EFFECTS OF INFORMATION LITERACY ON FARMERS' TRANSITION TO GREEN PRODUCTION

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Abstract. The agricultural sector of China continues to make excessive use of chemical fertilizers, pesticides, and other chemicals, severely contaminating agricultural non-point source and concealing product quality and safety risks. Consequently, the key to promoting the green development of agriculture is determining how to facilitate farmers in their transition to green production. Based on micro-survey data, this paper empirically explored the impact of information literacy on farmers' willingness to transform to green production; the mechanism of the effect was analyzed through an ordered logit model (Ologit model) and a mediating effects model, where the mediating effects were examined using the theory of protection motivation. The findings indicated that farmers' willingness to transition to green production was significantly influenced by information literacy and its dimensions; farming households were more likely to transition to green production if they were aware of their information demands and had the abilities to use information; protection motivation played a partial mediating role between farmers' information literacy and willingness to transform green production; and the mediating effect of coping assement was stronger. This paper offers new research and theoretical perspectives for the study of farmers' green production, as well as policy recommendations for the government's willingness to promote green production in terms of information literacy education, environmental protection publicity, skills, and methods training.
Keywords: *information literacy, farmers' green production transition, conservation motivation theory, ordered logit model*

Introduction

According to the China Rural Development Report (2021) - Modernising Agriculture and Rural Areas Towards 2035, "Accelerating the building of a strong agricultural country,....., is a necessary condition for the comprehensive construction of a strong socialist modern state and an important initiative." One of the key characteristics of a strong agricultural nation is its capacity for the sustainable development of agriculture, and the use of green production can support this development. However, agricultural development of China is currently concerning, the ecological environment is worsening, and widespread resource shortages exist (Li et al., 2021). Therefore, it is necessary to develop green agriculture. Since 2014, the Central Government's No. 1 document has suggested green production to alleviate the problem of environmental pollution in agriculture for six consecutive years; according to the 14th Five-Year Plan for Green Development in Agriculture, China must still encourage green development in agriculture; The 20th National Congress report continues to stress "green development promotion. It is evident that promoting the transition of Chinese agriculture to green development is particularly critical. In addition, the citizens' consumption needs are continuously being upgraded to not only "eat well," but also "eat healthily, and eat

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safely". It can be claimed that green consumption has become essential to the pursuit of a better living, making the growth of green agriculture essential.

Green agriculture is a new form of agriculture that can successfully protect the environment and promote sustainable development based on the principles of ecological balance, circular development, and green living, as well as the system of sustainable agricultural development techniques (Deng et al., 2022). Green Agriculture as the development of green agriculture is largely driven by the green production behavior of farmers. So, this study employed farmers as the research object to investigate ways to encourage them to transition to green production.

Currently, some literature explores the factors that influence farmers to make the transition to green production at the macro level, such as policy environment (Zhu et al., 2022), social environment (Wang et al., 2022), and market environment (Ding et al., 2022). Although these elements serve as external stimuli for green production and promote it, they cannot fundamentally alter the behavior of individuals. Bacon stated in his Theory of Habit that "human behavior is governed by thought" or that cognition determines behavior, therefore, several researchers have examined the green production behavior of farmers at the micro level, including individual characteristics (Li et al., 2022) and cognition (Greiner et al., 2009). In the information age, however, information literacy has become a fundamental skill for adapting to the information society, and the solutions to many problems require the use of a vast array of information tools and key information sources. It is evident that in today's information-rich society, the ability to determine when information is required and to obtain, evaluate, and utilize it efficiently has become a crucial predictor of individual behavior (Bawden et al., 2001). However, no research has been discovered that explains the motives and processes underpinning farmers' participation in green agriculture from the standpoint of information literacy. Consequently, the main purpose of this study was to investigate the effect of farmers' information literacy on their transition to green production.

Farmers automatically activate protection mechanisms when considering whether to engage in risky and uncertain green production techniques since they are exposed to hazards from both economic and natural disasters while engaging in green production activities (Greiner et al., 2009). According to the rational smallholder theory, farmers as "economic agents" tend to be risk-averse and aim to maximize their own interests in order to protect themselves. According to Darwin's theory of group selection, As 'social beings', in order to ensure human existence, individuals will develop pro-social behaviour; hence, farmers engaging in green production is an pro-social behaviour which is also a group protection behaviour. Based on this, this study used protection motivation theory (Kothe et al., 2019) as its theoretical foundation to further reveal the underlying mechanism of information literacy influencing farmers' green production behavior. This paper provides a new theoretical perspective for related research and a theoretical basis for promoting farmers' spontaneous initiatives to engage in green production in practice.

Review of the literature

The investigation of the elements driving the transition to green production

Green production transition in agriculture is simply a shift in agricultural production methods that eventually manifests itself in farmers using sophisticated technology and green practices led by green production ideals to achieve resource conservation and

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environmental preservation. Green agricultural production includes the development of organic and recycling agriculture, the use of water-saving irrigation technology, straw return technology and so on. Currently, the literature on the factors influencing farmers' green product transformation contains both macro and micro-individual factors. In terms of macro elements, Zhu and Chen discovered that different farm household characteristics have distinct preferences for agricultural policies (Zhu et al., 2022). Wang et al. (2022) discovered that both network social capital and environmental social capital can boost farmers' willingness to protect the environment. Ding et al. (2022) demonstrated that market incentives can greatly increase farmers' adoption of green pesticides, which are safe and harmless to human health, environmentally friendly, ultra-low dosage, and produced through green processes. Many researchers have found that individual features such as age, education level, and health status influence farmers' green production behavior to some extent (Li et al., 2022; Zheng et al., 2022). Hu et al. (2022) discovered that risk perception had a large and unfavorable impact on tea growers' willingness to employ green prevention and control technology. Li et al. (2022) in-depth study found that the negative effect of economic risk perceptions was more significant, whereas the influence of environmental risk perceptions was moderate. Although existing studies have covered both macro and micro factors, macro factors can only act as stimuli for farmers' green production behaviour but cannot fundamentally influence it. "Cognition determines behavior," proposed British philosopher Francis Bacon. At the micro-individual level, some researchers have investigated the impact of farmers' cognition on their green production behavior. However, considering that cognition is the product of knowledge internalization (Wokke et al., 2020). It is obvious that information literacy, defined as an assessment of an individual's information awareness and ability to acquire, comprehend, and apply information, is a factor that profoundly alters farmers' attitudes about green production and hence impacts their green production behavior. However, no scholars have been identified to conduct research on this topic. As a result, the purpose of this article is to investigate the relationship between information literacy and farmers' willingness to convert green production, as well as how information literacy influences farmers' willingness to transform green production.

Research related to information literacy

Paul (1974), President of the American Information Industry Association (AIA), defined information literacy as "the skills of individuals who use information tools to gather information to solve problems" (Zurkowski, 1974). According to the American Library Association (1989), people with information literacy can determine when information is needed, retrieve it accurately, evaluate it honestly, and use it effectively. Doyle (1992), in the Final Report of the National Forum on Information Literacy, described information literacy as the ability to recognize one's information needs, access information successfully, use information critically, and integrate information into one's body of knowledge. Based on existing conceptual definitions, the US National Library, and Information Science Council (Babu, 2003) expanded information literacy to include information awareness and information competency. Existing researches showed that information literacy was closely related to human behaviour, and the behaviour of individuals varies according to the level of information literacy. For instance, Wu et al. (2022) demonstrated that the complexity of implementing epidemic prevention and control varies between groups with high and poor information literacy. Hicks et al.

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(2022) observed that training individuals about affirmative behavior through practices of information literacy will encourage individuals to make suitable decisions. Zhu et al. (2021) discovered that the information literacy abilities of college students were a strong predictor of their social media competence.

On the basis of previous research, this paper defines farmers' information literacy as a sensitivity to information and the ability to obtain, comprehend, and use information, which primarily comprises information awareness and information competence. Information awareness is the extent to which individuals perceive information, which is represented in their understanding of the demand and value of information; information competence is the capacity to acquire information through multiple sources and to process, understand, and use it. In this research, the protection motivation theory is introduced in order to investigate the mechanism of information literacy in influencing farmers' transition to green production.

Protection motivation theory

The protection motivation theory was created by psychologist Rogers (1975) to describe a process that protective behaviour occurs when an individual analyses and understands information to perceive a threat. The theory has three components: information sources, cognitive mediators, and coping strategies. Information sources include external environmental factors such as verbal persuasion (e.g., fear assessment) and observational learning (e.g., watching what happens to others) as well as internal individual characteristics such as personality traits, previous or similar threat experiences; cognitive mediators refer to the threat assessment and response assessment that individuals make after receiving information from information sources. The threat assessment describes both the individual's perception of the threat and the likelihood of its occurrence. When confronted with a threat, the threat assessment represents the individual's evaluation of the severity of threat and the likelihood of the threat occurring; Response assessment describes their level of trust in the threat response, their confidence in their own response to the threat, and their assessment of the cost of responding to the threat, when the individual perceives the threat; And coping mode is a person's protective or non-protective behavior as determined by the integrated assessment. As shown in *Figure 1*, the protection motivation theory was originally widely used to study individual health issues, such as explaining the processes by which individuals develop self-protective intentions and behaviors in the face of health threats (Ma et al., 2022; Ding et al., 2022). It has since been applied to issues such as food safety (Zhu et al., 2022) and privacy protection (Chen et al., 2016; Chang et al., 2022). According to Darwin's rational choice theory, individuals, as 'social beings', will not only engage in self-protective behaviour, but will also engage in group-protective or pro-social behaviour to ensure human survival, which supports the extension of production motivation theory to group-protective or pro-social behaviour. Kim et al. (2013) pioneered the application of protection motivation theory to the study of pro-social behavior in individuals. Subsequent scholars have examined the pro-social behavior of various populations. Using conservation motivation theory as a framework, Keshavarz et al. investigated the environmental behavior of farmers and discovered that social context, threat assessment, and response assessment greatly influenced farmers' environmental behavior in drought conditions (Keshavarz et al., 2016). Shafiei (2020) examined the pro-environmental behavior of university students and shown that it derived from their assessment of threats and their ability to deal with them. The findings

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implied that university students' pro-environmental behavior was influenced by their perception of threats and their capacity to deal with them.

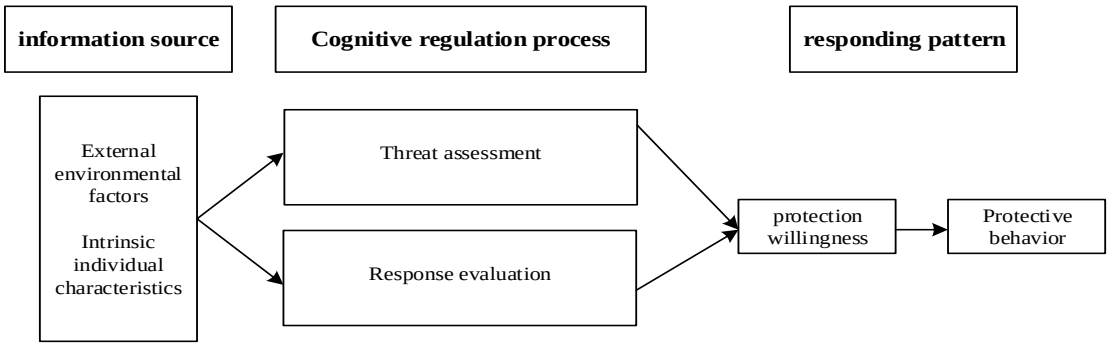

Figure 1. *Theory of protection motivation*

Since green production behavior is pro-social behavior, and information literacy as an individual characteristic affects farmers' access to and interpretation of information. Therefore, information literacy can be utilized as an independent variable to encourage farmers to do threat and response assessments, develop protective motivation, and then produce protective behavior. Using protection motivation theory as a theoretical foundation, this research analyzed how information literacy affected farmers' willingness to transition to green production.

Research hypothesis and model construction

The impact of information literacy on farmers' green production transition

According to the knowledge, information, and behavior model, knowledge is a prerequisite and behavior is the result of an individual's behavioral change process. As we all know, knowledge is obtained by identifying, acquiring, and processing information, so information will have an impact on individual behavioural change. With the popularity of the Internet, people have more ways to access various types of information. But the content and form of information accessed by different individuals varies, reflecting their different levels of information literacy. For farmers, green production transformation is the dynamic behaviour of farmers to participate in the high-quality development of agriculture by increasing their awareness of green production in agriculture. Therefore, information literacy, which reflects an individual's information sensitivity and ability to acquire, comprehend, and apply information, plays a crucial part in the process of green production transformation. Information literacy consists of two dimensions: information awareness and information capability. Hence, the impact of information literacy on farmers' green production transformation is analysed in terms of both information awareness and information capability.

Information awareness relates to an individual's recognition of information, perception of the importance of information, and subjective motivation to acquire information, including information value awareness and information need awareness. According to existing research, consciousness was a prerequisite for behaviour and behaviour determines the outcome (Jaeger et al., 2021). Thus, information awareness may lead to individual behavioural change. Some scholars have found that information

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awareness can also have an impact on individuals' behaviour through research on information literacy. Zuo et al. (2022) found a positive correlation between information awareness and vaccination behavior. Therefore, the greater the farmers' informational awareness, the greater their potential desire to transition to green production.

Information competence refers to an individual's ability to collect, judge, process, and use information as needed. Farmers process a large amount of information from the outside world to form their perceptions and change their behaviour. Green production is a new production method, with certain costs, technology, and other risks. Farmers, as "rational economic individuals," will assess both the rewards and risks of the new production method. If farmers have good access to information, they can quickly and efficiently obtain more accurate information on green production technologies, market information, etc., which is conducive to optimizing resource allocation, reducing the uncertainty associated with the transition to green production, and encouraging farmers' willingness to transform to green production. Secondly, the change to green production demands additional new knowledge and abilities. If farmers have a solid grasp of information, it can boost their capacity to comprehend green production, so enhancing their comprehension and encouraging them to migrate to green production. The ultimate goal of acquiring and comprehending information is to apply it to production techniques in order to increase output and money. The more one's ability to utilize information, the easier it is to transition to green production. For example, Wu et al. observed that strong access to information can boost farmers' adoption of green preventative and control technologies (Wu et al., 2021). Therefore, the following hypothesis (*Table 1*) is proposed:

Table 1. *Research hypotheses*

Hypothesis	Content
H1	Information literacy positively influences farmers' willingness to transition to green production.
H2	Information awareness positively influences farmers' willingness to transition to green production.
H2a	Information awareness positively influences farmers' willingness to transition to green production.
H2b	Awareness of information needs positively influences farmers' willingness to transition to green production.
H3	Information capacity positively influences farmers' willingness to transition to green production.
H3a	Information accessibility positively influences farmers' willingness to transition to green production.
H3b	Information comprehension capacity positively influences farmers' willingness to transition to green production.
H3c	Information use capacity positively influences farmers' willingness to transition to green production.

The mediating role of protection motivation

The "Information-Motivation-Behavioural Skills" model of behavioural interventions takes behavioural interventions as the starting point for determining behavioural change and divides the factors of behavioural change into three components: information,

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motivation, and behavioural skills, which can interact to influence individual behaviour (Whiteley et al., 2018). The three components can influence individual behavior through interaction. Consequently, according to the 'information-motivation-behavior' generation mechanism, when individuals access information, it motivates them and leads to certain behaviors, with motivation serving as a mediator between information and behavior. Existing research confirmed that motivation is the mediator of pro-environmental behaviour through the activation of information (Ehret et al., 2022). Behaviour is influenced by multiple motivations. Protection motivation is a type of motivation that can also be triggered by information. Differences in the form and content of information accessed by different individuals can also create different levels of protective motivation. Information literacy assesses an individual's ability to access, understand and use information. Therefore, in this paper, information literacy is employed as the independent variable to increase individuals' protective motivation and then to promote green production behaviour. In other words, protective motivation mediates the relationship between information literacy and farmers' willingness to transform to green production. Protection motivation includes threat assessment and response assessment, leading to the hypothesis (*Table 2*) that:

Table 2. *Research hypotheses*

Hypothesis	Content
H4	The mediating role of conservation motives in the influence of information literacy on farmers' willingness to transform green production.
H4a	The mediating role of threat assessment in the influence of information literacy on farmers' willingness to transform green production.
H4b	The mediating role of coping assessments in the influence of information literacy on farmers' willingness to transform green production.

Based on the above hypotheses, this paper incorporates information literacy, protection motivation and farmers' willingness to transform green production into the same framework. The logical relationship framework of this paper is shown in *Figure 2*.

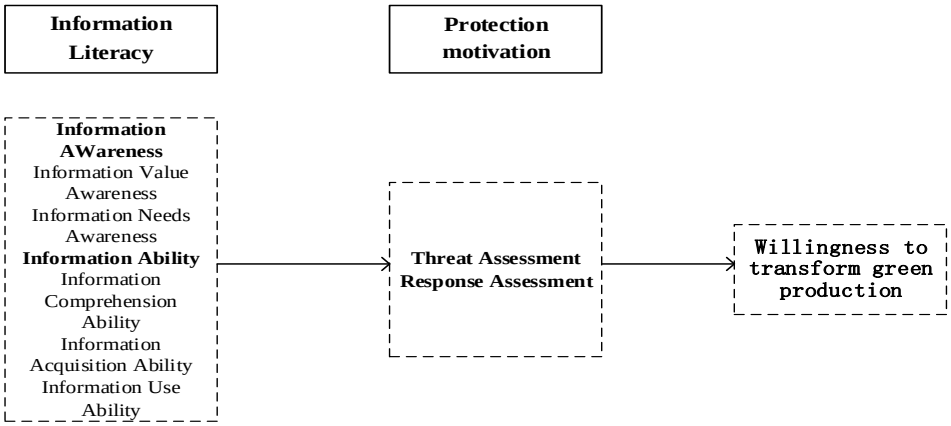

Figure 2. *Logical framework of information literacy, conservation motivation and farmers' willingness to transition to green production*

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Study design

Sample selection and data collection

This data is based on a questionnaire survey conducted by the research team in 2022 in Henan Province, a large agricultural province, on the theme of "Farmers' willingness to transform green production". Henan is a typical agricultural province in China, accounting for $1/10^{th}$ of the country's grain production and a large proportion of the agricultural population, making it a more representative choice. Taking into account the different geographical distribution and economic development levels, the research team selected four representative sample cities in Henan Province, namely Luohe, Xinyang, Sanmenxia and Anyang. During the survey, 3~5 townships were randomly selected in each of the four cities, and 2~4 villages in each township were selected for the field survey. The questionnaire included farmers' characteristics, household characteristics, information literacy level and willingness to transform green production. 312 valid questionnaires were returned, for a response rate of 86.4%, after 361 questionnaires were distributed. The willingness of the sample farmers to convert to green production is, on average, 4.142; 55.45% of the sample is male and 44.55% is female, making the male-to-female ratio close to. The average age of the sample farmers was 32.685. The average level of education was junior high school. The majority of homes lack village officials, between one and two persons engage in agriculture, and the average crop cultivation area is 6420 sqm (*Table 3*).

Table 3. *Description of variables and descriptive statistics*

Variable name	Variable definitions	Average value	Standard deviation
Willingness to transform green production	I have the will to make the transition to green production (Richter's five-point scale was used for this problem)	4.142	0.772
Gender	Your gender: 1=male; 0=female	0.5545	0.490
Age	Your age?	32.685	0.632
Education level	Your education level: 1=primary school and below; 2=junior high school; 3=high school or secondary school; 4=college and above	2.986	0.956
Size of arable land	Area of crops grown by your family (sqm)	9.653	18.735
Is a village officer	Does your household have a village officer: 1=yes; 0=no	1.227	0.419
Number of people working in agriculture	What is the number of people working in your household:1=~2; 2=3~4; 3=5~6; 4=6 and more	1.678	0.838

Variable selection and measurement

1. Dependent variable. Farmers' willingness to transition to green production. This paper refers to Yu Ting's willingness scale (Luo et al., 2022), where farmers' willingness to transform green production is expressed as "I have the willingness to transition to green production," using a five-point Likert scale with the options "1=strongly disagree; 2=disagree; 3=average; 4=agree; 5=strongly agree" (*Table 4*).

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Table 4. *Indicator system for measuring information literacy and motivation to protect*

Variable type	Variable name	Measurement questions	Factor load	Cronbach, α	Portfolio credibility	AVE
Information literacy						
Information Awareness	Information Value Awareness	1. Information is important to me	0.876	0.950	0.952	0.833
		2. Information can change my life	0.966			
		3. Information can increase my income level	0.908			
		4. The mutual exchange of information can lead to common prosperity	0.899			
	Information Needs Awareness	1.I am eager to get useful information on green production	0.921	0.910	0.923	0.801
		2.When I come across information on green production, I often write it down	0.821			
		3. I want to learn about green production	0.939			
Information Ability	Information Comprehension Ability	1. I am familiar with the agricultural policies issued by the Central Government in recent years	0.893	0.967	0.943	0.846
		2. I am familiar with information about the transition to green production in agriculture	0.920			
		3. I can understand information about green production in agriculture	0.945			
	Information Acquisition Ability	1. I can access information on green production via the internet	0.947	0.949	0.963	0.897
		2.I can access green production information through paper-based printed materials such as books, newspapers and magazines	0.970			
		3.I have access to green production information from a variety of sources	0.925			
	Information Use Ability	1. After acquiring certain green production techniques, I will apply these techniques to actual planting	0.925	0.965	0.962	0.865
		2. I will adjust my production methods accordingly once I understand the market demand for produce	0.938			
		3. I can use the information I obtain to solve practical problems	0.934			
		4. I was able to sort out their main meaning from a large amount of information on green production	0.923			
Information Ethics	1. I understand the laws, regulations and ethics related to computer networks 2. I will comply with the relevant national laws and regulations when accessing and using information about green production 3. I will not spread unconfirmed information about green production 4. I will not misrepresent the green production message 5. I will respect the intellectual property rights of others when accessing information about green production					
Protection motivation						
Threat Assessment		1. Non-green production methods cause serious environmental pollution to agricultural production	0.962	0.969	0.975	0.868
		2. Non-green production methods lead	0.892			

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	to significant increases in production costs				
	3. Non-green production methods have serious negative impacts on society	0.958			
	4. Non-green production methods have the potential to pollute the agricultural production environment	0.861			
	5. Non-green production methods have the potential to increase production costs	0.952			
	6. Non-green production methods have the potential to have a negative impact on society	0.961			
Response Assessment	1. I can afford to produce green	0.95	0.899	0.982	0.857
	2. I have the conditions for green production	0.879			
	3. I have time to learn about green production	0.948			
	4. Green production can improve soil quality	0.97			
	5. Green production can improve the agricultural production environment	0.849			
	6. Green production can increase income	0.887			
	7. Green production can reduce air pollution	0.903			
	8. Green production will cost more money	0.978			
	9. Green production consumes more time	0.967			
	10. Green production can consume more energy	0.962			

2. Independent variables. The independent variable in this paper is information literacy, which is measured using two dimensions: information awareness and information competence. The Likert five-point scale was used to measure a total of 18 measurement items, and the specific measures are shown in *Table 4*. Factor analysis was conducted using principal component analysis, with a cumulative variance contribution rate of 77.95%. Information literacy was calculated using each factor's percentage of variance contribution as the weight.

3. Mediating variables. The mediating variable in this paper is protection motivation. Using the protection motivation scale developed by Ding (2022) and Zheng et al. (2021). Set measurement items from two dimensions, threat assessment and reaction assessment, as shown in *Table 4*, using a five-point Likert scale for a total of 16 measurement items. Principal component analysis was used to conduct factor analysis, with a cumulative variance contribution of 83.23 percent. Each factor's percentage of variance contribution was used as the weight to calculate the motivation to protect.

4. Control variables. In this paper, gender, age, size of cultivated land and whether they are village cadres were set as control variables.

Reliability tests

In this research, the questionnaire's reliability and validity were evaluated. Cronbach's alpha coefficient evaluates reliability. Higher reliability indicats higher reliability of the variables measured by the scale; Validity is measured by convergent

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validity and discriminant validity. Higher validity indicating higher accuracy of the variables measured by the scale.

This paper examined the reliability and validity of the Farmers' Information Literacy and Protection Motivation Scale, the results are shown in *Table 4*. The Cronbach's alpha coefficient for each dimensional measure was more significant than 0.8, indicating the scale had good reliability. The convergent validity test was conducted with the help of Amos 28.0 software. The factor loadings of each question item were all more significant than 0.8, and the reliability of the combination of variables was greater than 0.8, indicating good convergent validity. The AVE values were used to test the discriminant validity; the results were shown in *Table 5*. The square root of the AVE of each variable was more significant than the correlation coefficient between the two variables, so there was good discriminant validity. Therefore, the validity of the scale was good.

Table 5. *Information literacy discriminant validity test*

	Information Value Awareness	Information Needs Awareness	Information Acquisition Ability	Information Comprehension Ability	Information Use ability	Threat Assessment	Response Assessment
Information Value Awareness	0.913						
Information Needs Awareness	0.8	0.895					
Information Acquisition Ability	0.574	0.699	0.947				
Information Comprehension Ability	0.578	0.699	0.876	0.920			
Information Use ability	0.68	0.772	0.78	0.79	0.930		
Threat Assessment	0.369	0.425	0.392	0.496	0.491	0.932	
Response assessment	0.668	0.618	0.594	0.7	0.65	0.547	0.926

Hypothesis testing

Multiple regression analysis

Using Stata 16.0 software, this research builded an ordered logit model. *Table 6* displays the outcomes of the ordered logit regressions of farmers' information literacy and transition to green production, as well as the regression outcomes of the robustness tests using OLS models. Model (1) contains only the control variables, Model (2) adds a composite measure of information literacy to the control variables, Model (3) adds a composite measure of the mediating variable conservation motivation, and Model (4) is a regression that employs least squares to reduce the impact of the selected regression model on the results. The addition of independent and mediating variables to model (1) resulted in a progressive increase in R^2 values and no significant differences in the significance and coefficients of the variables, suggesting the robustness of the results. In addition, the coefficients and significance of the independent variable information literacy and the mediating variable motive to protect did not change significantly following the OLS regression, showing that the results are stable.

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Table 6. *The impact information literacy on farmers' green production transformation*

Variables	Willingness to transform green production			
	(1)	(2)	(3)	(4)
Information Literacy		2.814***	0.980**	0.210***
		(9.22)	(2.54)	(2.66)
Protection motivation			2.516***	0.500***
			(6.95)	(7.89)
Gender	0.678**	0.523*	0.379	0.072
	(2.47)	(1.70)	(1.12)	(1.01)
Age	-0.339	-0.129	0.349	0.062
	(-1.36)	(-0.46)	(1.12)	(0.95)
Education level	0.325*	0.052	0.179	0.045
	(1.92)	(0.28)	(0.86)	(1.05)
Availability of village officials	0.758**	0.346	0.548	0.064
	(2.20)	(0.88)	(1.18)	(0.74)
Number of people working in agriculture	-0.143	-0.175	-0.135	-0.045
	(-0.80)	(-0.86)	(-0.60)	(-0.95)
Planted area	0.253*	0.320**	0.410**	0.089**
	(1.79)	(1.96)	(2.25)	(2.49)
Constant term				3.669***
				(15.62)
Adjusted R^2 / Pseudo-R^2	0.0614	0.3099	0.4392	0.594
F/Wald values	33.12	56.82	156.35	76.46

*represents $p < 0.1$,** represents $p < 0.05$,*** represents $p < 0.01$, and values in brackets represent standard errors

(1) Analysis and explanation of the impact of information literacy on the transformation of farmers' green production.

Table 6's models (2) and (3) indicate that information literacy positively affects farmers' willingness to migrate to green production at the 1% significant level, showing that the better farmers' information literacy, the more eager they are to move to green production. Therefore, the H1 theory is confirmed.

(2) Analysis and explanation of the impact of control variables on the transition to farmers' green production.

At the 5% significance level, the data indicates that the size of farmers' cultivated land has a favorable effect on their propensity to produce green. Due to their superior capital endowment, large-scale farmers enjoy this advantage; They are better able to allocate resources and are more focused on long-term rewards, resulting in a greater willingness to produce environmentally friendly goods. Both education level and the presence or absence of village leaders are statistically significant at the 10% level, with positive correlations on farmers' willingness to transition to green production. Farmers with a higher degree of education are more receptive to new ideas, better able to perceive and comprehend new concepts, and more likely to accept new ideas. Therefore, the greater the farmers' education, the greater their willingness to transit to green

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production; farmers with access to political resources have an advantage. Their broader and deeper understanding of subsidies and incentives associated with green production can increase their desire to transition to green production.

(3) The impact of information literacy dimensions on the transformation of farmers' green production.

Table 7 demonstrates the effect of each dimension of information literacy on farmers' shift to green production. At the 1% significance level, the data indicates that both information awareness and information ability have a significant and positive influence on farmers' desire to convert to green production, confirming hypotheses H2 and H3.

Table 7. *The impact of information literacy dimensions on farmers' green production transition*

	Willingness to produce green		
	(5)	**(6)**	**(7)**
Information awareness	0.567***		
	(0.14)		
Information Value Awareness		0.769**	
		(0.231)	
Information Needs Awareness		1.092***	
		(0.235)	
Information Ability	0.456***		
	(0.097)		
Information Acquisition Ability			0.488*
			(0.296)
Information Comprehension Ability			0.211
			(0.311)
Information Use Ability			1.279***
			(0.282)
Pseudo-R2	0.3135	0.2649	0.2878
Wald values	145.73	123.14	133.76

*represents $p < 0.1$,** represents $p < 0.05$,*** represents $p < 0.01$, and values in brackets represent standard errors

Testing for mediating effects

(1) A test of the mediating effect of the protection motivation as a whole.

Table 8 demonstrates the examination of the mediating influence of conservation motive in information literacy on farmers' desire to transition to green production. Model (8) demonstrates that farmers' information literacy significantly effects their willingness to green production, with a significance level of 1%. Model (9) demonstrates that farmers' information literacy has a favorable effect on their conservation drive. It can be observed from model (10) that after the introduction of the conservation motive, which positively influences farmers' willingness to transition to green production, information literacy remains significant at the 1% level, but the coefficient declines from 0.69 to 0.21. Consequently, the protection motivation partially mediates the effect of information literacy on farmers' willingness to transition to green production, and hypothesis H5 was tested.

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Table 8. *The mediating effect of protection motivation in the transformation of information literacy to influence green production*

Variables	Willingness to produce green (8)	Protection motives (9)	Willingness to produce green (10)
Information Literacy	0.690***	0.960***	0.210**
	(12.10)	(17.33)	(2.66)
Protection motivation			0.5***
			(7.89)
R2	0.471	0.628	0.6097
F-value	27.612	51.388	39.25

*represents p < 0.1,** represents p < 0.05,*** represents p < 0.01, and values in brackets represent standard errors

(2) Testing the mediating effects of the dimensions of protection motivation.

At the 1% significance level, models (12) and (13) indicate that farmers' information literacy effects threat assessment and response assessment positively, with coefficients of 1.18 and 1.895%, respectively. After the incorporation of threat assessment and response assessment, models (14) and (15) indicate that information literacy significantly increases farmers' willingness to transition to green agriculture at the 1% significance level. However, the coefficients decrease to 0.572, indicating that threat assessment and coping evaluation partially mediate the association between information literacy and farmers' green production transition, hypothesis H5a and H5b was tested (*Table 9*).

Table 9. *The mediating role of the dimensions of protection motivation in information literacy influencing farmers' willingness to transition to green production*

	Willingness to transform green production (11)	Threat assessment (12)	Response assessment (13)	Green production Willingness to transform (14)	Green production Willingness to transform (15)
Information Literacy	0.690***	1.180***	1.895***	0.572***	0.203***
	(12.10)	(8.09)	(16.79)	(0.064)	(0.076)
Threat Assessment				0.1***	
				(0.027)	
Response assessment					0.257***
					(0.031)
R2	0.471	0.358	0.462	0.619	0.621
F	27.612	17.629	26.622	29.251	41.19

*represents p < 0.1,** represents p < 0.05,*** represents p < 0.01, and values in brackets represent standard errors

(3) Robustness tests for mediating effects.

The robustness test for the mediating usefulness of the protective motive was performed with 5,000 random samples using the Bootstrap technique, and if the

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confidence interval of the test results do not include 0, it shows that the mediating effect occurred, as shown in *Table 10*. The 95% confidence interval for the protection motivation's mediating effect is [0.2662, 0.7054], with the interval not including 0 suggesting the existence of a protection motive mediating effect. Similarly, the threat assessment and reaction assessment mediating effect tests yielded a 95% confidence interval of no 0 for both. As a result, the mediating effect test is significant for each dimension of protective motive, and the mediating effect value for response assessment was much greater than for threat assessment.

Table 10. *Bootstrap test for intermediate effects*

Intermediary role test	Total effect	Intermediary effect	Boot SE.	95% BootCI	Effectiveness ratio
Protection Motives	0.69	0.48	0.000	0.2662-0.7054	69.6%
Threat Assessment	0.69	0.118	0.000	0.2639-0.0635	17.1%
Response Assessment	0.69	0.487	0.000	0.2679-0.7034	71%

Discussion

Farmers' information literacy can support their willingness to transition to sustainable agriculture. The stronger the farmers' information literacy, the bigger their endowment, which is favorable to resource allocation optimization and rationalizing production. Information literacy can assist farmers in obtaining new knowledge and skills in order to increase the practicability and operability of green production transformation and reduce risk.

Understanding of information requirements is more important for farmers' willingness to transition to green production than awareness of information's usefulness. This result demonstrates that, in order to transition to green production, one must first precisely understand their information requirements. Farmers' willingness to transition to green production is favorably influenced by their capacity to effectively utilize information. The ability to use information in the production process and increase farmers' environmental protection concepts and green production practices is the key to increasing farmers' desire to transition to green production, which has led to this outcome.

The association between information literacy and farmers' willingness to produce sustainably is mediated by protection motivation. This result may be the consequence of the "Ducker effect," in which farmers with limited information literacy are more likely to feel confident. They may underestimate the threat's severity and exaggerate its control due to their lack of understanding. Consequently, farmers with poor levels of information literacy are less likely to be motivated to protect and will not engage in protective behavior. On the other side, farmers with a greater level of information literacy can get knowledge about dangers through a variety of sources, which might stimulate the individual drive to protect and thereby increase their willingness to transition to green production.

The mediated effect value of the assessment of the response was much greater than that of the assessment of the threat. Due to the government's intense propaganda, people

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pay sufficient attention to environmental issues for the majority of farmers to recognize that non-green production can harm humans and perceive the threat; however, this has little bearing on whether or not the farmer transitions to green production. Therefore, information literacy influences farmers‘ transition to green production not primarily through improving threat assessment. Instead, farmers with a high level of information literacy can acquire more technical, market, and policy information about green production, so strengthening their capacity to deal with risks and increasing their willingness to transition to green production. Therefore, farmers' willingness to transition to green production depends more on response assessment; farmers with a high level of information literacy can contribute to the transition by enhancing their perception of their ability to adapt to threats.

Conclusions and policy recommendations

Conclusion

This paper applied an ordered logit model to 312 randomly selected farm household research data from Henan and Hebei provinces. It developed an information literacy system and introduced the protection motivation theory in order to assess the impact of farmers' information literacy on their willingness to transition to green production. Firstly the findings indicate that enhancing farmers' information literacy facilitates their transition to green production. Secondly, the influence of information literacy promotion on the green production transformation of farmers varies. Information demand awareness has a greater influence than information value awareness, although information use ability has the greatest impact among information abilities. Thirdly, the transition to green production is also influenced by farmers' consideration of self-protection and group protection, as they pay greater attention to their own abilities to deal with dangers during the assessment process.

Policy recommendations

Based on the above findings, the following policy recommendations are offered. Firstly, there is an urgent need for the government to enhance farmer education in information literacy. Farmers' information literacy can facilitate the transition to green production. In addition to improving infrastructure such as broadband networks, mobile networks, and digital e-commerce networks to bridge the first-generation digital divide, the government must improve information literacy education for farmers to narrow the second-generation digital divide in order to encourage farmers to adopt green production techniques. Establishing an information literacy education system in accordance with farmers' demands and the function of schools and village libraries can foster farmers' information literacy. Secondly, focus on developing understanding of information requirements and the capacity to use information. The government can organize the cultivation of farmers' knowledge of their information needs, allowing them to transition from passively receiving information to actively acquiring it. And the government may play a guiding role in assisting farmers to apply the information they have acquired to the agricultural production process, utilizing environmentally friendly and safe production methods to achieve a green production transformation. Thirdly, Raising farmers' awareness of protection and training them in the techniques. As farmers' green production behavior is a result of their careful consideration of self-

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protection and group protection, the government can use various media channels to promote awareness of protection and increase the concept of environmental protection among farmers; furthermore, as farmers consider their own ability to cope with threats more when assessing, village-by-village training on green production techniques and processes can be organized to improve farmers' self-efficacy and responsiveness by enhancing their grasp of the costs, benefits, and methods of green production. Simultaneously, cutting production costs through public subsidies can encourage their propensity to move to green production.

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