, the model results re-emphasized the importance of trust to farmers' behavior choices. Contrary to the results of the agricultural area model, the agricultural and pastoral area structural equation model did not demonstrate the relationship between psychological distance and farmers' behavior. The findings suggest that the hypothesized relationship between farmers' behavior and psychological distance may not hold in the context of climate change, and that it may be difficult to change farmers' behavior by manipulating the variable of psychological distance.

6 Conclusion and policy recommendations

Our research will help policymakers to implement policies that can help farmers overcome the challenges associated with climate change. In this regard, the government needs to recognize the different backgrounds of farmers and their differing reactions, which may affect the ability of farmers to adjust their agricultural practices. In addition, policymakers also need to pay attention to various factors that affect farmers' perceptions and responses to climate change adaptation.

The findings showed that in agricultural areas, belief can predict the dimension of psychological distance, and psychological distance affects farmers' risk perception, which means that increasing farmers' beliefs about climate change can improve farmers' risk perception. The model proves that psychological distance, risk salience and farmers' adaptive behavior are highly positively correlated. Risk perception is positively correlated with farmers' mitigation behavior, but it does not prove the impact of farmers' beliefs on farmers' behavior. At the same time, the research proves that in agricultural and pastoral areas, farmers' beliefs, risk salience, and trust have significant driving effects on adaptation and mitigation behaviors in agricultural and pastoral areas. Finally, The model demonstrated that trust has the same effect in agropastoral and agricultural areas, especially on farmers' coping behaviors. The government's behavior can induce farmers to adapt to climate change, understand the potential harm of climate change, and take the initiative to implement mitigation measures. The explanatory power of government trust does not vary with the sociodemographic characteristics of farmers.

The study can help policy makers develop risk communication strategies for farmers in different regions to cope with climate change. According to the research conclusion, trust is an important factor to improve farmers' behavior and plays a key role in farmers' behavior. Government agencies should provide information on different climate change scenarios, seasonal changes and projections at the regional and national levels. They should also provide information about the impact of these climate change hazards, which will ultimately influence farmer coping behaviour.

Agricultural area extension services can play a key role in increasing farmers' knowledge, visibility of climate change impacts. In addition, extension services in agro-pastoral areas should provide farmers with more information so that they can properly understand the issue of climate change. Governments should encourage institutions to educate and guide farmers on the causes, impacts, adaptation and mitigation options of climate change so that farmers can make informed decisions about the best available mitigation and adaptation options.

Data availability statement

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

Author contributions

YP: Investigation, Conceptualization, Methodology, Software, Data curation, Software, Validation, Writing-Original draft preparation. PW: Investigation, Visualization, Supervision, Writing-Reviewing and Editing. XZ: Revised opinions, Writing-Reviewing and Editing. LC: Investigation.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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