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Assessing psychological factors on farmers' intention to apply organic manure: an application of extended theory of planned behavior

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Abstract
Different from the previous studies on social and economic impacts, this study focused on the assessment of psychological factors on farmers' application of organic manure. We explored the psychological evaluation based on the extended theory of planned behavior (TPB), which consists of attitude (AT), perceived behavior control (PBC), subjective norm, moral norm (MN), environmental risk perception (ERP), and perceived policy effectiveness (PPE). Further, we explored the moderating effects of PPE. We studied 235 tea growers in China to verify the model and analyzed the psychological factors in their decisions regarding organic manure application. The results showed that by incorporating psychological factors, such as MN, ERP, and PPE, the extended TPB's ability to explain farmers' intention to apply organic manure increased by 6%. The results also confirmed that psychological factors (ERP, PPE, AT, PBC, and MN) positively influenced farmers' inclination to use organic manure. Finally, PPE was found to have a negative mediating effect on attitude and intention. Given the influence of these psychological factors (PBC, ERP, and PPE), we discovered that increasing the policy publicity, raising the policy subsidy, and promoting the popularization of sustainable agriculture and environmental awareness, are essential to encourage farmers' utilization of organic manure.

Keywords Sustainable agriculture · Psychological factors · Organic manure · Theory of planned behavior

1 Introduction

Excessive use of chemical fertilizers and discarded agricultural waste have caused significant threats to the environment (Elahi et al., 2019a, b; Bagheri et al., 2022; Elahi et al., 2019a; Li & Chen, 2020), including soil degradation, water pollution, and other

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environmental pollution issues (Han & Zhao, 2009; Liu et al., 2013; Sierra et al., 2015; Stuart et al., 2014; Wauters et al., 2010). Studies have confirmed that organic manure application can reduce greenhouse gas emissions (Liu et al., 2015) and improve the ability of soil to carry out carbon sequestration (Hui et al., 2017), which is significant for promoting the sustainable development of agriculture (Ning et al., 2017).

Most scholars have studied the environmental benefits of using organic manure. The application of organic manure has been proven to restore soil bacterial community diversity and increase crop yields (Gu et al., 2019; Li et al., 2022; Liang et al., 2022; Morra et al., 2021; Zhai et al., 2022). Some scholars have investigated the effects of social and policy factors on applying organic manure. (Li & Shen, 2021; Yang et al., 2020). Research on the topics above is of great significance for applying organic manure. However, few scholars have analyzed the behavior of farmers' willingness to use organic manure, especially the psychological factors affecting farmers' use of organic manure. Estimating the adoption behavior is imperative (Elahi et al., 2021a). Therefore, it is essential to explore the influence of psychological factors on farmers' intentions to apply organic manure.

Many scholars have applied various theories to study farmers' intentions to adopt different technologies (Elahi et al., 2021a, 2022a), including the protection motivation theory (Raza et al., 2019), the value belief—norm theory (Stern, 2000), and the theory of planned behavior (Ajzen, 1991). Since its inception, the theory of planned behavior (TPB) has found its application in a wide range of areas. These diverse applications include security (Danso et al., 2022; Man et al., 2021; Mucinhato et al., 2022; Tan et al., 2022); consumer behavior (Aboelmaged, 2021; Berki-Kiss & Menrad, 2022; Ding et al., 2022; D'Souza, 2022; Lim & An, 2021); agricultural diversification (Senger et al., 2017); nutrient management (Daxini et al., 2018); and the improvement of natural grasslands (Borges & Lansink, 2016). Some researchers have also conducted preliminary studies on the safe use of pesticides (Bagheri et al., 2021; Govindharaj et al., 2021; Savari & Gharechaee, 2020; Yi et al., 2021; Zheng et al., 2020). However, most of the studies above have limitations and cannot fully explain the intention of farmers to use organic manure. Therefore, we extended the initial TPB to assess the influence of psychological factors on farmers' intentions to utilize organic manure.

This study assessed the influence of psychological factors on the application of organic manure by farmers. We added moral norm (MN), environmental risk perception (ERP), and perceived policy effectiveness (PPE) to extend the initial TPB (I-TPB) and further explored the moderating effect of PPE on other psychological factors. The main contributions of this study are as follows: (1) it analyzed the psychological factors affecting farmers' willingness to adopt organic manure by using TPB and widened the TPB application fields; (2) it extended I-TPB with the addition of MN, ERP, and PPE, and enhanced TPB's ability to explain farmers' behavioral intention (IT) toward organic manure application; and (3) through the analysis of the adjustment effect of PPE, it provided practical suggestions for the promotion of organic manure.

2 Background of the research

The following sections introduce the application of the TPB in different fields, especially in the field of sustainable agriculture. It also raises the extension of the TPB, which provides a reference for the extension of the TPB in this paper.

2.1 Literature review

2.1.1 The development of sustainable agriculture

Research on sustainable development in the agricultural field is of great significance to realizing a greener future. Sustainable agriculture involves agricultural production, planting, and other aspects. Nguyen and Drakou (2021) found behaviors of adopting sustainable agriculture were significantly influenced by their perception. From an economic point of view, investment-ready and food-secure small producers are more willing to adopt agricultural technology options (Branca et al., 2022). Industrial agglomeration and industrial structure upgrading also play an essential role in the sustainable development of China's agriculture (Zhang et al., 2022a, 2022b). In terms of chemical fertilizers and pesticides, some scholars also explored whether pesticides would hinder the development of sustainable agriculture (Lykogianni et al., 2021). Researchers are working hard to develop environment-friendly agricultural materials in an attempt to reduce the damage which is caused by fertilizer overuse and pesticide residue. In the application of organic manure, researchers found that the application of organic manure could increase yields (Jiang et al., 2022b). The application of organic manure also has a positive effect on soil fertility (Muscolo et al., 2021). Therefore, it is essential to promote the application of organic manure to the sustainable development of agriculture.

2.1.2 The application of TPB

TPB has been widely used in various fields since it was put forward. It includes research on consumer behavior, safety, and agriculture, as shown in Table 1. Especially in the field of agriculture, it has also been fully applied. Cao et al. (2022) integrated value belief—norm theory and TPB. He found that the TPB and the VBN models can be well-integrated to examine smallholders' pro-environmental behaviors. Li et al. (2021) used TPB to study the driving mechanism for farmers to adopt improved agricultural systems in China. He found that perceived behavioral control has a great influence on farmers' willingness. Elahi et al. (2022a) adopted TPB to examine farmers' intention and willingness to install a PV water pump. He found that government support, education and awareness may increase acceptance of the PV pump. Some experts and scholars also used TPB to study the application of pesticides and fertilizers (Bagheri et al., 2021; Govindharaj et al., 2021; Savari & Gharechaee, 2020; Yi et al., 2021; Zheng et al., 2020).

2.1.3 The extension of the TPB

The original theory of TPB consists of AT, SN, and PBC. With further research by scholars, it was found that the three indicators could no longer explain intention well. Therefore, scholars are exploring other indicators to increase the explanatory power of theoretical models of planned behavior. As shown in Table 2, MN, self-identity, ERP, PPE, and other indicators are, respectively, extended to the TPB.

Combined with the above literature review, this paper adopts extended TPB to study the psychological factors of farmers' use of organic manure and analyze the influence of psychological factors on farmers' use of organic manure.

Table 1 The application of TPB

Application	Author(s)
Consumers behavior	D'Souza (2022)
	Ding et al. (2022)
	Berki-Kiss and Menrad (2022)
	Aboelmaged (2021)
	Lim and An (2021)
Security	Tan et al. (2022)
	Man et al. (2021)
	Mucinhato et al. (2022)
	Danso et al. (2022)
Agriculture	Senger et al. (2017)
	Daxini et al. (2018)
	Borges and Lansink (2016)
	Savari and Gharechaee (2020)
	Bagheri et al. (2021)
	Zheng et al. (2020)
	Yi et al. (2021)
	Govindharaj et al. (2021)
Environmental protection	Muñoz et al (2016)
	Echegaray and Hansstein (2017)
	Greaves et al. (2013)
	Blok et al. (2015)

Table 2 The extension of TPB

Indicators	Author (s)
MN	Tonglet et al. (2004)
	Davis et al. (2006)
	Chan and Bishop (2013)
	Chen (2016)
self-identity	Ataei et al. (2021)
	Arvola et al. (2008)
	Fielding et al. (2008)
	Mancha and Yoder (2015)
Environmental risk perception	Wang et al. (2021)
Perceived policy effectiveness	Lin and Guan (2021)

2.2 Conceptual framework

This study considered the influence of psychological factors on farmers' organic manure application. The initial TPB (I-TPB) was extended. We added MN, ERP, and PPE to the I-TPB model to obtain the extended TPB(E-TPB).

2.2.1 I-TPB

The TPB was first discovered by Ajzen (1991). It is a valuable tool which can be used to explain differences between intentions and behaviors. In the I-TPB, intention determines human behavior. Simultaneously, the behavior was determined by attitude (AT), perceived behavior control (PBC), and subjective norm (SN).

Attitude (AT) reflects people's evaluations of specific behavior. People's attitude can be positive or negative, and a negative attitude can harm behavior (Gholamrezai et al., 2021; Läpple & Kelley, 2013; Savari & Gharechaee, 2020; Wauters et al., 2010). D'Souza found that attitude had a positive statistical significance on participants' behavior (2022). As a result, we assume that farmers' attitudes toward organic manure have a positive statistical significance in their willingness to use it.

H1: AT has positive statistical significance on farmers' willingness to use organic manure.

Perceived Behavior Control (PBC) reflects experience and common obstacles, and represents the individual's perception of how difficult it is to act (Ajzen, 1991; Ranjbar et al., 2021). For farmers, PBC reflects the complexity of farmers' cognition and operation of organic manure application technology. If a farmer thinks that he can efficiently perform a task, he will have the willingness to act (Gao et al., 2017). As a result, we assumed that PBC has a positive statistical significance on farmers' willingness to use organic manure.

H2: PBC has positive statistical significance on farmers' willingness to use organic manure.

Subjective Norm (SN) refers to the social pressure perceived by the subject, that is, the recognition of people or the environment around the performance of a particular behavior (Ajzen, 1991). When people make decisions, they are often restricted by social norms and influenced by people who have intimate relationships with them. For farmers, the application of organic manure can be affected by the government, neighbors, relatives, and friends. As a result, we assumed that SN has a positive statistical significance on farmers' willingness to use organic manure.

H3: SN has positive statistical significance on farmers' willingness to use organic manure.

2.2.2 E-TPB

Recently, scholars have found that the I-TPB is no longer sufficient to explain people's intentions and have attempted to extend the I-TPB. Ajzen (2005), who proposed the TPB, believes that new structures could be used to extend it. Tama et al. (2021) added knowledge and perceived climatic threats to conventional farming to assess farmers' willingness to conserve agriculture. Ataei et al. (2021) compared TPB with the health belief model and found that perceived risk had a specific explanatory power on farmers' behavior.

Moral Norm (MN) assesses a person's beliefs and emotional values (Arvola et al., 2008). Leonard et al. (2004) thought that MN could significantly increase the prediction of the intent of an ethical approach. Some scholars have also extended the initial TPB by adding self-identity (Arvola et al., 2008; Ataei et al., 2021) and MN (Leonard et al., 2004). Other scholars have added MN to the I-TPB model and have confirmed that MN

is related to intention (Chan & Bishop, 2013; Chen, 2016; Davis et al., 2006; Tonglet et al., 2004). Therefore, MN was incorporated into E-TPB to enhance the explanatory ability of farmers' willingness to use organic manure.

H4: MN has positive statistical significance on farmers' willingness to use organic manure.

Environmental Risk Perception (ERP) is an essential factor for environmental protection and can improve individuals' nature-friendly behavior (Savari & Gharechaee, 2020). Wang added farmers' perceived climatic threats from conventional farming to study farmers' intentions and found they have a positive statistical significance on farmers' organic manure application (Wang et al., 2021). Some scholars have found a correlation between ERP and pro-environmental behavior (Barbaro et al., 2015; Wang et al., 2020). Citizens' environmental risk perceptions have a positive influence on the regional environment. (Liu et al., 2020; Nastran, 2015). Considering the positive impact of organic manure on the environment, it is necessary to add ERP to the E-TPB.

H5: ERP has positive statistical significance on farmers' willingness to use organic manure.

Perceived Policy Effectiveness (PPE) is an individual's evaluation of the transparency, adequacy, and convenience (Wan & Shen, 2013). Wan et al. (2014) found that policy incentives are an incentive means. If people perceive strong incentives, their willingness to engage in certain behaviors is enhanced. Policy promotion often has a positive statistical significance in promoting new technology in China (Jiang et al., 2022). Policy support increases recycling intentions (Wan & Shen, 2013). Additionally, PPE is beneficial for reducing food waste (Lin & Guan, 2021). As a result, we assumed that PPE has a positive statistical significance on farmers' willingness to use organic manure.

H6: PPE has positive statistical significance on farmers' willingness to use organic manure.

Referring to the research model of Savari and Gharechaee (2020), we added MN, ERP, and PPE into the I-TPB to form E-TPB.

2.3 The moderating effect of PPE

Based on the extended theoretical model, this study explores the moderating effect of PPE. Scholars have pointed out that PPE may act as an incentive to motivate people to recycle (Wan & Shen, 2013). Wan and Shen (2013) studied the regulating effect of PPE on recycling intention and found that PPE had particular regulating functions. Therefore, we proposed the following hypotheses to explore the moderating effect of PPE:

h1: PPE positively moderates the relationship between AT and farmers' willingness to use organic manures.

h2: PPE positively moderates the relationship between PBC and farmers' willingness to use organic manures.

h3: PPE positively moderates the relationship between SN and farmers' willingness to use organic manure.

h4: PPE positively moderates the relationship between MN and farmers' willingness to use organic manures.

h5: PPE positively moderates the relationship between ERP and farmers' willingness to use organic manure.

To sum up, Fig. 1 shows our theoretical model:

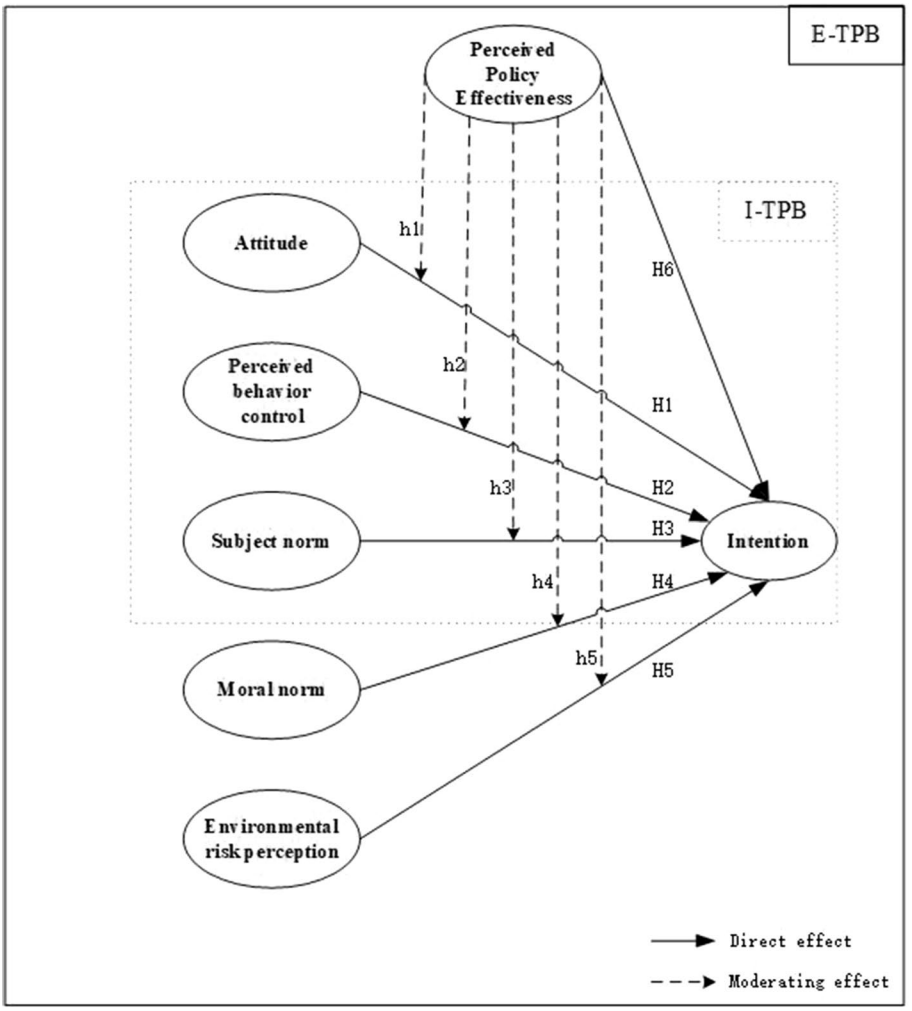

Fig. 1 The theoretical framework of this study

3 Material and methods

3.1 Study area

The excessive use of chemical fertilizers has caused severe pollution problems in agriculture, especially in China (Jin et al., 2018; Yang et al., 2019). Chinese fertilizer use is 325.6 kg of nitrogen per hectare, far exceeding the world average of 123 kg per hectare in 2019 (Jiang et al., 2022). As an agricultural country, China has made a series of attempts to promote the use of organic manure (MARA & PRC, 2017). In 2021, China made efforts to reduce chemical fertilizers and pesticides and optimize the pilot implementation of replacing chemical fertilizers with organic manure in fruits, vegetables, and tea (MARA & PRC, 2021).

As the origin of tea, China is a vast territory for tea cultivation. China's tea planting area has reached 3.217 million hectares. Tea production had reached 2.932 million tons by 2020 (NBSC, 2021). China distributes tea planting in Anhui, Fujian, and 14 other provinces. However, some problems exist, such as an unreasonable fertilization structure and insufficient use of organic manure in most planting areas. Considering the geographical environment and differences in tea planting varieties, we chose Anhui provinces for investigation. Lu'an and Anqing, located in the hinterland of Dabie Mountains, are the main tea-producing areas in Anhui province. These two cities are the main planting areas of tea in China, involving famous tea brands such as Lu'an Guapian, and Huoshan Huangya, which have geographical indications and are tea products with Chinese characteristics (Fig. 2).

3.2 Sample collection

Following (Elahi et al., 2021b, 2022b), we used a simple random sampling method to select tea planting areas in Lu'an and Anqing cities. Two research groups were organized from March 2022 to April 2022. One group conducted offline field interviews and distributed questionnaires. Affected by COVID-19, another group conducted surveys using an online distribution of questionnaires. Considering the educational level of tea farmers and other factors, our interviewers received professional training. Thus, they had a good understanding of tea farmers' intentions during the questionnaire survey. According to previous research, 100–150 samples are usually the minimum sample size for Structural Equation Modeling (Muthén & Muthén, 2002; Tama et al., 2021; Tinsley & Tinsley, 1987). According to the research by Bentler and Chou (1987), when potential variables have multiple indicators, at least five cases must be considered for each parameter. Considering that this study included 24 indicators, at least 120 samples should be investigated. Ultimately, we distributed 360 questionnaires and obtained 275 responses. The response rate was 76.39%. A total of 235 questionnaires were valid (130 paper questionnaires and 105 online questionnaires), with an effective rate of 85.45%.

3.3 Designing the questionnaire

The questionnaire consisted of three modules. The first module explained the research objectives. The second module mainly investigated the basic information of tea farmers, such as their gender and tea planting scale. The third module described the seven potential variables (IT, AT, PBC, SN, MN, ERP, and PPE) of our model. We designed 30 related indicators and determined 24 observation values to measure seven potential variables through a literature review, expert discussion, and predictive tests. A structured questionnaire was then developed using the Likert 5-point scale for investigation (as shown in Table 3).

3.4 Data analysis

SPSS.25 and AMOS16.0 were used for subsequent data analysis and processing in this study. First, the collected data were input into SPSS.25 for analysis. Data with missing values were processed using the table-list method. Second, we used a descriptive statistical method to analyze the basic characteristics of tea farmers. We used the Pearson correlation coefficient to test the correlations among the seven latent variables. Then,

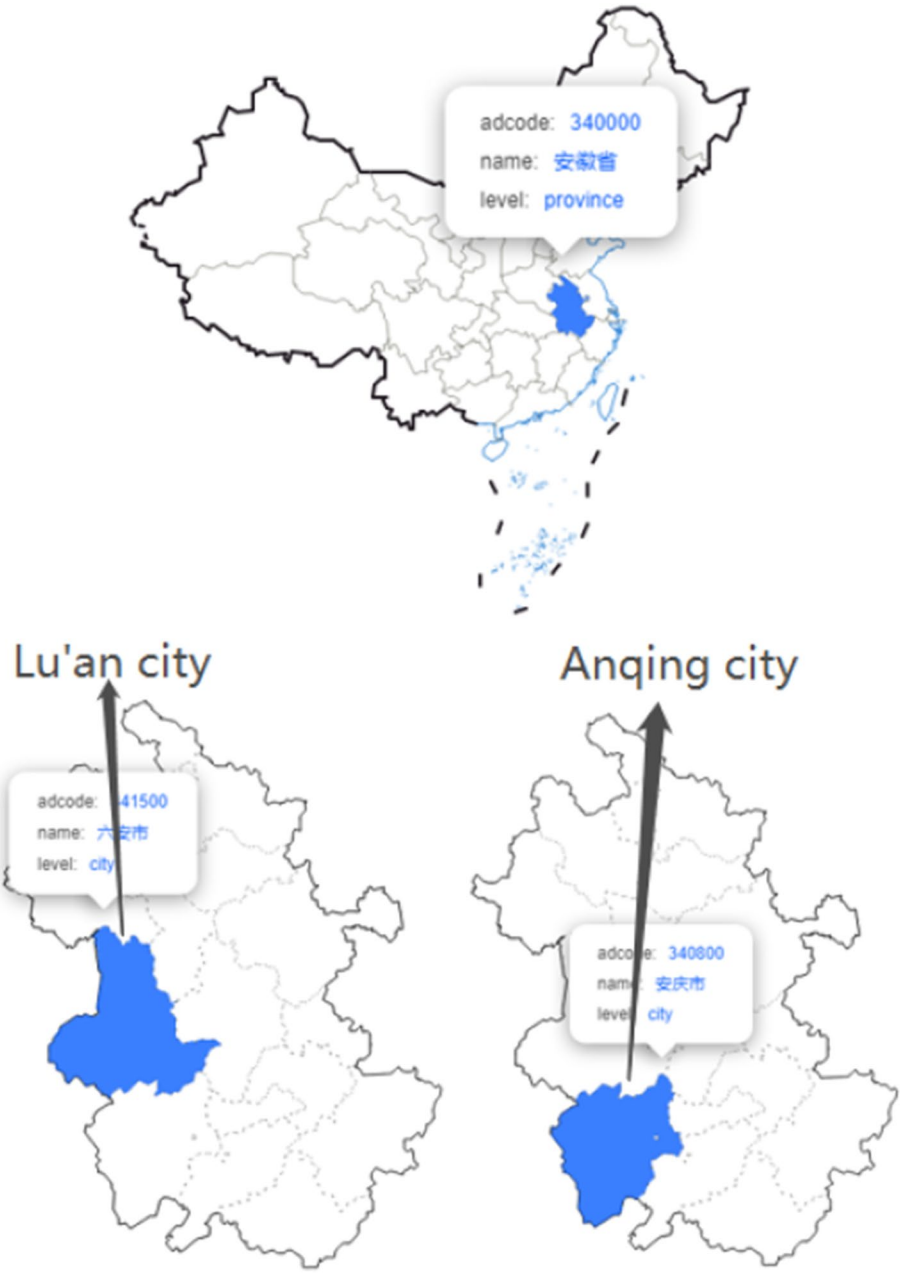

Fig. 2 Map of Anhui Province

we used the alpha model to test the reliability and validity of the questionnaire, and Cronbach's alpha was used to test the observed values of the seven potential variables. Finally, AMOS16.0 was used for structural equation modeling.

Table 3 Description of constructs

Latent variable	Observed item statements	Sources
IT	I tend to use organic manure in my tea plantations	Savari and Gharechaee (2020), Yadav and Pathak (2016), Bagheri et al. (2019)
	I tend to increase the use of organic manure in accordance with government guidelines	
	I tend to regularly reduce the use of chemical fertilizer in my tea plantations	
	I tend to promote organic manure to my neighbors	
AT	I have a positive attitude toward organic manure application	Sarma (2022), Despotović et al. (2019) and Yadav and Pathak (2016)
	I think organic manure has a good future	
	I think using organic manure makes me feel good	
PBC	I think organic manure is simple	Chin et al., (2016) and Mkhize and Ellis (2020)
	I know a lot about the application of organic manure in tea plantations	
	I think it is easy to buy organic manure nearby	
	I think the use of organic manure is entirely up to me	
SN	My family supports my use of organic manure	Chin et al. (2016), Bagheri et al. (2019) and Daxini et al. (2019)
	My neighbors and friends approve of my behavior on using organic manure	
	If I increase my use of organic manure, people around me will approve of me	
	I think it is what citizens should do to response to the call of the government	
MN	Under the background of sustainable development, it is necessary to increase the use of organic manure	Savari and Gharechaee (2020) and Ataei et al. (2021)
	Protecting the environment is a moral responsibility	
	I think I have the obligation to encourage farmers around to use organic manure	
ERP	I think the environment is getting worse and worse	Yadav and Pathak (2016), Mostafa (2009) and Wang et al. (2021)
	I think adopting organic manure can protect the environment	
	I think the use of organic manure can improve soil quality	
PPE	I think government subsidies reduce the cost of using organic manure	Zhang et al. (2022a, b) and Yi et al. (2021)
	I think the use of organic manure supports national strategies	
	I think the government supports the use of organic manure	

4 Results

4.1 Basic characteristics of survey subjects

Among all the farmers interviewed, males accounted for the majority (66.81%), and 40–60 years was the primary age group of the farmers (68.93%). The interviewees generally had a low education level, and less than 8.09% had received undergraduate education and above. More than 91.49% of respondents were small- and medium-scale tea farmers, which is in line with the background of the small-scale peasant economy in China (Table 4).

4.2 Model parameters

Average variance extracted (AVE), Cronbach's alpha (CA), Kaiser–Meyer–Olkin (KMO), and composite reliability (CR) were used to assess the reliability and construct validity of the survey data. As shown in Table 5 and 6, all seven potential variables had satisfactory reliability and validity.

4.3 Correlation coefficients between variables

The following table presents the Pearson correlation coefficients between the various variables. We found that IT is related to other latent variables (Table 7).

4.4 Model fitness index

To verify the fitness of I-TPB, E-TPB, the root mean square error of approximation (RMSEA), Tucker-Lewis index (TLI), root mean square residual (RMSR), and comparative fit index (CFI) were examined. According to Table 8, all indicators were in the range of the expected values, and the model-fitting effect was good.

4.5 Model results

4.5.1 I-TPB

We tested the I-TPB (AT, SN, and PBC). As shown in Table 9, I-TPB ($\frac{\lambda^2}{df} = 2.452, \mathrm{RMSEA} = 0.079, \mathrm{TLI} = 0.969, \mathrm{CFI} = 0.975, \mathrm{SRMR} = 0.023$), indicating that I-TPB has an excellent fitting effect. The I-TPB could explain 66% of the variance in farmers' intention to use organic manure. As shown in Table 6, AT ($beta = 0.368, t = 6.702, P < 0.001$) and PBC ($beta = 0.472, t = 6.263, P < 0.001$) had statistically significant effects on farmers' intentions. H1 and H2 were confirmed. Because SN ($b = 0.076, t = 1.216, P > 0.05$) has no significant effects, H3 cannot be accepted.

4.6 E-TPB

According to Table 10, $\frac{\lambda^2}{df} = 2.888, \text{RMSEA} = 0.09, \text{TLI} = 0.928, \text{CFI} = 0.94, \text{SRMR} = 0.044$, they are indicating that E-TPB has a good fitting effect. E-TPB can explain 72% of the variance in farmers' intention to use organic manure, which is significantly improved compared to the I-TPB. In particular, the explanatory power of farmers' intention to use organic materials increased by 6% compared with the I-TPB. As shown in Table 8, $AT(beta = 0.217, t = 3.661, P < 0.001)$;$PBC(beta = 0.33, t = 4.503, P < 0.001)$; $MN(beta = 0.151, t = 2.908, P < 0.05)$;$ERP(beta = 0.151, t = 2.804, P < 0.05)$; $PPE(beta = 0.21, t = 3.605, P < 0.001)$. Therefore, we accept hypotheses H1, H2, H4, H5, and H6. AT, PBC, MN, ERP, and PPE have statistically significant effects on farmers' intentions. However, SN ($b = 0.024, t = 0.26, P > 0.05$) cannot be demonstrated to have a significant effect, and H3 cannot be accepted.

Table 4 Demographic characteristics of respondents ($n = 235$)

Variables	Frequency	Percentage (%)
Gender		
Male	157	66.81
Female	78	33.19
Sex		
30 and younger	20	8.51
30–40	23	9.79
40–50	84	35.74
50–60	78	33.19
60 and above	30	12.77
Education level		
Up to primary education	115	48.94
Senior school	101	42.98
High school and above	19	8.09
Size of farm (in acres)		
< 1.65	134	57.02
1.65–8.24	81	34.47
> 8.24	20	8.51

Table 5 Reference ranges

	Reference ranges	
AVE	> 0.5	Leguina (2015)
CA	> 0.7	Hinton et al. (2014)
KMO	> 0.5	Norušis (2011)
CR	> 0.7	Leguina (2015)

Table 6 Results of reliability and convergence validity

Constructs	Variables	Mean	SD	Factor loadings	AVE	CR	CA	KMO
Intention (IT)					0.851	0.958	0.957	0.862
	IT1	4.05	1.13	0.958				
	IT2	4	1.21	0.894				
	IT3	3.86	1.21	0.876				
	IT4	3.96	1.2	0.958				
Attitude (AT)					0.915	0.97	0.97	0.782
	AT1	3.94	1.23	0.948				
	AT2	3.87	1.24	0.967				
	AT3	3.83	1.27	0.956				
Perceived behavior control (PBC)					0.855	0.959	0.959	0.847
	PBC1	3.82	1.33	0.917				
	PBC2	3.68	1.37	0.966				
	PBC3	3.78	1.31	0.929				
	PBC4	3.69	1.33	0.885				
Subjective norm (SN)					0.874	0.965	0.964	0.87
	SN1	4	1.13	0.952				
	SN2	3.85	1.18	0.893				
	SN3	3.92	1.15	0.967				
	SN4	4.09	1.15	0.925				
Moral norm (MN)					0.885	0.958	0.957	0.772
	MN1	4.12	1.08	0.917				
	MN2	4.14	1.08	0.947				
	MN3	3.99	1.18	0.958				
Environmental risk perception (ERP)					0.695	0.871	0.856	0.698
	ERP1	4.14	1.1	0.737				
	ERP2	4.2	1	0.909				
	ERP3	4.21	0.98	0.846				
Perceived policy effectiveness (PPE)					0.817	0.93	0.93	0.752
	PPE1	3.98	1.26	0.841				
	PPE2	4.08	1.21	0.922				
	PPE3	4.14	1.24	0.946				

4.6.1 Moderating effects

According to Table 11, only one of the five moderating effects (PBC and PPE) was significant. In addition, the coefficient of the interaction term was negative. When PPE is weak, a strong PBC is associated with a more vital willingness to apply organic manure.

A possible explanation is that when the government designs effective policies to promote the implementation of organic manure, the effect of PBC on the use of organic manure will become weaker. When the policy subsidy intensity is relatively large, farmers tend to respond to the policy implementation; even though the application of organic manure is more complicated than chemical fertilizer, farmers are willing to overcome it.

Table 7 Correlation coefficients between variables

	Mean	SD	IT	AT	PBC	SN	MN	ERP	PPE
IT	3.966	1.118	1						
AT	3.878	1.210	0.672**	1					
PBC	3.740	1.259	0.732**	0.608**	1				
SN	3.964	1.097	0.554**	0.403**	0.700**	1			
MN	4.084	1.072	0.544**	0.555**	0.484**	0.388**	1		
ERP	4.183	0.911	0.522**	0.325**	0.470**	0.487**	0.383**	1	
PPE	4.067	1.157	0.635**	0.555**	0.592**	0.412**	0.291**	0.428**	1

Table 8 Model fitting index

	Standard range	I-TPB	E-TPB
λ^2/df	$1 < \lambda^2/df < 3$	2.452	2.888
RMSEA	< 0.10	0.079	0.09
TLI	> 0.9	0.969	0.928
CFI	> 0.9	0.975	0.94
SRMR	< 1.0	0.023	0.044
R^2	/	0.66	0.72

Table 9 The result of I-TPB

I-TPB							
path			beta	SE	*t*-value	*P* value	Supported or not
IN	<--	AT	0.368	0.049	6.702	***	Supported
IN	<--	PBC	0.472	0.069	6.263	***	Supported
IN	<--	SN	0.076	0.061	1.216	ns	Not supported

***Significant at $P < 0.001$; **Significant at $P < 0.01$; *significant at $P < 0.05$, ns non-significant

According to Figs. 3 and 4, we found that PBC is the most important psychological factor affecting farmers' intention to use organic manure, followed by AT and PPE, and ERP and MN. Combined with the results of the investigation and analysis, the complexities of applying organic manure are an important factor restricting the promotion of organic manure. Therefore, promoting a more convenient and efficient method is a crucial measure to using organic manure. Based on the results, we propose the following management recommendations. First,

Table 10 Results of E-TPB

E-TPB							
Path			Beta	SE	*t*-value	*P* value	Supported or not
IT	<--	AT	0.217	0.053	3.661	***	Supported
IT	<--	PBC	0.33	0.065	4.503	***	Supported
IT	<--	SN	0.009	0.059	0.149	0.881	Not supported
IT	<--	MN	0.151	0.05	2.908	**	Supported
IT	<--	ERP	0.151	0.071	2.804	**	Supported
IT	<--	PPE	0.21	0.06	3.605	***	Supported

***Significant at $P<0.001$; **Significant at $P<0.01$; *significant at $P<0.05$, ns non-significant

Table 11 Results of moderating effects

Path			Beta	S.E	C.R	*P*	Supported or not
I	<--	PPE*AT	0.064	0.040	1.046	0.295	Not supported
I	<--	PPE*PBC	-0.210	0.045	−2.885	0.004	Supported
I	<--	PPE*SN	0.070	0.054	1.086	0.278	Not supported
I	<--	PPE*MN	0.083	0.035	1.721	0.085	Not supported
I	<--	PPE*ERP	−0.027	0.062	−0.414	0.679	Not supported

we should increase the investment in organic manure research and development, strengthen scientific research, and improve the mechanization level of organic manure. Second, we should further promote the popularization of knowledge of organic manure, so that the majority of farmers fully understand the benefits of organic manure. This will increase farmers' acceptance of organic manure. Third, the government should increase technical training in organic manure application and train a group of agricultural technology experts and research professionals to guide farmers in organic manure application. Fourth, infrastructure construction should be strengthened, the problem of organic manure transportation solved, and the problem of organic manure sales and transportation channels resolved.

5 Discussion

The results show that first, it is meaningful to extend the I-TPB. Compared with the I-TPB, the explanatory power of the E-TPB for farmers' intention to use organic manure successfully increased from 66 to 72%. Second, the main factors affecting farmers' willingness to use organic manure were AT, PBC, MN, ERP, and PPE. Finally, PPE negatively moderated the effect of PBC on farmers' intentions to use organic manure.

5.1 PBC: the most important psychological factor influencing farmers' intention to use organic manure

PBC has a significant impact on intention, the same as the findings of Mahon et al. (2006) and Botetzagias et al. (2015). In the interviews, we found that farmers' perception of the difficulty of applying organic manure determines their intention. Farmers who believe that applying organic manure is troublesome tend to have a lower willingness, which is similar to the results of previous research (Bagheri et al., 2019; Borges et al., 2014; Bruijnis et al., 2013; Savari & Gharechaee, 2020). Therefore, the government should strengthen the research of organic manure and promote the convenience of using methods. Improving the availability of organic manure increases farmers' willingness to apply it.

5.2 AT and MN had a significant positive correlation with farmers' intention to use organic manure

Research has shown that AT plays a vital role in human intention (Ajzen, 1991). Similar to studies by Ledesma et al. (2018), Damalas and Koutroubas (2018), and Maleksaeidi and Keshavarz (2019), AT plays a crucial role in intention. Attitude plays a significant role in farmers' willingness to use organic manures. When farmers are aware of the harmful effects of pesticides, they use them safely (Yuantari et al., 2015). It can be inferred that

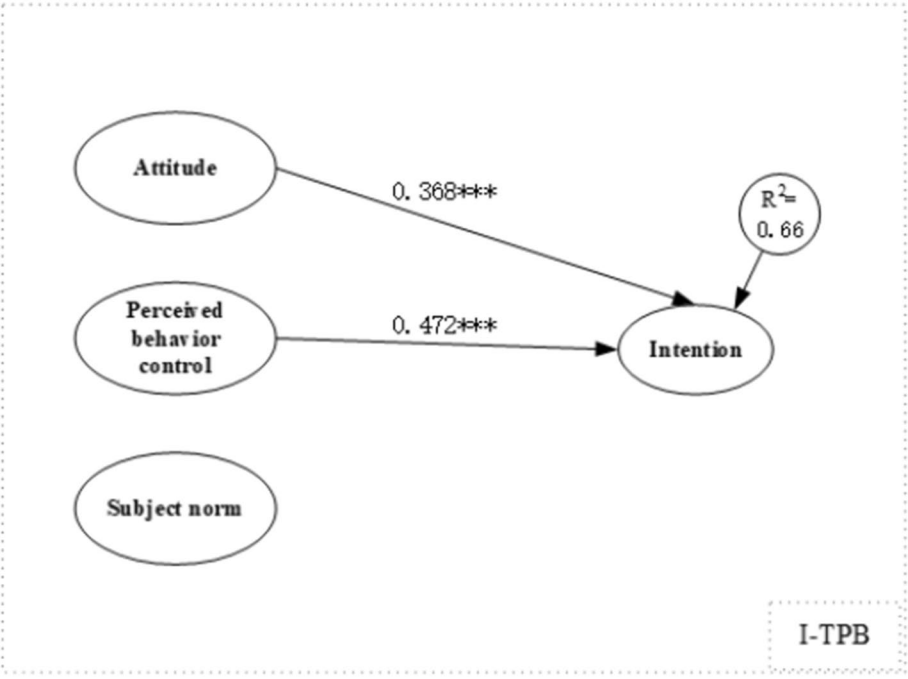

Fig. 3 Normalized path coefficient of I-TPB

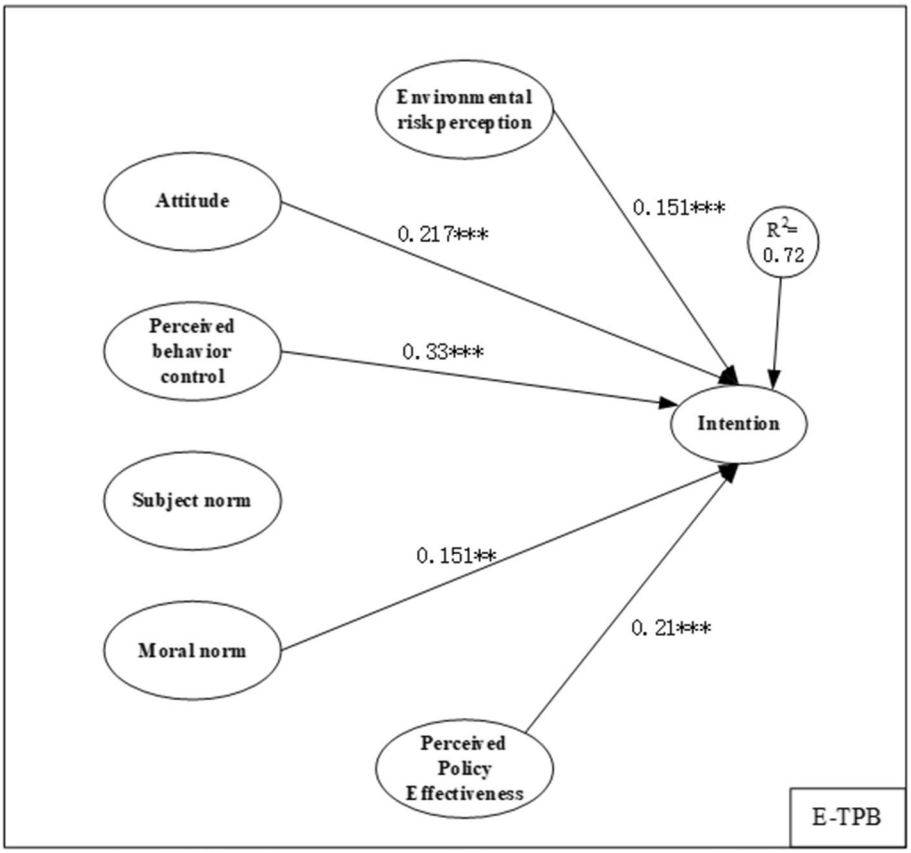

Fig. 4 Normalized path coefficient of E-TPB

when farmers realize the environmental benefits of organic manure application, their attitudes toward organic manure will become positive.

MN has a significant impact on farmers' intention to use organic manure, which is similar to the findings of Savari and Gharechaee (2020). Some studies have explored the relationship between MN and AT (Arvola et al., 2008). The MN can directly or indirectly influence intention. In this study, MN directly affected the intention to apply organic manure. This psychological factor can be added to models that simulate farmers' intentions.

5.3 PPE and ERP has been proven to improve farmers' intention to apply organic manure use behavior

PPE and ERP significantly affected on farmers' intentions to use organic manure. This is similar to the results reported by Wang et al. (2021) and Savari and Gharechaee (2020). ERP is a subjective factor that represents farmers' understanding of current environmental hazards, whether organic manure benefits the environment, and whether environmental pollution caused by chemical fertilizer will harm their lives. We found that the impact of

PPE on farmers' intentions was also significant, especially in China. China's policies often have a substantial effect on farmers. According to the results of the survey, many farmers held a dialectical attitude toward the application of chemical fertilizer. They believe that applying chemical fertilizer could improve yield to a certain extent, but the environmental harm caused by chemical fertilizer is immeasurable. At the same time, although the yield improvement brought about by organic manure is not as evident as chemical fertilizer, organic manure could improve soil quality and the environment. The government also has a positive attitude toward organic manure, which is an essential means of enhancing the application of organic manure.

5.4 PPE's negative moderating effect between PBC and IT

PPE has a negative moderating effect on PBC control intention. PBC is the most critical factor affecting the application of organic manure. This result is of great significance for organic manure promotion policies. Perceived difficulties largely restricted farmers' willingness to apply organic manure, but when policy guidance continuously strengthens, the PBC of farmers intends to influence organic manure application.

5.5 No significant effect was found between SN and intention

In the results of this paper, we did not find a significant effect between SN and IT, which may be different from the results of many studies. But it can be explained, and some experts and scholars have found this phenomenon. Similar to the results of Botetzagias et al. (2015), we did not find that SN had a significant effect on intention. So as in the studies by Thomas and Sharp (2013), and Martin et al. (2006). An explanation of this puzzle may be offered by Schwartz (1977), who argued that social norms might be personally adopted and thus become internalized, 'personal moral' norms. In this paper, although SN doesn't impact farmers' willingness to apply organic manure, MN has a significant impact on farmers' willingness to use organic manure.

6 Conclusion

This study is the first attempt to simulate the intention of tea farmers to use organic manure with an extended TPB. It explored the main psychological factors influencing farmers' willingness to use organic manure. The results showed that the extended TPB increased the explanatory power of farmers' intention to use organic manure by 6% compared with the I-TPB, and that PPE negatively moderated the effect of PBC on intention.

The present work could provide a reference for scholars and policymakers with its theoretical contributions and practical guidance. First, considering the vital influence of PBC on farmers' organic manure application behavior, the government should strengthen the research investment in organic manure. Reducing the complexity of using organic manure from the technical level, for example, could promote farmers' willingness to use organic manure. Second, government-led promotion of organic manure can effectively improve farmers' moral norm (MN) and perceived policy effectiveness (PPE). When more farmers recognize that organic manure could enhance the quality of tea, they are more willing to use organic manure. Third, considering the influence of ERP on farmers' willingness to apply organic manure, the popularization of sustainable agriculture and environmental

protection strategy should be strengthened, to improve farmers' awareness of environmental protection and to encourage the use of organic manure. Fourth, the government should increase organic manure subsidies. Considering the significant influence of PPE on farmers' organic manure application behavior and the active response of Chinese farmers to the government's policies, the costs of organic manure application should be reduced to incentivize the use of organic manure. Fifth, the government should invest in the technical training of organic manure application, and provide a group of trained agricultural technology experts to guide the farmers on the more reasonable and convenient use of organic manure. Sixth, the transportation infrastructure needs investment and upgrade to solve the challenge of organic manure transport, to reduce the costs of organic manure application.

There is additional work that could further the study in this paper. Understanding and compensating for the potential difference between the questionnaire-based intention and the farmers' actual behavior of organic manure application could bring more fidelity to the present study. In addition, incorporating the collective impact of the market and government could reveal new insights into the issue of organic manure application.

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Declarations

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