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Online or offline? The impact of environmental knowledge acquisition on environmental behavior of Chinese farmers based on social capital perspective

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With the development of mobile internet, Chinese farmers have started to access diversified information through social media, on one hand, based on breadth of information. On the other hand, as most farmers still live in rural areas, their socio-economic characteristics and lifestyles are in homogeneous acquaintance social network relationships, i.e. interpersonal interactions in offline homogeneous networks are still considered as the way for farmers to access homogeneous information (breadth of information depth). Based on social capital theory, social networks are structural social capital where trust and reciprocity are known as a relational social capital. Further, this study divides structural social capital into connective social capital (social media access to information) and bonding social capital (offline interpersonal interaction access to information) based on the differences in their information sources. The empirical study finds that structural social capital has a positive impact on farmers' environmental knowledge acquisition which influences their environmental behavior. In addition, relational social capital (trust and reciprocity) plays a mediating role in the influence of structural social capital on farmers' environmental behavior.

KEYWORDS

social capital, social media, environmental behavior, knowledge acquisition, farmer

1 Introduction

At the 75th UN General Assembly General Debate and Climate Ambition Summit, President Xi Jinping proposed that China should strive to peak its carbon dioxide emissions by 2030 and work towards achieving carbon neutrality by 2060 (Shiyong et al., 2022). This major strategic development and systemic change will inevitably force a green development and low-carbon transformation of the way of economic development, promote high-quality development of China's economy, and profoundly change the lifestyles of members of society at large towards a green and low-carbon direction (Wang et al., 2022). Agriculture is an important source of greenhouse gas emissions and environmental protection in agriculture (D Wu, 2021). Rural areas are considered as the top priority for achieving carbon peaking and carbon neutrality. As the year 2022 is the opening year of the 14th Five-Year Plan, the issue of environmental protection in rural areas has become a hot topic in China's agricultural development (Zhao J C et al., 2022).

In today's rural environmental issues, the level of awareness of farmers largely determines the development of rural environmental protection and implementation of national policies which is also related to the progress of a series of construction work in rural environmental protection (Davis L S et al., 2020). Due to the low level of education and environmental awareness of farmers, the level of awareness and toxicity of agricultural waste is low, resulting in agricultural waste not being effectively recycled and the rural environment not being effectively protected. Thus, this affects rural agriculture to a certain extent, causing pollution of the rural environment and increasing the burden on farmers, enterprises, government, and society (Zheng X Q et al., 2020). Therefore, it is increasingly important to work to effectively raise farmers' awareness of environmental protection, which is not only related to the development of environmental protection, but also closely related to the implementation of China's sustainable development strategy, and is more conducive to the construction of a harmonious socialist society (Jimenez-Navarro J P et al., 2020).

Awareness depends on having a certain level of knowledge about environmental protection (Minton, 2018). Therefore, access to knowledge and environmental education is the key in solving rural and farmer environmental problems (H Qasim et al., 2019). With the spread of social media, the way in which farmers acquire knowledge has changed (Joo. et al., 2018). Traditional offline face-to-face interaction is still a major way of acquiring information (Mouakket, 2015). However, the diversity of information available in social media has enriched farmers' knowledge of environmental protection. Research on the impact of information access methods on farmers' environmental behavior is still in its early stages (Danna Greenberg and Hibbert, 2020). Therefore, some interesting research questions are: Which information access methods are

more effective in influencing farmers' environmental behavior? What are the underlying mechanisms? Those questions deserve special attention.

At present, academic research on rural environmental governance focuses on three areas: Firstly, policy changes, that can be mainly revolved around time (Zhao et al., 2005). Secondly, representational issues, including the characteristics, difficulties, and problems of rural environmental protection (Li Z G and Wang J, 2021). Thirdly, governance models, which mostly focus on socially interactive and participatory environmental protection models (Mallapaty, 2020). While academic research has focused on the government's leading role in environmental governance in terms of policy mechanisms, practical challenges, and governance models, which has contributed to the improvement of the rural environment at the macro level (Kang Y et al., 2020), there is little research on the participation of non-governmental actors in environmental governance at the micro level (Shiyong Z et al., 2022).

This study uses media as a tool and social capital as a theoretical framework to explore and investigate the impact of different types of social capital on farmers' environmental behavior and their underlying mechanisms (Wei W et al., 2020). This study contributes to the literature on rural environmental protection in several ways. Firstly, our study is one of the pioneering studies examining the role of social capital on environmental behavior. Secondly, we capture the significant effects of different types of social capital on environmental behavior, which provides new insights into the optimization of environmental strategies from the perspective of social capital characteristics. Thirdly, we propose the perceived risk as a mediator in the model to explain farmers' environmental awareness and behaviour by revealing their perceptions of different types of social capital and extending the current literature.

The people's desire is a prerequisite for promoting specific environmental behaviours (Zheng X Q et al., 2020). The farmers who work in agriculture are the ones who carry out and directly benefit from rural environmental protection behaviour (Jimenez-Navarro J P et al., 2020). Therefore, it is important to promote farmers' willingness to protect the environment in rural areas (Mallapaty S, 2020). The availability of appropriate knowledge is an important factor in the formation of behavioural awareness among individuals (He J K et al., 2020). So, when we focus on people's awareness of environmental protection behaviour, we consider their knowledge of environmental protection, which in turn influences their willingness and behaviour to protect the environment (Zhou Y et al., 2019). According to communication theory, in the process of information interaction, factors such as the object of communication and the way of communication affect the final communication effect (F Su et al., 2021). Therefore, this study analyses the influence of the type of knowledge source on the environmental protection willingness and behaviour of farmers in the process of focusing on the

formation of their environmental protection awareness, and proposes corresponding environmental protection publicity strategies to assist the rural environmental protection cause.

2 Review of the literature

2.1 Social capital

The social capital dimension includes structural social capital, cognitive social capital, and relational social capital (N Wen, 2020). Structural social capital emphasizes the association between individuals, i.e. the formation of network relationships (M Oliver et al., 2020). Relational social capital emphasizes interactions based on associations, i.e. reciprocity and trust (Y Mou and Lin, 2017). Cognitive social capital emphasizes organizational norms such as a common language during interaction (Homero Gil De Zú Iga and Scherman, 2017).

2.1.1 Structural social capital—social networks

Structural social capital refers to the effect that the structure of a network has on the overall value of social capital (G Calado et al., 2017); factors such as the size and density of the network in which an individual is embedded, as well as the individual's own position in the network such as degree centrality and eigenvector centrality, all influence the amount of value that the network brings to the individual which can be influenced by the value that the structure of the group has created (A Zubiaga and Ji, 2014). Group convergent behaviour is more likely to occur when the network density within the group is high, meaning that individuals within the group interact more frequently (J Piyapong and Tsunemi, 2014). An individual's position in the network means that the person has direct or indirect access to resources, and if the person has more access to resources, other individuals are more likely to interact with the person for resource utilization motives (Berger, 2014).

In the age of mobile internet, people can interact online through social media. Some studies point out that online interaction can be achieved across time and space constraints (F Su et al., 2021). However, the authenticity and real-time characteristics of traditional offline interactions make offline interactions to be considered as one of the main ways for people to access information (D Agapito et al., 2013). According to some scholars, social capital can be further divided into bridging and bonding social capital according to the mode of interaction (online or offline) (Wei W et al., 2021, G. E Newman et al., 2017). In online interactions, users can relate to strangers (heterogeneous nodes) through the internet and gain access to a wide range of information, i.e., they gain access to information through bridging social capital (Ž Kolbla et al., 2018). In offline interactions, users are more likely to be dealing with networks of acquaintances (homogeneous nodes),

and the information they receive is more credible, i.e., through bonding social capital (K. P Winterich et al., 2018).

As urbanization accelerates, urban dwellers are beginning to rely less on offline communication, and even acquaintances can share information through social media (S. T Fiske, 2018). Moreover, in underdeveloped areas, offline face-to-face communication is still one of the most common ways people interact with each other (H Chen et al., 2018). With the spread of social media, interpersonal interaction and social media use are two of the most common forms of farmer interaction in underdeveloped areas (e.g., rural areas), and can generate corresponding social capital (P Torres et al., 2017). Specifically, because of the simplicity of farmers' lives, offline interpersonal interactions are frequent and limited to a limited group of people (acquaintance networks—strong relationship networks) and have a higher potential to generate bonding social capital (G. E Newman and G Diesendruck, 2017). Social media social networks can connect users to the outside world and reach out to other users that they do not know (stranger networks—weak relationship networks), but these connections are mostly superficial and not deep, and are mostly connective social capital (M McGowan et al., 2017). Based on the daily habits of Chinese farmers, this study measures farmers' offline interpersonal communication and online social media use to represent their connective and bonding social capital (F Hayes, 2017).

2.1.2 Adhesive social capital

Rural China is a communication environment that has been characterized by homogeneous social capital for thousands of years, with bonding social capital in the form of interpersonal discussions in acquaintance societies (T. P Derdenger et al., 2017). As one of the key theoretical underpinnings of the homogeneous social capital interaction hypothesis, Andrei have derived the affective-interaction hypothesis as the Homophily hypothesis, which states that emotional friendship connections tend to be based on the principle of homogeneity, i.e. (A. G Andrei et al., 2017). the like-me hypothesis: social interactions tend to occur between individuals with similar economic and lifestyle characteristics (Y Wang and Wang, 2016). The Homophily hypothesis is based on the principle of like-me: social interactions tend to occur between individuals with similar economic and lifestyle characteristics (L Su et al., 2016). This homogeneity is found in the social network relationships of the farmers who are the mainstay of our countryside, who make their living from the land, and who have similar levels of education (C. L Newman et al., 2016). Social networks are more likely to be established among people with similar socio-demographics, or Status Homophily, because they share similar ideas, attitudes and values (D. J Li and Liu, 2016). In terms of the conditions under which the social capital homophily interaction hypothesis applies, this theory fits in

many ways with the study of environmental communication in farmers' social networks in China (S Kazakova et al., 2016).

The homogeneity of our farmers in many ways, including their living environment, education level and daily activities, as well as the frequency of their daily interactions and their confinement to a small area, makes it easy to generate adhesive social capital (E Fang et al., 2016). Therefore, we use farmers' interpersonal communication behavior to measure their social capital (Song G J et al., 2021). In rural environmental communication in China, more inputs in a homogeneous social network will lead to more social resources, which in turn will lead to more scientific knowledge or scientific action by the inputters, which is the theoretical goal of this empirical study (Du H B et al., 2021).

2.1.3 Connective social capital

Social media use is a current emerging form of social capital for farmers, i.e., connected social capital on behalf of farmers (Kang Y et al., 2020). Electronic networking is an emerging form of social capital that carries resources beyond the mere use of information, bringing with it a new social capital and representing the advent of a revolutionary rise in social capital (Liu and Yang, 2020). The facilitation of information flows, the influence of social ties on the decisions of organizational agents, the use of social networks as proof to gain more capital, and the ability of social ties to enhance identity and recognition (Davis L S et al., 2020). In communication terms, the degree of information use and channel bias brings social capital to the user (Zheng X Q et al., 2020). However, the Internet is open, diverse, inclusive, cross-regional, cross-industry and cross-class, and is a heterogeneous interaction of social capital, or connective social capital (Chen C et al., 2019).

The social media environment allows farmers to connect with other users from different backgrounds and hence have easy access to diverse information (Jimenez-Navarro J P et al., 2020). Social capital theory suggests that individuals in the position of a broker will have access to a greater diversity of information, leading to the development of bridging social capital (Liu X P et al., 2018). The use of social media provides farmers with easy access to groups of people from different life experience backgrounds, thus creating bridging social capital (Han H et al., 2018). For farmers in an environment of homogeneous social capital, internet use is important for accessing environmental resources (Davis L S et al., 2020).

The internet is an emerging social capital that is particularly important in an environment of social capital homogeneity, and is a new form of access to resources for farmers that breaks the limits of geography, ethnicity and occupation (Xiao H et al., 2019). Some studies have compared online and offline access to information and found that social media use allows users to access more and newer information about different social connections in the process of obtaining information, and social capital that is easily overlooked or inaccessible offline

(Chen C et al., 2019). There are also studies that focus on social media platforms, in the form of online questionnaires that measure the connected social capital or bonding social capital that respondents have through the content of social media platforms (Liu X P et al., 2018). However, these studies differ in their classification of social media and types of social capital, while there is no clear classification of the population surveyed (He J K et al., 2020). Unlike the above studies, this study has a clear target group and classification.

2.1.4 Relational social capital—trust and reciprocity

Baker defines the information conveyed during interpersonal interactions as relational social capital (Dranka and Ferreira, 2018). In contrast to structural social capital, which emphasizes the establishment of relationships and the position of individuals in a network, relational structural capital emphasizes the value of information during the interaction of individuals based on network relationships (Bekalu M A et al., 2018). This trust in others and reciprocity has a positive impact on the value creation of the group as a whole (Dunlop S M et al., 2010). When individuals feel that the organization and other individuals within it are trustworthy, in which they share a common value goal, and that it is a win-win situation, then individuals are more willing to help and give their resources to the organization and other individuals (Sarvary, 2011). However, they do not have the willingness to interact, and they do not add value to the resources available (Borrayo E A et al., 2016).

Organizational research suggests that trust is a psychological state of willingness to expose weaknesses, which is a state based on the trustor's positive expectation of the trustee's intentions and behaviors that are not expected to harm the trustor (Bekalu M A et al., 2018). Borrayo notes that reciprocity is also a manifestation of relational social capital, i.e., secondary interactions are more likely to occur when the interaction can benefit both parties to the interaction, which focuses on the analysis of group value in terms of short- and long-term interactions. This is primarily an analysis of the magnitude of group value in terms of short- and long-term interactions (Borrayo E A et al., 2016).

Sociological research points out two main sources of value perception, trust, and reciprocity (Wang W et al., 2019). Trust refers to the expectation that the trusted person will act from the trustor's perspective, aiming to maximize the trustor's interests and fulfill the trustee's responsibilities and obligations (H Risselada et al., 2018). Reciprocity refers to the expectation that the recipient will give equal consideration to his or her own interests (S Pike and Lubell, 2018). In addition, trust and reciprocity are prevalent in areas such as science and technology innovation, environmental health, and financial investment (W Gong and Li, 2017).

Based on the above, this study will test the following hypotheses:

Hypothesis_1a: Farmers' communication through online social media increases their perception of trust in the information source.

Hypothesis_1b: Farmers' perception of reciprocity of information sources can be increased through online social media communication.

Hypothesis_1c: Farmers can increase their perception of trust in information sources through offline interpersonal interactions.

Hypothesis_1d: Farmers can increase their perceptions of reciprocity towards information sources through offline interpersonal interactions.

2.2 Environmental behavior

Environmental Protection Behavior (EPB) or Pro-environmental Behavior (PEB), for example, this is one of the key outcomes of social capital interactions, and this is an extremely important variable in environmental communication research (C. Y. Chen et al., 2017). In the social capital paradigm, environmental behavior is an important dependent variable linking social network relationships, perceptions of trust and environmental knowledge, resulting in a model that is quite predictive of pro-environmental behavior (Baltas et al., 2017). There is a clear causal mechanism in the social capital theory paradigm.

The interaction of networks of social relationships leads to information interaction and thus knowledge learning, which further influences user behavior (Y. Yang et al., 2016). Stephens argues that social capital interactions result in knowledge, emotional support and behavior, i.e. (Stephens et al., 2016). They emphasize that individuals have better behavioral outcomes as a result of access to social network resources (Kumar et al., 2016). The hypothesis of homogeneity of social capital comes in part from his understanding of Chinese society, particularly rural society, and there is a lack of empirical research to support the hypothesis of whether internet use and interpersonal discussions in a homogeneous environment can lead to changes in environmental behavior (He J K et al., 2020).

In recent years, there have been new developments in the quantitative study of social capital and environmental behavior in China (Zheng X Q et al., 2020). One study divided the core elements of farmers' social capital into three independent variables: trust, reciprocity norms, and civic engagement networks, and the dependent variable was farmers' willingness to invest in environmental protection (Wang W et al., 2019). This study examines farmers' willingness to engage in environmental behavior mainly from the perspective of financial investment (Y. Jiang et al., 2016). In order to explore the relationship between

farmers' social capital and environmental behavior, one study has empirically classified social capital in general into three independent variables: network media, external interaction, and village identity (S. Hazari et al., 2016). The study is somewhat over-generalized and does not optimize the specific pathway of external interaction as an important variable of social capital, as internet use and interpersonal discussions play an extremely important role in farmers' lives (Wang et al., 2015).

Therefore, this study uses the theoretical paradigm of social capital as a framework and structural social capital as the independent variable to consider the role of farmers' offline interpersonal interactions (adhesive social capital) and online social media use (connective social capital) on their relational social capital (trust and reciprocity), and furthermore on their environmental behavior. The empirical approach provides a scientific basis for breaking the bottleneck of farmers' inherent capital in a homogenous social capital environment.

Based on the above, this study will formulate and test the following hypotheses:

Hypothesis_2a: Trust perception as a mediating variable explains the positive relationship between farmers' offline interpersonal discussions and environmental knowledge.

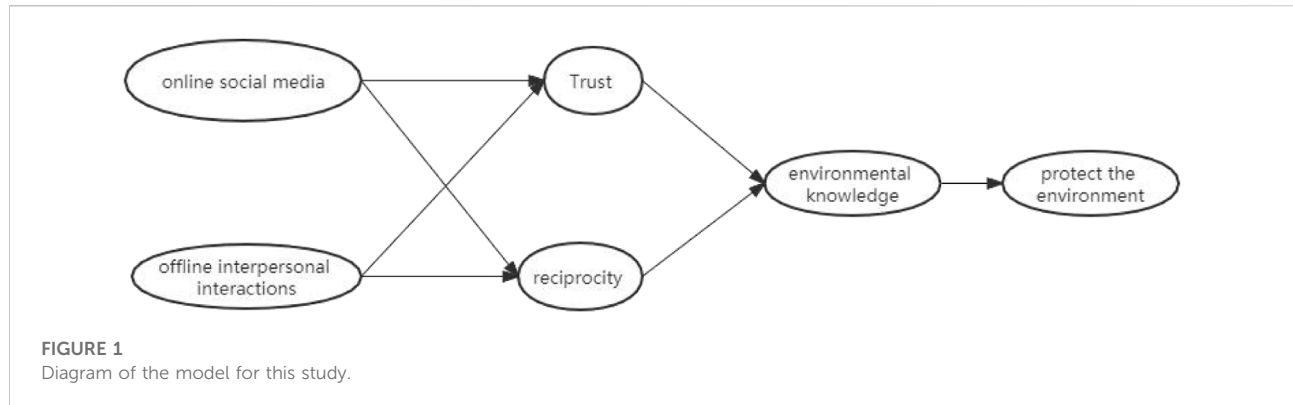
Hypothesis_2b: Trust perception as a mediating variable explains the positive relationship between farmers' online social media communication and environmental knowledge.

Hypothesis_2c: Perception of reciprocity as a mediating variable explains the positive relationship between farmers' offline interpersonal discussions and environmental knowledge.

Hypothesis_2d: Perception of reciprocity as a mediating variable explains the positive relationship between farmers' online social media communication and environmental knowledge.

2.3 Environmental knowledge

On the one hand, there is a correlation between environmental behavior and environmental knowledge (Han H et al., 2018). Several psycho-behavioral theoretical models confirm that behavior is mostly based on cognition, and the environmental behavior in this study is no exception (Zhou Y et al., 2019). Therefore, it is assumed that environmental behavior is based on environmental knowledge (He J K et al., 2020). On the other hand, social capital and knowledge are closely linked. In a knowledge society, the structure of knowledge determines to some extent the social network relationships, which drive the accumulation of social capital, and the process of networked social learning leads to new knowledge production, output and behavioral change (Jimenez-Navarro J P



et al., 2020). Previous research has shown that the growth of environmental knowledge has a positive effect on environmental attitudes and behavior, and that environmental knowledge is a prerequisite for environmental behavior in certain environments or conditions (Dong F et al., 2018). In studies exploring urban residents' perceptions of environmental pollution in China, environmental knowledge was introduced as an important variable in the model and was found to have a significant mediating effect on perceptions of environmental risk (Dranka G. G and Ferreira P, 2018). However, differences in the external conditions and intrinsic subject traits of environmental knowledge and environmental behavior dictate that the growth of environmental knowledge does not always lead to environmental behavior, and a rather complex conditional relationship is required to maintain consistency between the two (Ooms J A et al., 2017). For example, in studies related to rural life and production experiences, it has been found that whether environmental knowledge is derived from direct or indirect experience has different effects on environmental behavior; individual attitudes, behavioral habits, social norms and cultural traditions all have an impact on environmental behavior (Bekalu M A et al., 2018).

Based on the above, this paper proposes and tests the following hypotheses, using the willingness of our farmers to protect the environment as the dependent variable:

Hypothesis_3: Farmers' knowledge of environmental protection is positively correlated with their willingness to protect the environment.

Based on this, the research model for this study is shown in Figure 1.

3 Research methodology

3.1 Sample selection

In this study, samples were obtained by Purposive Sampling combined with Stratified Sampling (Majchrzak A

et al., 2013). Because of the need for social capital homogeneity theory, the samples were selected from representative rural areas for the study (Dranka G. G and Ferreira P, 2018), namely Longsheng County in Guilin, Guangxi, as an agricultural area in the south of China, Jili County in Hubei, as a traditional plain agricultural area, and Qinzhou City in Guangxi Zhuang Autonomous Region, as an agricultural area near the sea. Representative districts were then selected in the target cities and counties, and then representative villages were selected in the districts (Moran M B et al., 2016). Due to the presence of illiterate or literacy-challenged households in rural areas, the research team used primary and secondary school students, or assisted family members, neighbors or townspeople through primary and secondary school students to read in order to complete the questionnaires. Due to the special situation of media use in rural areas, the questionnaires were mainly distributed in paper form (Yang K et al., 2015; Laer T V et al., 2014).

The following criteria were met (Zhang and Hanaoka, 2021): 1) The farming population was based on farming households, and no duplication of surveys was allowed; 2) Farming households had their own contracted land (including some farming households who rented out their farming land to others); 3) The place of economic activity was mainly rural; and 4) Farming households' living accommodation and living space was mainly rural. A total of 1,541 questionnaires were distributed and 1,216 valid questionnaires were obtained, with a valid return rate of 79%.

3.2 Measurement indicators

3.2.1 Dependent variable measurement: Design of farmers' environmental behaviour

The rural environmental behavior is the dependent variable and a total of 5 questions have been used to measure ($\alpha = 0.85$), including: "Do you specifically collect plastic bags and other rubbish from your cultivated land, house site, etc." "Do you sort

your rubbish”, “Do you discuss environmental issues with relatives, neighbors, etc.”, and many others (Kang Y et al., 2020). The Kalombach reliability analysis has met the criteria ($\alpha = 0.76$). The first part of the questionnaire is about private EB, while the last two questions are about public EP such as “participation in environmental activities” and “environmental information” (Liu S and Yang J Z, 2020). The questionnaire is based on a 5-point scale, with 1 being ‘never’ and 5 being ‘very often’, and the final score is averaged (Zheng X Q et al., 2020). The design considers the actual environmental aspects of rural agricultural production and livelihoods, and balances all aspects (Chen A et al., 2020).

3.2.2 Independent variable measurement: Online social media use vs. offline interpersonal interactions

The social media use in rural areas is different from urban areas which is more akin to media exposure, where media is a life scenario in many cases (Liu X P et al., 2018). This paper draws on Lin and Li’s Media Attention Scale, which is scored on a 5-point scale, with 1 being ‘never’ and 5 being ‘very often’ (Laer T V et al., 2014). The pre-test data shows that rural television use is the highest, with smartphone use also dominating. In order to optimize the measurement structure of media use in this study, traditional media (including magazines, newspapers, radio, and television, $\alpha = 0.78$) and social media (including microblogs, WeChat, Jitterbug, etc., $\alpha = 0.81$) have been combined and scored as a mean (Zhang R and Hanaoka T, 2021). Interpersonal discussions consisted of two questions measuring the frequency of “you discuss with your family” and “you discuss with your relatives and friends” on environmental health issues, both of which are very representative forms of communication in homogeneous social capital interactions (Du H B et al., 2021). A five-point scale was used (1 for ‘hardly ever’ and 5 for ‘very often’) and the scores for the variables were summed to form an indicator.

3.2.3 Mediating variable measurement: Farmers’ environmental knowledge design

The design of rural environmental protection knowledge questions requires a certain degree of science and authority (Sorescu, 2008). This study draws on a resource for national rural environmental protection publicity, rural environmental protection tips, and incorporates local environmental protection practices to design a questionnaire on rural environmental protection knowledge, environmental risk perception, and environmental behavior (R Mugge and W Dahl, 2013). Targeting rural farmers in China, it provides a detailed information on some of the basic environmental knowledge and issues currently prevalent in China’s rural areas, covering the range of knowledge on the decentralized, random, hidden, not easily monitored and difficult to quantify nature of pollution facing China’s rural areas, while taking care to integrate environmental knowledge with China’s

agricultural production and life (M Zhao et al., 2014). The scale consists of 11 knowledge questions, which are dichotomous variables of single choice (1 = correct, 0 = incorrect), with each question being worth 1 point and all corrects adding up to a total of 11 points, with missing values being incorrect answers. There is no Kalombach reliability analysis because the variables are judged to be correct or incorrect (A. F Hayes, 2017).

3.2.4 Measurement of two parallel mediating variables: Trust and reciprocity

The trust perceptions have been designed to measure trust perceptions with four questions on a five-point scale (1 being totally disagree and 5 being strongly agree). The questions included “This information is reliable”, “Your information is trustworthy”, “I believe this information will be useful to me” etc. Scores for this part of the variable measure are scored according to summation into indicators (Minton, 2018).

The perception of reciprocity consists of 7 questions. A five-point scale of 1 (totally disagree) to 5 (strongly agree) was used. The questions include “I share correct and useful information when I come across it” and “I am willing to share my knowledge with others”. The Karonbach value is achieved ($\alpha = 0.82$) (K. P. Winterich et al., 2018).

3.3 Sample characteristics

The sample sizes for Longsheng, Jianli and Qinzhou were 384, 398 and 434, respectively, with a total valid sample of 1,216. In terms of sample characteristics, 62% were female and 38% were male, with an average age of 53 years ($SD = 12.35$), and the largest proportion, 36.4% of the total, was over 55 years old. The average number of household members was 4.41 ($SD = 1.62$), indicating that rural areas are still dominated by traditional households with several generations living together, and homogeneity is still evident. However, the use of social media scored 3.24 ($SD = 1.26$), second only to television at 3.51 ($SD = 0.92$), which is a traditional media. This suggests that social media has a very important role to play in the dissemination of information in rural areas (D Wu, 2021).

In terms of demographic variables (see Table 1), there is also a convergence in terms of educational attainment and economic attributes. The majority of rural inhabitants have primary and lower secondary education (73.2%), while those with no schooling (17.2%) and upper secondary education (7.9%) account for 26.8% of the total. In economic terms, those who consider themselves to be “average families” (61.4%) and “families in difficulty” (18%) make up the majority of the population, accounting for 79.4% of the total; poor families (10.4%) and “The lowest number of people, 0.9%, considered themselves to be from rich families. It can be seen that cultural education and economic attributes are important homogeneous features in the sample (Song G J et al., 2021).

TABLE 1 Basic background information on the sample population.

Variables	Probability (percentage)	Variables	Probability (percentage)
Gender		Education level	
Man	469 (38.6%)	No schooling	210 (17.2%)
Woman	747 (61.4%)	Primary education level	381 (31.3%)
Age		Lower secondary education	510 (41.9%)
Less than 18 years	2 (0.1%)	High school education	96 (7.9%)
18–25	15 (1.2%)	University level and above	19 (1.6%)
26–35	96 (7.9%)	Household economic attributes	
36–45	310 (25.5%)	Poor families	127 (10.4%)
46–55	350 (28.9%)	Families in difficulty	219 (18%)
Over 55 years old	443 (34.4)	General household	747 (61.4%)
		well-off families	111 (9.1%)
		Affluent Families	12 (0.9%)

TABLE 2 Correlation coefficients between the sample's social media use, interpersonal discussions and each variable.

	Offline interpersonal discussions	Online social media usage	Confidence	Reciprocity	Environmental knowledge	Environmental behaviour
Offline interpersonal discussions	1					
Online social media usage	0.255*	1				
Confidence	0.161*	0.131**	1			
Reciprocity	0.195**	0.042	0.144**	1		
Environmental knowledge	0.012	0.069*	0.255**	0.190*	1	
Environmental behaviour	0.348*	0.178**	-0.077**	0.089*	0.084***	1

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

4 Data analysis

4.1 Correlation analysis

The results of the correlation analysis of the independent and mediating variables using SPSS are shown in Table 2, where there was a significant correlation between farmers' offline interpersonal discussions and their online social media use ($r = 0.255$, $p < 0.05$) (Mallapaty S, 2020). Social media use was significantly and positively correlated with perceptions of trust ($r = 0.131$, $p < 0.01$), thus supporting Hypothesis 1a; with environmental knowledge ($r = 0.069$, $p < 0.01$) and with environmental behavior ($r = 0.178$, $p < 0.01$). On the other hand, there was no significant correlation between social media use and perceptions of reciprocity ($r = 0.042$, $p > 0.05$), thus negating Hypothesis 1b. Offline interpersonal interactions were significantly positively correlated with perceptions of trust ($r = 0.161$, $p < 0.05$), thus supporting Hypothesis 1c; a significant

positive correlation with perceptions of reciprocity ($r = 0.195$, $p < 0.01$) further supports Hypothesis 1d. Among all the significant correlation coefficients, interpersonal discussion had the greatest correlation with environmental behavior ($r = 0.348$, $p < 0.01$), which is worth further exploration when examined in terms of homogeneous interaction outcomes (Jimenez-Navarro J P et al., 2020).

4.2 Demographic variables are significantly associated with environmental knowledge and behavior

The age of the rural population has a negative relationship with environmental knowledge and behavior. Currently, a significant proportion of the rural population is old, with the average age of the sample being 53 years (SD = 12.35), and the phenomenon of rural ageing is quite serious. Age is an important

TABLE 3 Table of correlation coefficients between sample age and environmental communication variables.

	Age	Confidence	Reciprocity	Environmental knowledge	Environmental behavior
Age	1				
Confidence	-0.032	1			
Reciprocity	-0.105*	0.144**	1		
Environmental knowledge	-0.126*	0.255**	0.190	1	
Environmental behavior	-0.198**	-0.077**	0.089	0.084***	1

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

TABLE 4 Effect of educational attainment and household income on each dependent variable.

	Confidence		Reciprocity		Environmental knowledge		Environmental behaviour	
	F	sig.	F	sig.	F	sig.	F	sig.
Education level	1.64	0.163	7.12***	001	3.51**	0.009	22.12***	0.001
Household income	3.15*	0.010	5.12***	001	4.56***	001	4.27**	0.002

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

indicator system to examine the homogeneity and homogeneous interaction of farmers' social capital (Cai A et al., 2021). Table 3 shows that the older a farmer is, the lower his or her environmental knowledge score is, and the two are significantly negatively correlated ($r = -0.126$, $p < 0.05$); on the other hand, the age of a farmer is significantly negatively correlated with his or her environmental behaviour ($r = -0.198$, $p < 0.01$). These statistical findings are generally in line with our common knowledge that rural environmental issues are closely related to the ageing of the rural population, as older people do not have responsive environmental knowledge, resulting in less environmental awareness (Zheng et al., 2019).

Further analysis from Table 3 revealed that age size was largely negatively correlated with trust and reciprocity, with a significant negative correlation with reciprocity ($r = -0.105$, $p < 0.05$). These statistics suggest that older rural residents, to some extent, solidify the attribute of homogeneity of their social capital and do not easily trust others. Therefore, there is a need to consider how to overcome the negative effects of ageing in the rural environmental process (Jun et al., 2022).

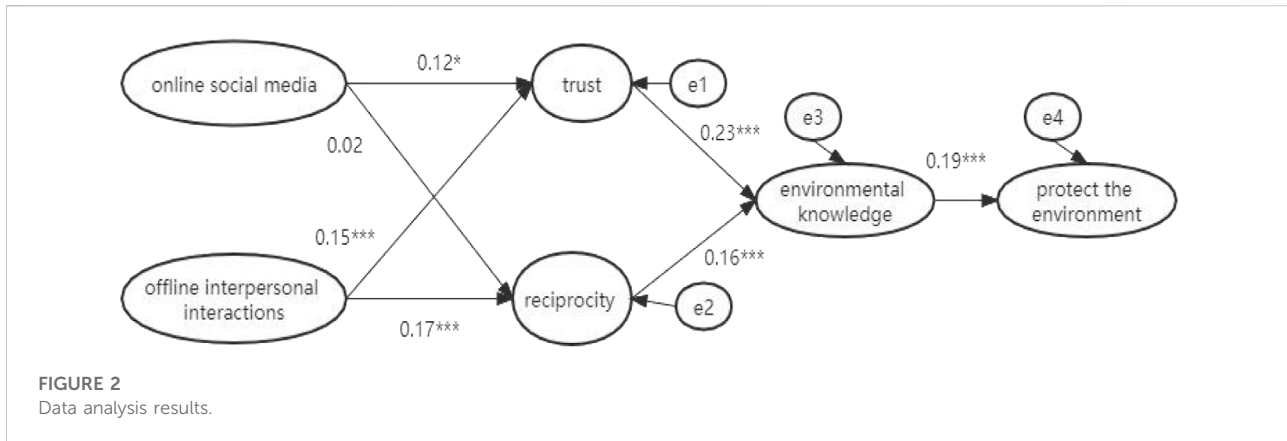
As shown in Table 4, educational attainment and household income were also significant demographic variables. Statistically, education has no effect on perceptions of trust $F(1, 1,216) = 1.64$, $p > 0.05$; education has an effect on perceptions of reciprocity $F(1, 1,216) = 7.12$, <0.001 ; education has an effect on farmers' knowledge of environmental protection $F(1, 1,216) = 3.51$, <0.01 ; education has an effect on farmers' environmental behavior $F(1, 1,216) = 22.12$, <0.001 . This suggests that more education is beneficial for acquiring knowledge about

environmental protection. In the same way, a high level of education is not only motivated by self-interest in environmental protection, but also by reciprocity (Zheng Shiyong and Jiang Suping, 2019).

As shown in Table 4, household income had an effect on perceptions of trust, $F(1, 1,007) = 3.15$, $p < 0.05$, and reciprocity, $F(1, 1,216) = 5.12$, $p < 0.001$; household income had an effect on farmers' environmental knowledge, $F(1, 1,216) = 4.56$, $p < 0.001$; and court income had an effect on farmers' environmental behavior, $F(1, 1,216) = 4.27$, $p < 0.01$; This confirms the Chinese proverb: "When one has enough food and clothing, one knows what is honorable and disgraceful", and only when people have solved the problem of food and clothing will they pay more attention to environmental issues (Wang et al., 2022).

4.3 Cause and effect analysis

To further explore the relationships between the variables, this study uses structural equation modelling to clarify the effects of online social media use and offline interpersonal discussions on a range of environmentally relevant variables (Xiao et al., 2019). In the model, online social media use and offline interpersonal discussions were set as independent variables, trust and reciprocity were set as two parallel mediating variables, environmental knowledge was used as a subsequent mediator to link the two parallel mediating variables to the dependent variable environmental behavior, while age, educational background, religion, and household income were



included as control variables in the model. After adjustment and modification, the new model showed a good fit with the data (see Figure 2) (Wang et al., 2022).

The results of the structural equation model showed that farmers' offline interpersonal discussions had a significant effect on reciprocity ($\beta = 0.17, p < 0.001$), which in turn significantly influenced farmers' environmental knowledge ($\beta = 0.16, p < 0.001$), thus supporting Hypothesis 2a. In addition, farmers' perceptions of trust positively influenced their environmental knowledge ($\beta = 0.23, p < 0.001$), while perceptions of trust were significantly influenced by social media use ($\beta = 0.12, p < 0.05$), thus supporting Hypothesis 2b. Both trust and reciprocity had a significant effect on environmental knowledge, but trust had a greater effect on environmental knowledge than trust; farmers' social media use did not have a significant effect on reciprocity ($\beta = 0.02, p > 0.05$), and thus did not support Hypothesis 2d. Interpersonal discussions had a significant effect on trust ($\beta = 0.15, p < 0.01$) and reciprocity ($\beta = 0.01$). This suggests that the main source of trust and reciprocity for farmers is offline interpersonal discussions, and that social media use is more for self-interest motives, to gain knowledge, rather than to provide benefits to other users. At the same time, it reflects the fact that offline interaction is still the main way of accessing information in rural areas, showing the practical utility of homogeneous interaction in rural areas (Shiyong Z et al., 2021).

Finally, we also found a positive correlation between environmental knowledge and environmental behavior ($\beta = 0.19, p < 0.001$), thus supporting Hypothesis 3. This suggests that environmental knowledge and awareness is necessary to improve farmers' environmental behavior (Shiyong Z et al., 2022).

5 Discussion and conclusion

This study, conducted in a representative sample of three rural areas in China, has found that offline interpersonal

discussions and online social media use, as the main forms of social network interaction among farmers, had a positive effect on promoting trust and reciprocity in information acquisition, environmental knowledge and environmental behavior in an environment where farmers are relatively homogeneous in terms of social capital, while at the same time displaying different characteristics. The main findings are as follows:

- (1) This study has found that farmers' adhesive social capital (offline interpersonal discussions) continues to play a greater role than connective social capital (online social media use). The positive effect of interpersonal discussions as bonding social capital in environmental communication among farmers in China is greater than that of social media use as connecting social capital. This is reflected in the relationship between the effect of social media use on the two parallel mediating variables in the structural equation, namely the insignificant effect on reciprocity ($\beta = 0.02, p > 0.05$) and the weak effect on trust ($\beta = 0.12, p < 0.05$); On the other hand, interpersonal discussion has a significant effect on trust ($\beta = 0.15, p < 0.001$) and reciprocity ($\beta = 0.17, p < 0.001$). In line with Lazarsfeld and Morton's hypothesis of homogeneous interactions in "affective-interaction", this study has verified that the effect of homogeneous interactions of affective friendship, bonding social capital (offline interpersonal interactions), was significantly stronger than the effect of connecting social capital (social media use) in environmental communication among farmers (Zhang et al., 2022). This suggests that in the field of environmental health topics, the effect of social media use in China's vernacular acquaintance social groups is still difficult to break through the homogeneous interaction effect of social network relationships characterized by 'emotion—interaction—resources'. In other words, in terms of social learning in environmental communication, the role of interpersonal discussion as a form of bonding social capital of rural residents is still deeply

rooted, and the influence of social media use as a form of connective capital is difficult to surpass for the time being.

- (2) The impact of social media also plays a role in the communication of environmental protection in rural China in an environment of social capital homogeneity. However, the perceptions of trust play a major motivating role in this process, while perceptions of reciprocity do not. Due to the fact that farmers are generally less educated and have less knowledge about environmental protection, they use the internet more for self-serving motives to learn and obtain information. Since they have less valuable information, they use social media less for altruistic motives reciprocity (S Zheng et al., 2022). Most of the people that we meet during the online use of social media are strangers, and there are more differences between users, i.e. the online network is a heterogeneous network. In contrast, the scope of offline interpersonal interactions is usually limited to a certain geographical area. Farmers' offline interpersonal network relationships are a homogeneous network due to the similarity of their geographical characteristics, and therefore, it is easier to share environmental knowledge in a homogeneous network out of self-interest and altruistic motives.
- (3) Environmental knowledge in rural areas is mostly derived from labor experiences and interpersonal discussions rather than heterogeneous interactions of social capital. From farmers in India to those in other developing countries, farmers' environmental knowledge comes from keen observation of their daily work and from communication and discussion between collaborators, which cumulatively leads to 'everyday knowledge'. The statistics (see Table 1) show that, although they all belong to the same large group of farmers, there is little difference in their cultural (mainly primary and lower secondary school levels) and economic levels (Zheng et al., 2022). In a homogeneous social network of socio-economic characteristics and lifestyles, characterized by similar types and amounts of resources, interactions tend to take place within this social network of similar or adjacent socially situated relationships; and access to resources is positively related to the number of interactions they have, with emotional friendship relationships playing an important connecting role. These specific claims are supported by the empirical results of this study.

6 Management implications

- (1) Environmental knowledge dissemination and environmental activities should be primarily relied upon offline. This study found that the current sources of knowledge for farmers are still largely based on offline networks of acquaintances. The role of online social media has not been fully utilised (S Zheng et al., 2022). This finding is consistent with the

loss of youth labour in the census data. It suggests that many of the young farmers with social media skills and higher education have moved to the cities. Older farmers, on the other hand, have certain thresholds and barriers to the use of social media. Therefore, offline campaigns should still be used as the main tool when conducting environmental campaigns in rural areas. At the same time, the use of social media should be actively promoted and popularised. Broaden the channels through which farmers can access knowledge and diversify their sources of knowledge.

- (2) Social communication strategies should be chosen for environmental protection publicity based on trust mechanisms. Knowledge learning among farmers is more out of trust, so some social strategies in the marketing field, such as viral marketing strategies, can be used for environmental knowledge promotion. Choosing highly respected individuals as seed users makes other individuals have a higher response to the environmental knowledge promoted by the seed users and the environmental activities initiated by them due to their higher appeal and trust. This enhances the acceptance of environmental knowledge.
- (3) A knowledge diffusion strategy of homogeneous networks should be used. Our study found that farmers' information sources mainly rely on information sharing from other users in homogeneous networks, which means that the identity of propagators in environmental knowledge diffusion should be positioned as peer nodes in homogeneous networks, not necessarily opinion leaders from heterogeneous networks. That is, the identity reduces the social distance between the information sharer and the receiver, which in turn enhances the persuasive effect.

7 Research limitations and future research directions

This study empirically validates some of the hypotheses in theories about the homogeneity of social capital. Social media use, as virtual social network relationships in electronic space, has become a new type of connected social capital for contemporary people to break out of the homogeneous environment of social capital such as geography, group, clan, and even social class, and still brings limited resources in the current communication of environmental protection in rural China. The revolutionary rise in social capital has been brought about by the internet and its heterogeneous reciprocal effects are not clearly highlighted in all elements of current rural environmental communication in China due to population loss and ageing issues in rural areas. In contrast, interpersonal discussions, a local, contextual-emotional form of communication that serves as bonding social capital, play an important role in communication among farmers with similar lifestyles, social-psychological proximity, and economic status.

However, the following limitations exist in this study:

- (1) Limitations of the sample selection area of the research questionnaire. In this study, samples have been selected from representative rural areas for the study, namely Longsheng County in Guangxi Guilin as the southern agricultural area of China, Jili County in Hubei as the traditional plain agricultural area, and Qinzhou City in Guangxi Zhuang Autonomous Region as the sea-facing agricultural area. Representative districts have then been selected from the target cities and counties, and then representative villages have been selected from the districts. Overall, only three counties were selected, and of the 1,636 counties within China, we have selected only three with specific geographical characteristics. Therefore, in future studies, the area of research can be expanded.
- (2) Differences between counties of the same type have been ignored. In this study, we have selected three geographical types of counties. However, even for counties of the same type, there is uneven development. With urbanisation, some of the counties that are traditionally agricultural and slow to develop have serious population loss and obvious ageing characteristics, which introduces some bias into the data sampling for this study. Therefore, in future research, it may be possible to conduct separate studies on environmental behaviour for areas with different levels of economic development.
- (3) Social capital is used as a mediator in this study. The main consideration is the perception of differences in trust and reciprocity brought about by the source of information access. However, in practice the same phenomenon can be explained by different theories, for example offline networks of acquaintances are more of a fixed social norm; whereas online networks of strangers have access to more differentiated information, creating an informational influence. From this perspective, the use of social influence theory (informational vs. normative influence) also seems to explain the difference in persuasive effects brought about online and offline. Therefore, in future research, we can try to adopt more theories to explain the phenomenon in environmental behaviour and explore the underlying mechanisms.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and

institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

Conceptualization, JZ; Writing—review and editing, SZ; Writing—original draft; SZ. Data curation, MK; Formal analysis, X-GY; Methodology, X-GY. Revising and funding provide—RC.

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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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