Journal of Cleaner Production 380 (2022) 134895

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Driving mechanism for farmers' participation in improving farmland ecosystem: Evidence from China

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ARTICLE INFO

Keywords:
Developing sustainable farmland
Farmland infrastructure
Environmental-friendly agricultural production practices
Extended theory of planned behavior

ABSTRACT

Aiming to enhance national food security, China has constructed the high-standard farmland (HSF) on a massive scale and gained significant achievements. However, early high-standard farmland construction (HFC) paid little attention to ecology, and single engineering practices had limited effect on land quality improvement and non-point source pollution control in farmland. China is conducting to explore the development of sustainable farmland (DSF) that better meets the needs of production-ecology-livelihood. And the improvement in farmland construction standards has overloaded the central finance. As the direct stakeholder, farmers should play a role in DSF. Hence, exploring how to encourage and mobilize farmers' willingness is the crucial issues. The study aims to analyze farmers' participation in DSF based on 1133 samples from four provinces or autonomous region by employing the extended theory of planned behavior (ETPB). The results demonstrated: a) Farmers' intention was impacted by perceived behavior control (PBC), subjective norms (SN), and attitude (AT) to DSF. b) Agricultural production conditions (APCs) negatively moderated TPB construct, while policy evaluation (PE) positively moderated. The findings implied: a) Multiform and multi-standard DSF participation mode should be created for satisfying farmers' demands. b) Farmers' cooperatives can serve as an intermediary platform to tackle the participation constraints of group capacity. c) The government should promote multi-benefits of DSF and strengthen farmers' training to increase ecological awareness. Meanwhile, there is an imperious demand to strengthen the interactive platform, personal networks, so as to boost the scope and speed of DSF information dissemination among farmers. d) It enlightened policymakers to conduct DSF in a result-led and site-specific manner to maximize the utilization efficiency of resource.

1. Introduction

The sustainable management of the agri-system is imperative for achieving UN-Sustainable Development Goals (SDGs), especially the development of sustainable agriculture to meet Goal 2: zero hunger (FAO[1]). Farmland system provides the largest share of food supply and has an essential contribution to socio-economic development in the world (Stephens et al., 2018). Agriculture is the top priority of the national development strategy, especially for China with a population of 1.4 billion. Since the Reform and Opening-up for creating the agricultural household contract responsibility system from 1978, China has achieved significant progress in agricultural production while it is still limited by fragmented land and imperfect irrigation facilities. Medium to low-yield fields account for over 70% of 120 million ha in Chinese

Abbreviations: HSF, High-standard farmland; HFC, High-standard farmland Construction; TPB, Theory of Planned Behavior; ETPB, Extended Theory of Planned Behavior; SEM, Structural Equation Model; SF, Sustainable Farmland; DSF, Developing Sustainable Farmland; EFAPP, Environmental-friendly Agricultural Production Practices; AT, Attitude; SN, Subjective Norms; PBC, Perceived Behavior Control; INT, Intention; PE, Policy evaluation; APCs, Agricultural Production Conditions; CLQ, Cultivated-land-quality; FIC, Farmland Infrastructure Conditions; NLDCP, National Land Development and Consolidation Plan; OSPCHF, Opinions on Solidly Promoting the Construction of High-standard Farmland; NHSCP, The National High-standard Farmland Construction Plan.

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[1] https://www.fao.org/sustainable-development-goals/indicators/zh/.

https://doi.org/10.1016/j.jclepro.2022.134895
Received 2 August 2022; Received in revised form 13 October 2022; Accepted 24 October 2022
Available online 28 October 2022

cultivated land.[2] In fact, China has an excellent design for large-scale construction of high-standard farmland (HSF), aiming to enhance national food security.[3] Developing HSF has boosted crop yield by 10–20% compared to conventional farmland, with an expense reduction of CNY 7,500 per ha[4] in production. However, its principal efforts aim to improve farmland infrastructure conditions (FIC) on production, but ignoring the ecological attributes of farmland system.

China utilizes more chemical fertilizers and pesticides than developed countries, at 506.1 kg/ha and 10.3 kg/ha, respectively.[5] Excessive agri-chemical inputs and haphazard agricultural waste management have resulted in non-point source pollution, with serious environmental problems (Dubey et al., 2016; Gruber, 2017; Gu et al., 2015; Han and Zhang, 2020; Gao et al., 2019; Liu et al., 2018; Wanger et al., 2020). The integrated benefits of environmental-friendly agricultural production practices (EFAPP) have been piloted and demonstrated (Cowie et al., 2018; Johnson et al., 2016; Zhang et al., 2022). Its contributions to promote cultivated land quality (CLQ) and ecological conservation, and adapt climate change should not be underestimated (Hu et al., 2020; Li, W. et al., 2021; Lili et al., 2022; Maris et al., 2015; Wang et al., 2020a,b; C. Wei et al., 2021; Zhang et al., 2019). China has implemented associated policies to encourage the application of EFAPP, but there is no institutional scheme that integrates engineering and agronomic measures with systematically responding to the demand for sustainable agricultural development. Developing sustainable farmland (DSF) is not only upgrading farmland infrastructures, but also promoting EFAPP to synergistically establish sustainable agricultural production system by farmland construction.

The current management mode of high-standard farmland construction (HFC) has led to the dilemmas caused by “high administrative leading-low farmers’ participation.” Firstly, China has already constructed 53 million ha of HSF. The total investment is CNY 86.7 billion in 2020.[6] The farmland development activity, which is ultimately led and invested by the central government, has brought tremendous pressure on central finance. Secondly, the investment, which is CNY 19,500 per ha, hardly achieve sustainable agricultural yield objectives. The current agricultural production conditions are still insufficient response to natural disasters. Agricultural disaster area reached 20 million ha, resulting in CNY 370 billion loss in 2020.[7] Farmland is also subjected to increasing expectations such as “guaranteeing agricultural product security, providing ecological function, and performing cultural services”. In this context, encouraging the participation of stakeholders is the critical pathway to upgrading standards and improving the benefits of farmland. As a practitioner of farmland utilization, agricultural producers deserve to have a primary role in DSF. Smallholder farmers account for more than 98% entities, with approximately 70% of total cultivated land in 2016 in China.[8] To understand farmers’ attitude is helpful for policy innovation and practice guidance on land-use concerns (Huang et al., 2017; Vukina et al., 2008). Hence, it is imperative to assess whether farmers are interested in volunteering with DSF and what factors influence their decisions. A comprehensive of the influence mechanism will help the government to formulate more effective policies.

In general, the intention is an individual’s psychological preference for a behavior. Furthermore, behavior is an individual’s adopted action in the past. Decision-making is the transformation process from intention to behavior, which is dynamic. Farmers’ intention is their psychological preference to participate in DSF. Whether farmers have participated in DSF in the past is considered as the behavior. DSF-related policies have just been implemented currently in China. Farmers’ participation behavior and decision-making have not been developed. Thus, focusing on farmers’ intention at this stage is especially critical. Farmers’ intention, behavior, and decision on farmland management were generally influenced by their gender, age, education, family size, income (Liu and Chen, 2012; Liu and Tan, 2006; Luu, 2020; Malawska et al., 2014; Seroa da Motta and Ortiz, 2018; Thinda et al., 2020; Wang et al., 2021; Zhu et al., 2010), and benefit expectations (Hernandez-Espallardo et al., 2013). In terms of variables, the influencing factors were mainly related to farmer or household characteristics. The effect of these indicators was limited. There was still a lack of information to explain the motivation of farmers to participate in sustainable agriculture development.

Socio-psychological analysis methods are widely used to identify human behavior motivation and its influencing factors, improve understanding of farmers’ decisions, and guide policy design (Adnan et al., 2017; Borges et al., 2014; Floress et al., 2017; Wang et al., 2020a,b; Wauters and Mathijs, 2013; Yazdanpanah et al., 2014). In the resource and environment management studies, Theory of Planned Behavior (TPB) has been employed in assessments of biodiversity enhancement (Spash et al., 2009), agriculture system improvement (Li et al., 2021), and pro-environmental behavior (de Leeuw et al., 2015). Despite the demonstrated benefits of TPB, the current application has certain limitations (Agidew and Singh, 2018). The original framework didn’t consider potential factors including environmental endowments and government incentive program, which could stimulate behavior change (Meijer et al., 2015a; Pratt and Wingenbach, 2016).

An acceptable modification of TPB is an efficient method to address its imperfections and boost theoretical explanatory power (Savari and Gharechaee, 2020; Tama et al., 2021). Recently, the method based on the extended theory of planned behavior (ETPB) has been widely applied in agriculture. For example, the new conceptualizations of knowledge, moral norm, and perceived threats of intensified agriculture were appended to the TPB framework that revealed farmers’ attitudes (AT) toward conserving farm biodiversity (Maleksaeidi and Keshavarz, 2019). Tama et al. (2020) introduced knowledge and perceived climatic threats to analyze the influences on farmers’ intention to adopt conservation agriculture consistently. The subsidy policy was used as an extension of TPB to discover that it affected farmers’ intention to conduct green manure rotation. Environmental literacy was involved in ETPB to fit farmers’ attitudes in mitigating non-point source pollution (Li et al., 2021; Wang et al., 2018a,b).

The study employed the ETPB framework to illuminate the drivers of farmers’ participation in DSF by introducing policy evaluation (PE) and agricultural production conditions (APCs) to enrich the literature. It was widespread that PE affected farmers’ cognition and behavior intentions (Huang et al., 2017; Xie et al., 2018; Yu et al., 2018). However, the literatures are still focused on a single activity related to farmland construction. It lacks an in-depth investigation of the mechanism that shapes farmers’ behavior intention (INT) on integrated farmland development. The expected findings can provide new insights for policymakers and practitioners to design or adjust schemes related to improve farmland ecosystem or formulate more appropriate agricultural strategies.

The ultimate purpose of the study is to develop an improved

[2] Report of the State Council on Land Management and Mineral Resources Development and Utilization and Protection (http://www.npc.gov.cn/zgrdw/huiyi/cwh/1130/2013-01/06/content_1750100.htm).

[3] https://www.chinadaily.com.cna20210923WS614bbba1a310cdd39bc6ad54.html)">High-standard farmland can improve food security (https://www.chinadaily.com.cn/a/202109/23/WS614bbba1a310cdd39bc6ad54.html).

[4] China High-Standard Farmland Construction Plan (2021–2030) (https://www.ndrc.gov.cn/fggz/fzzlgh/gjjzxgh/202111/P020211102598713060217.pdf).

[5] http://www.stats.gov.cntjsjndsj2021indexch.htm)">2021 China Statistical Yearbook (http://www.stats.gov.cn/tjsj/ndsj/2021/indexch.htm).

[6] https://baijiahao.baidu.com/s?id=1710844140410199335&wfr=spider&for=pc.

[7] 2021 China Statistical Yearbook (http://www.stats.gov.cn/tjsj/ndsj/2021/indexch.htm).

[8] The Third National Agricultural Census Bulletin (http://www.stats.gov.cntjsjtjgbnypcgbqgnypcgb)">http://www.stats.gov.cn/tjsj/tjgb/nypcgb/qgnypcgb/).

framework, ETPB, to provide a comprehensive understanding of the causal relationships with concerning farmers' behavior intention to contribute to DSF. In particular, the study aims to achieve improvements in the following three dimensions: 1) to examine the model suitability of ETPB for farmers' intention to contribute to DSF; 2) to identify potential influencing factors of farmers' behavior INT in addressing agricultural development strategies; and 3) to explore the impacts of PE and APCs (e.g., CLQ & FIC) on TPB construct.

2. Theoretical and hypotheses

2.1. Description of sustainable farmland (SF)

To actively promote the sustainable objectives of agricultural development, farmland construction has entered a new era of integrated "quantity, quality and ecology" in China. The latest HFC plan proposes to create a green farmland pilot demonstration.[9] It aims to integrate and promote high-quality infrastructure and high-efficiency technologies, enhance the environmental protection capacity of farmland, increase the adequate supply of qualified agricultural products, and develop a sustainable farmland system that combines soil quality enhancement, non-point source pollution prevention, and ecological landscape improvement of cultivated land. Compared with HSF, the green farmland upholds the concept of sustainable development and attaches more important functions to unite with agricultural production, perpetual utilization of resources, and ecological protection, which is to explore a new mode of farmland development. Therefore, green farmland is equal to sustainable farmland (SF) based on its connotation in the study.

Fang et al. (2021) proposed the green farmland development (DSF) mode in different areas of the Yellow River Basin by field survey. Wang (2022) divided the content of DSF into two major activities, namely infrastructure construction and soil fertility enhancement of farmland, which also specify the construction items. Furthermore, Hubei Province conducted a pilot in establishing a SF system framework in 2020 (Fig. S 1).

The connotation of SF and its specific construction activities (Table S 2) are defined by integrating academics and institutional frameworks. DSF mode is promoted to meet the multifunctional synergy of farmland ecosystem. The primary activities of DSF include the construction of eco-friendly farmland infrastructure and promotion of agricultural production practices with environmental-economic benefits. These two critical activities contribute to the goals of increasing farmland productivity, the prevention and control of agricultural non-point source pollution, ecological restoration and biodiversity enhancement. The SF benefits of economic-ecology-society can be significantly superior to conventional farmland (Fig. 1).

2.2. Theoretical analysis of farmers' participation in DSF activities

The study aims to guide farmers' participation in DSF, which is attributed to the fact that the content and standard of farmland construction have changed with the goals and plans of agricultural development in different stages[10,11] (Zhou and Cao, 2020). DSF focuses on the farmland functions of production, livelihood and ecology. Meanwhile, the finance demand is increasing in farmland construction. The single financing mode led by the government is not advisable for farmland

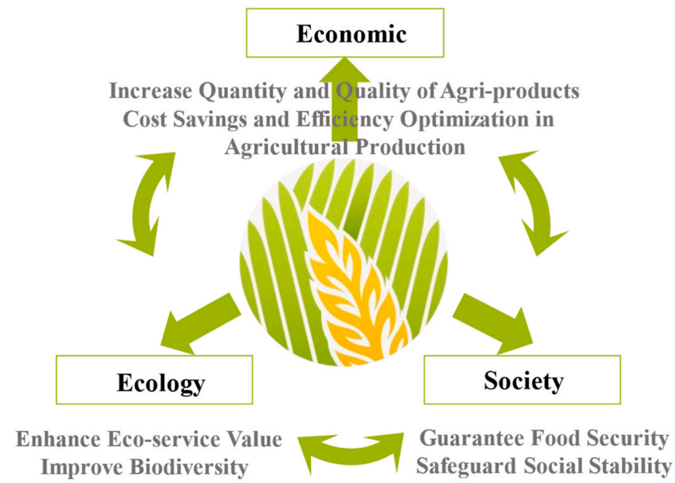

Fig. 1. The benefits of developing sustainable farmland (DSF).

construction. Agricultural producers should play a role in the construction activities as they are the primary actors in farmland utilization. Thus, based on the central finance bearing the basic farmland construction, farmers are encouraged to participate in the incremental part of the farmland construction. It is conducive to solving the dilemma between capital restriction and the inability of construction standards to meet the needs of modern agricultural production.

Based on the assumption of "homo-economicus" in neoclassical economics, the farmers, as decision-making entity, would select the behavior practices that maximize their utility under certain constraints. It is necessary to identify the participant activities that align with the farmers' capacity and fundamental interests. On one hand, agricultural infrastructure belongs to public goods (Liu and Ji, 2020). It is generally believed that farmland infrastructure, represented by drainage and irrigation ditches and field roads, is a "quasi-public goods" (Wang and Liu, 2019). Meanwhile, farmland belongs to farmers as "private goods" with exclusivity and competition in terms of use. Therefore, it is reasonable and necessary to consider farmers' decisions, behaviors, and influences on their participation in the construction and renovation of "quasi-public goods" and "private goods" in SF infrastructure (Wang et al., 2021). On the other hand, as the primary actors in applying EFAPP, it is crucial to guide farmers to in-depth adopt relevant practices (Li et al., 2020, 2021; Liu and Zheng, 2021). Based on the above analysis, the study identified the targets boundaries and key activities of farmers' participation in DSF (Fig. 2). The following is to further focus on farmers' willingness to contribute to DSF according to the framework, reveal the pathways of farmers' decision-making, and deeply explore the influencing factors and acting mechanism of behavior INT.

2.3. TPB and its extended framework

Ajzen (1991) proposed that TPB is a derivative of the theory of reasoned action (TRA), which constructs a "cognition - intention - behavior" driving mode that integrates factors from actors, internal management, and the external environment. It is widely applied in the study of decision-making behavior. The core of TPB is based on the psychological perspective to explain the individual decision-making process. In TPB, attitude (AT), subjective norms (SN), and perceived behavior control (PBC) jointly determine individual INT (Ajzen, 1991; Ajzen and Madden, 1986). In addition, there may be interaction between AT, SN and PBC (Icek and Driver, 1992). Farmers' participation behavior is a joint participation of two activities of DSF, which is still in the exploratory stage for policy development. The TPB construct allows for trade-offs based on the presence of actual behavior (Daxini et al., 2019; Li et al., 2020c; Tama et al., 2021; Tao et al., 2021). Consequently,

[9] China High-Standard Farmland Construction Plan (2021-2030) (https://www.ndrc.gov.cn/fggz/fzzlgh/gjjzxgh/202111/P020211102598713060217.pdf).

[10] National land development and consolidation plan (2001–2010) (https://jlps.mnr.gov.cn/global/reward!readResult.do?resultId=eafe035b-4564-41c1-aae5-5f6a202a72a1).

[11] Opinions on solidly promoting the construction of high-standard farmland (http://www.gov.cn/xinwen/2017-02/22/content_5169998.htm).

Fig. 2. Targets and key activities of farmers' participation in DSF.

the examination of the behavior dimension is not addressed in the framework of the study.

ETPB could better reveal farmers' decisions than TPB (Carrington et al., 2010).The policy support influences the propensity to embrace agricultural green production (AGP) (Chen et al., 2017). The current conditions can impact farmers' willingness to invest in irrigation facilities (Hui and Siyu, 2012), while external knowledge (Ru et al., 2018), value perception (Li et al., 2020c; Zhang et al., 2020), and trust (Ashworth et al., 2012; Midden and Huijts, 2009) can be employed as moderating factors in the TPB framework. The study considers the current system in China, in which the government led the support of FIC and EFAPP in the form of infrastructure investments and production subsidies. As an essential external contextual factor, the institutional background creates a specific incentive structure for practitioners, and the motivational orientation of the institution determines the direction of behavior (Chen et al., 2017). Farmers' evaluation on government actions (i.e., PE) reflected the benefits of the actions, so as to strengthen farmers' cognition. Meanwhile, the demonstrated benefits can stimulate the farmers' responsibility awareness and thus promote their enthusiasm to participate. Moreover, due to different resource endowments, farmers demonstrate different willingness to participate in DSF. The APCs are the crucial indicators for the precise design of regional policies. Generally speaking, it is an exciting experiment to consider the moderating role of PE and APCs on the TPB framework.

2.3.1. The influence of AT, SN, and PBC on intention

Institutional change theory suggests that individual cognition determines behavior, directly affecting inter-individual coordination. The differences in farmers' decision to participate in DSF are determined by their cognition. TPB believes that individual intention is the direct psychological factor to affect behavior (Ajzen, 1991), while AT, SN, and PBC influence the INT.

AT represents an individual's positive or negative opinion about any activity based on their beliefs and experiences. Positive behavior AT, such as the perception that DSF contributes to the efficiency of production, boost farmers' INT. Studies have demonstrated that farmers are more motivated to adopt suitable agricultural measures if they believe that they are beneficial with positive outcomes (Atinkut et al., 2020; Li et al., 2020a, b; Li et al., 2020c; Liu et al., 2021). The following hypothesis is formulated:

H1. A positive AT has a favorable influence on farmers' intention to participate in DSF.

SN describes the social pressure that individuals perceived when making decision on the behavior, and it reflects the influence on other people or groups. If an individual believes its behavior is important to getting supports from others, the more likely that the individual will perform it. Conversely, the less likely the individual will perform the behavior (Adam and Shauki, 2014; Jiang et al., 2018). The external influences on farmers' decision to participate in DSF primarily derive from family members, neighbors and friends, village committee, and local government. The questionnaire is set up with appropriate questions to reflect farmers' SN.

H2. The SN bolsters the farmers' intention to participate in DSF.

PBC describes the degree of difficulty that the individual perceives in conducting the behavior. Even if an individual has positive behavior AT and SN, one may have a lower INT to behave when one does not control the behavior. According to Jd et al. (2019), the greater one's ability to control these characteristics, the greater one's ability to develop behavior INT. In agricultural production, the PBC comprises individual condition profiles such as physical and capital contributions (Adnan et al., 2017; Andow et al., 2017; Li et al., 2021). Based on the analysis, it is expected that the INT of farmers' participation in DSF will improve their control beliefs about performing the behavior. From the above, the following hypothesis is formulated.

H3. PBC has a significant positive influence on farmers' INT participating in DSF.

2.3.2. The influence of agriculture production conditions on the TPB construct

Guagnano et al. (1995) proposed that the "Attitude-Context-Behavior" theory integrated external factors into the TPB framework and pointed out that environmentally responsible behavior results from the interaction between internal environmental attitudes and external contextual factors. DSF is based on the current farmland status with its resource endowments. The resource endowments prior to DSF are the external context that influences the actors (Wang et al., 2021). Moreover, behavior economic theory states that an actor's choice preference and willingness are influenced by their degree of knowledge about the relevant events. Consequently, when farmers consider that the agricultural production conditions can meet their psychological expectations, the enthusiasm for DSF declines.

H4a. CLQ negatively moderates farmers' INT to participate in DSF.

H4b. FIC negatively moderates farmers' INT to participate in DSF.

2.3.3. The influence of policy conditions on the TPB construct

The farmers' awareness on government actions is the beginning of the understanding of DSF, including the comprehensive evaluation on local government performance. The farmers' cognition has been explored on the government-implemented land expropriation (Bao et al., 2017; Cao and Zhang, 2018; Huang et al., 2017). Furthermore, the main aspects of government performance are regulatory conditions, profit distribution, right principles, and information responsiveness (Wang et al., 2018a,b). Favorable evaluations of administration practice can help farmers better understand DSF. Hence, the following hypothesis is proposed:

H5. PE positively moderates farmers' INT to participate in DSF.

3. Material and methods

3.1. Study region

The four provinces or autonomous region of the Yellow River Basin are selected as the study area (Fig. 4). The population amounts to 214 million, with 86.7 million rural residents, the GDP is CNY13.51 trillion, the agriculture GDP is CNY2.14 trillion, the cultivated land is 15.74 million ha, and the food production is 128 million tons, accounting for about one-fifth of China in 2020.[12] So, the area plays an important role in China's economic and social development. However, the farmland ecosystem is characterized by land surface fragmentation and imperfect infrastructures, such as drainage ditches and field roads. The low CLQ (grades 4–7) significantly limits production capacity. Agricultural practices of "High-input, High-consumption" have long been adopted, which hurts the sustainable agriculture development. How to upgrade production facilities and environment, enhance stability of food system and ecological function of farmland have become the focus of government and academia.

In this context, the Chinese government has conducted a series of farmland development activities, and by 2020, 9.12 million ha of HSF has been completed in these 4 provinces or autonomous region, accounting for 17% in China. It is the typical region regarding agricultural production characteristics and development potential. It is the crucial implementation region for high-quality agricultural development planning, and that is the principal consideration in which the region is selected for the study.

3.2. Sample collection

3.2.1. Questionnaire and survey

The survey was conducted from Sep-Dec 2021 by random household visits with professionally investigators in agricultural economics. Face-to-face interviews can improve the accuracy of the collected information. Moreover, the survey dates avoided the agricultural production seasons, and farmers had free time and patience to be interviewed. Totally, 1236 questionnaires were collected, including 1133 valid questionnaires, with an effective rate of 91.6%. Furthermore, the sample size in the study fully satisfied the sample reasonableness test (Wang et al., 2016, 2019).

3.3. Statistical analysis

3.3.1. Reliability and validity analysis

Reliability, convergent, and discriminant validity are used to assess the theoretical mode. The Cronbach's and composite reliability (CR) values should be N0.7, and reliability represents the internal consistency of the measurement items from a latent variable (Li et al., 2021; Zhang et al., 2020). The convergent validity of each measuring item and the average variance extraction (AVE) of each latent variable should be tested, which can be supported if the values are higher than N0.5 (Fornell and Larcker, 1981). If the square root of each AVE value is greater than the correlation coefficient of each variable, the discriminant validity can be validated (Paulraj et al., 2008).

3.3.2. Structural equation model (SEM)

SEM can simulate and evaluate a wide range of hypotheses on measurement by modeling complicated and obfuscated interactions between variables, both observable and unobserved (Fan et al., 1999; Hayduk et al., 2007; Mcintosh, 2012; Tabri and Elliott, 2012). Observed variables (OVs) are indicators, which are collected to reflect hypothetical constructs that cannot be directly assessed in SEM. Therefore, SEM can be divided into two basic models: the structural model and measurement model. To specify the relationships between the *OVs* and *LVs*, factor analysis is performed using the correlation matrix and varimax rotation with measurement models in SEM. Furthermore, the linkage in the *LVs* is modeled by utilizing confirmatory path analysis employing structural models in SEM.

The study adopted SEM to simulate and estimate the relationships in the model-based depicted in Fig. 3. In SEM, AT, SN, PBC, INT, APCs (CLQ & FIC), and PE function as *LVs*, which *OVs* measured through factor analysis.

The structural model is tested for constancy following two methods. The sample was divided into three groups based on education level and analyzed by a multi-group test. It could verify whether the stability of the structural model was disturbed by the education level of the respondents. Next, the sample was randomly grouped to check whether the sample size influenced the path relationship. In general, the $P \geq 0.05$, or changes in TFI values less than equal to 0.05, or $\triangle CFI \leq 0.01$ during model comparison, indicate that the stricter invariance hypothesis should not be rejected (Pousette and Hanse, 2002; Wu and Yao, 2006).

3.3.3. Moderation effect test

In regression analysis, testing the moderating effect of a variable means that the interaction effect of the moderating variable and the independent variable is verified to be significant (Xu et al., 2017). The regression equations for the moderating effect are as follows:

$$y = a + bx + cm + e \tag{2}$$

$$y = a + bx + cm + c'mx + e \tag{3}$$

Among the equations, m is the moderating variable, mx is the moderating effect, and the moderation effect means the analysis of whether c' significantly meets the statistically significant critical ratio. The moderating effect relationships were validated by using the hierarchical regression analysis.

Furthermore, this research used an ordinary least squares (OLS) regression analysis to examine the effect of farmers' characteristics on their intention to participate in DSF.

The SPSS 26.0, PROCESS, Stata 16.0, and AMOS 26.0 were applied to conduct the analyses in the study. SPSS 26.0 was used to perform descriptive statistical analysis, PROCESS was used to perform hierarchical regression, Stata 16.0 was used to conduct the OLS regression analysis, and AMOS 26.0 was used to perform SEM.

4. Results

4.1. Sample characteristics and OLS results

4.1.1. Socioeconomic characteristics of the sample

As shown in Table S4, most respondents were males, representing 62.8% of the overall sample size. Farmers aged 41–60 and over 60 years old occupied 59.4% and 29.3%, respectively, while farmers with only a primary education accounted for 32.7%. The findings showed that approximately 63% of farmers had less than 0.67 ha cultivated land. However, nearly 60% earn more than CNY 50,000 per year, which was

[12] China Statistical Yearbook 2021 (http://www.stats.gov.cn/tjsj/ndsj/2021/indexch.htm).

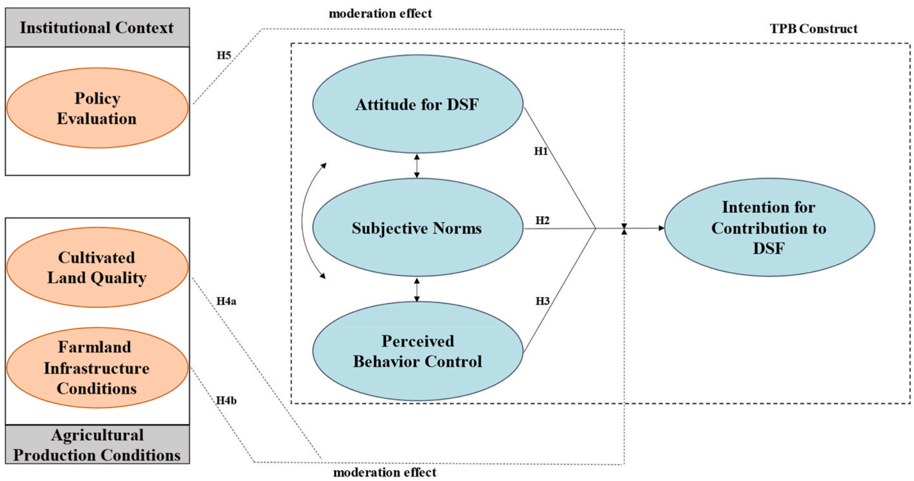

Fig. 3. The framework of the ETPB.

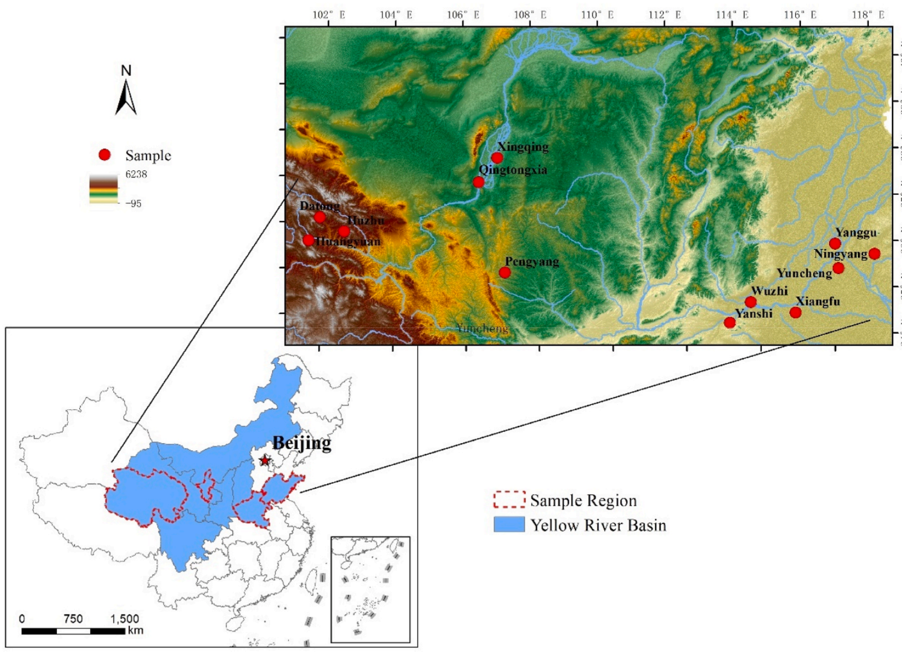

Fig. 4. Study region and sample distribution.

incomparable with the small size in cultivated land and reflected the fact that the proportion of non-farm income had increased (Han et al., 2018). Professional farmers declined, with 63.4% combining non-farm income to meet their livelihood needs. Moreover, about 60% of farmers had a negative attitude towards land transfer.

4.1.2. Results of OLS

Table S6 presented the OLS results. The results indicated that the farmers' gender and the land transfer situation could significantly affect their participation intention. Compared with female respondents, males were more willing to participate in DSF, and farmers with land transfer were more enthusiastic about participating in DSF.

4.2. Measured item descriptive statistics

In the survey, farmers were interviewed to respond the questions on a 5-point scale (1–5). Table 1 summarized the question items of all OVs and their measures. Overall, it was presented that farmers had a medium response to AT, SN, PBC, and INT questions. Fig. 5 shows the distribution of response levels to the observable variables. A relatively large number of farmers provided a high-level response to the AT and SN questions. Due to farmers' various control beliefs, their answers to PBC-related questions showed a relatively low response, with 60% of farmers indicated that their economic and health status had difficulties participating in DSF. 58% of farmers reported that they could not recognize barriers in farmland utilization, and 57% of farmers failed to understand the DSF related policies sufficiently. Behavior INT of farmers was at a high response (4-5scale) with a proportion of 48%. Besides, the study assessed the level of farmers' intention to participate based on the different forms of participation in DSF activities. According to the results (Fig. S2), the level of farmers' intention to participate (investment or labor, adoption of EFAPP) was low (mean = 2.19, 2.55, respectively). The expected conclusions of the study could contribute to enhancing farmers' INT.

Table 1 showed the APCs in the survey areas, and according to respondents' opinions, CLQ was degenerated and infertile. Concerning FIC, the drainage, irrigation facilities, and field roads were superior in Henan and Shandong's plains, but Qinghai and Ningxia's plateau were

Table 1
Descriptive statistics of the items used to measure the TPB construct.

LVs	*OVs*	Item descriptions	Scale of response (1–5)	Mean	Std.
AT	AT1	DSF can provide increased efficiency in agricultural production.	Strongly disagree (1)-Strongly agree (5)	3.166	1.150
	AT2	DSF contributes to the improvement of agricultural production conditions.		3.162	1.144
	AT3	DSF to enhance the eco-services of farmland.		3.306	1.154
	AT4	DSF helps to increase income in agriculture.		3.200	1.173
SN	SN1	My family's support has an impact on my engagement in DSF.	Strongly disagree (1)-Strongly agree (5)	3.437	1.208
	SN2	The attitudes of my neighbors and friends can drive my participation in DSF.		3.380	1.213
	SN3	The attention given to DSF by the village committee will encourage them to participate in the activity.		3.327	1.170
	SN4	The pressure from government can affect my decision to involvement in DSF.		3.238	1.175
PBC	PBC1	I understand the current obstacles to farmland utilization and have options for solution.	Strongly disagree (1)-Strongly agree (5)	3.246	1.202
	PBC2	I can understand the key activities of DSF and relevant policy.		3.177	1.176
	PBC3	My financial capacity and health condition can permit me to participate in DSF.		3.214	1.198
INT	INT1	I would like to contribute to the development of SF (Form: investment or labor).	Strongly disagree (1)-Strongly agree (5)	3.263	1.164
	INT2	I volunteer to promote joining DSF with other people.		3.173	1.148
	INT3	I will actively respond to village committee on land utilization and agricultural production issues.		3.303	1.162
CLQ	CLQ1	No soil hardening on the farmland.	Strongly disagree (1)-Strongly agree (5)	2.462	1.247
	CLQ2	Soil nutrient composition is adequate.		2.561	1.065
	CLQ3	We never dispose of agricultural waste plastics (Packages for fertilizer and pesticide, agri-film) indiscriminately.		2.794	1.155
FIC	FIC 1	I have no demand for land consolidation.	Strongly disagree (1)-Strongly agree (5)	2.881	1.332
	FIC 2	Existing irrigation and drainage ditches on farmland are adequately configured.		2.852	1.364
	FIC 3	Existing on-field roads meet production demand		2.883	1.324
	FIC 4	Existing fields with sufficient agricultural waste collection facilities.		2.847	1.337
PE	PE1	The government has conducted training on techniques related to DSF.	Strongly disagree (1)-Strongly agree (5)	3.832	0.929
	PE2	There is a high level of government investment in DSF.		4.002	0.883
	PE3	The government has promoted elements related to DSF.		3.817	0.958
	PE4	The government has appropriate regulatory mechanisms in DSF.		3.868	0.952

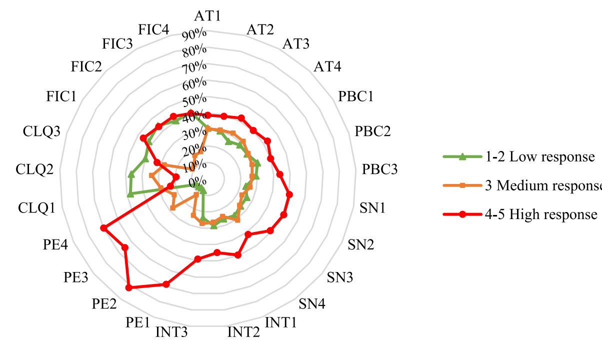

Fig. 5. Farmer responses as evaluated by a five-point Likert-type scale.

seriously lacking (Fig. S3). The farmers' evaluations of DSF policies, presented a high level of appraisal for government measures (mean = 3.88). Fig. 5 revealed that farmers were satisfied with the government conducting technical training, promoting SF and investment, and establishing the regulatory mechanism. The conclusion of the study can contribute to formulating the action plan and support system framework for DSF.

4.3. Measurement model

The results of exploratory factor tests and reliability validity tests were shown in Table 2. Cronbach's α > 0.7 indicated that the OVs given an adequate representation of the LVs and the model was sufficiently

Table 2
Reliability and validity test.

LVs	*OVs*	Std. Estimate	Cronbach's α	CR	AVE
AT	AT1	0.813	0.898	0.898	0.688
	AT2	0.847			
	AT3	0.799			
	AT4	0.858			
SN	SN1	0.788	0.886	0.887	0.665
	SN2	0.887			
	SN3	0.879			
	SN4	0.693			
INT	INT1	0.908	0.880	0.883	0.716
	INT2	0.828			
	INT3	0.799			
CLQ	CLQ1	0.772	0.818	0.818	0.600
	CLQ2	0.766			
	CLQ3	0.785			
FIC	FIC1	0.977	0.985	0.985	0.941
	FIC2	0.969			
	FIC3	0.976			
	FIC4	0.959			
PBC	PBC1	0.802	0.857	0.85	0.66
	PBC2	0.824			
	PBC3	0.822			
PE	PE1	0.879	0.937	0.937	0.789
	PE2	0.895			
	PE3	0.892			
	PE4	0.887			

reliable to be used in the analysis. The standard estimate loadings for OVs >0.7, The CR > 0.7, and AVE>0.5 confirmed the applicability of factor analysis.

4.4. Structural model

4.4.1. Goodness of fit

SEM was utilized in two steps, the first was to estimate the goodness of fit of the theoretical model for the OVs, and then was to measure the correlationship with the LVs (Hair et al., 2010; Kline et al., 2011; Livote and Wyka, 2009; Tabachnick and Fidell, 2007). Eight indices were selected in the study to assess the degree of model fit (Bagheri et al., 2019; Bondori et al., 2018). According to the results (Table 3), all indicators were better than the recommended values, which means the investigation data were suitable for SEM.

4.4.2. Results of SEM

Fig. 6 depicted the SEM standardized path coefficients (PCs) of the original TPB (Model 1). Tables (S 13–15) verified the ETPB findings after introducing the moderate factors. The strong positive impacts of AT (F1), SN (F2), and PBC (F3) in predicting INT were provided based on model 1, and H1, H2, and H3 were verified. PBC had the most significant influence on INT with a PC for 0.27 ($p < 0.01$), followed by SN for 0.24 ($p < 0.01$) and AT for 0.23 ($p < 0.01$). AT, SN and PBC were shown to have a favorable interaction. Farmers' AT, SN, and PBC all had a similar belief of "contribution to DSF," hence the three components impact each other. The result fitted perfectly with elements relationships of the TPB and reaffirmed the rationality of applying the theory in this study. Furthermore, Table 4 confirmed the discriminant validity.

The relationship between LVs and OVs variables was also obtained from the path analysis in Fig. 6. Farmers demonstrated favorable attitudes regarding the advantages of DSF, with the most robust performance in the AT for increasing income. The importance given by the village committee to the farmers' contribution to activity was the most critical factor that reveals SN with PC for 0.86 ($p < 0.01$). PBC consists of clarity of barriers to farmland utilization, sufficient information about DSF and its related policies, and the ability to contribute to economic and healthy conditions by participating in this activity. In terms of results, all factors were at a higher contribution. Consequently, hypotheses 1–3 were supported (Table 5).

4.4.3. Results of testing for multigroup invariance

Farmers' decisions to participate in agricultural actions were usually influenced by their education level (Jia et al., 2021; Mbaga-Semgalawe and Folmer, 2000). The literature revealed that farmers' education was a factor that reflected their environmental literacy, and enhancing farmers' environmental literacy could help to strengthen their motivation to participate in farmland ecological improvement (Vignola et al., 2010; Yu et al., 2017). Accordingly, the study conducted the multi-group analysis based on the respondents' education. The results show that $P > 0.05$ for Structural weights and Structural residuals (Table S 4). The model path coefficients, factor loadings, and variances did not make statistically significant differences in group comparisons. Farmers' education would not change the path assumptions, and the structural model was well stabilized. It is probably attributable to the survey way. Since SF is a new farmland mode, farmers still lack a uniform standard of knowledge about it. Hence, before formal questioning, the investigators intervened for the SF's effect by picture presentation and described the construction activities and related policies in detail. It provided farmers with a sufficient understanding of DSF and subsequently controlled the effect of farmers' different educational literacy on their intention to participate. Similarly, model constancy test results under random grouping proved that the theoretical model was not limited by sample size (Table S 7).

4.4.4. Results of moderating effect

Tables S13 and S14 showed the CLQ and FIC negative moderating the AT-INT, SN-INT, and PBC-INT pathways. It implied that better APCs could weaken the INT of farmers participating in DSF. In comparison, the moderating effect of CLQ (mean = -0.078) was greater than that of FIC (mean = -0.081). The reason was that CLQ had a more immediate influence on crop yields, while FIC's emerged benefits and efficiency required a long-term process. As a result, the INT of farmers' DSF involvement was more sensitive to CLQ's influence. Table S15 verified the role of PE as another regulator that acted positively in moderating the AT-INT, SN-INT, and PBC-INT interactions. Farmers' AT, SN, and PBC were transformed towards INT if they were more satisfied with government actions.

4.5. Scenario analysis

In part, the benefits of SF were estimated. Furthermore, it examined the regional investment contribution of farmers' involvement in DSF. The payments are 3862 CNY/ha, 2244 CNY/ha, 6624 CNY/ha, and 6160 CNY/ha in Qinghai, Ningxia, Shandong, and Henan, respectively, based on the number of rural family and area of cultivated land in each region. The construction costs of FIC are higher owing to geomorphological peculiarities of the plateau in Qinghai and Ningxia. However, the regions had the lowest rate of farmer investment. If the activities of DSF were conducted entirely by region, the maximum efficiency could not be achieved despite the multiple entities' efforts to broaden the financing source. Therefore, it also revealed that regional cooperation was required to accomplish optimal resource allocation.

How could DSF be used to achieve a "production-ecology" value of win-win? The integrated water-fertilizer technology is the deputy of demonstrating the benefits of DSF activities. It provides the irrigation facilities required for agricultural production while also having excellent ecological attributes. The application of the technology reduced fertilizer inputs and irrigation water by 30–50%, lowering GHG emissions from 28.69 billion kg CO_2-eq-kg^{-1} to 14.34–20.08 billion kg CO_2-eq-kg^{-1}. The quantified environmental-economic benefits of SF were shown in Table S16. Assessing the life cycle of SF construction and operation was helpful for agricultural production guidance and carbon management design in agriculture.

5. Discussions and implications

The inadequacy of FIC and the degradation of CLQ seriously restricted the potential for food production and the value achievement of ecological function for farmland in China. Current studies showed that agricultural infrastructure was vital to safeguard food security by increasing the capacity to mitigate and respond to natural disasters. Furthermore, encouraging the adoption of EFAPP helps to enhance the product quality and ecological function of farmland substantially. In other words, DSF could achieve a win-win scenario for agri-production and ecology. Farmers showed a medium response to the intention to participate in DSF. However, the results of the integrated participation forms reflected the real idea of their low intention to participate. It is related to the long-term lack of a participatory mechanism for farmers accompanying with farmland construction policy evolution. Meanwhile, it revealed farmers' dependence on government-led farmland construction. Consequently, the paper explains why farmers were reluctant to participate in DSF, and identifies the critical paths to enhance farmers' willingness to participate in DSF.

5.1. What realities are reflected in the farmers' characteristics?

Descriptive findings indicated the aging of population and the generally lower education level of rural labor. Besides, the cultivated land operated by farmers was small and scattered. Finally, the current purely agricultural production was increasingly unable to meet farmers'

Table 3
Goodness of fit measures of SEM model.

Index	χ^2/df	SRMR	RSMEA	GFI	AGFI	IFI	CFI	TLI
Estimate value for hypothetical model	2.640	0.020	0.038	0.977	0.966	0.988	0.988	0.984
Recommended level	<3	<0.08	<0.08	>0.9	>0.9	>0.9	>0.9	>0.9

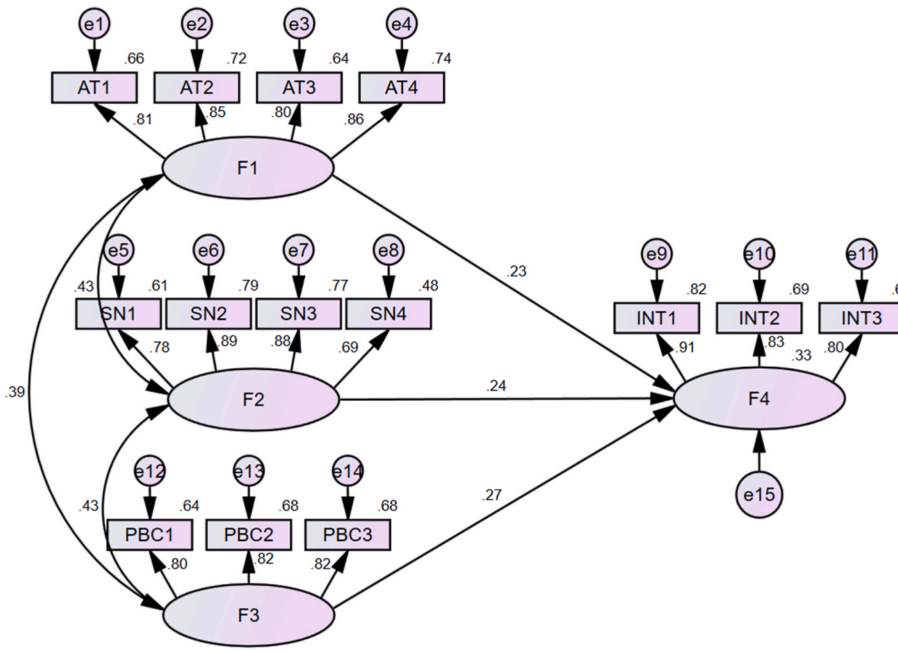

Fig. 6. Standardized PCs of the structural model for TPB (Model1).

Table 4
The discriminative validity results.

	PE	PBC	FIC	CLQ	INT	SN	AT
PE	**0.888**						
PBC	0.009	**0.816**					
FIC	0.008	0.089	**0.970**				
CLQ	0.130	0.073	0.066	**0.774**			
INT	0.057	0.462	0.046	0.099	**0.846**		
SN	0.036	0.430	0.255	0.095	0.453	**0.816**	
AT	0.055	0.392	0.061	0.087	0.439	0.431	**0.830**

The square root of the AVE for each construct was presented in bold and italic.

Table 5
Concrete results of Model1 and hypothesis testing.

Path	Hypothesis	Std. Estimate	S.E.	C.R.	P	Supported
AT→INT	H1	0.231	0.038	6.885	***	YES
SN→INT	H2	0.238	0.038	6.941	***	YES
PBC→INT	H3	0.269	0.038	7.740	***	YES

“***”, “**”, “*” significant at 1%, 5%, 10% level, respectively.

livelihood needs. In this context, some farmers were still reluctant to transfer their cultivated land. The phenomenon was caused by renting land with lower income than its production (Huang et al., 2017). In land transfer, price depended on the farmland conditions (Chen et al., 2020; Fu et al., 2022; Zhang and Wang, 2021). Current studies showed that the dilemmas in agricultural production were a reality so that DSF is necessary for the globe (Abubakari et al., 2016; Xu and Zhao, 2019; Zhao and Chen, 2018).

The OLS results showed that male farmers were more interested in participating in DSF. It was attributed to the fact that men were the primary labor and more concerned about improving farmland conditions. Furthermore, INT-related questions involved labor and investment. Men were more physically capable and better able to lead decisions in agricultural production. The results also revealed that farmers who had conducted land transfer were more enthusiastic about participating in DSF. It was that farmers who conducted land transfer were more aware of the market needs for farmland quality. DSF can improve farmland infrastructure and land quality. The improved farmland can increase the land rent and agricultural revenue, furnish production convenience, and provide a pleasant environment. DSF is a necessary action to meet the trend of land transfer.

5.2. Why do farmers show a low-willingness to contribute to DSF

The PBC (mean = 3.21) results showed medium perceived control of farmers on participating DSF. Jiang et al. (2018) also confirmed them. Furthermore, PBC was identified as the primary factor affecting farmers' INT. It suggested that control beliefs were of significant value in reinforcing INT, with constraints regarding personal financial ability, health, and ability to collaborate with DSF-related policy particularly salient (Hung Anh et al., 2019). Thus, if farmers cannot overcome the difficulties of livelihood endowment, they may lose enthusiasm and eventually fail to make positive decisions (Basanayak et al., 2013; P. et al., 2004; A et al., 2018; Grzelak et al., 2019; Lu and Xie, 2018; X. Wei et al., 2021). It illuminated that policy booking should provide differentiated participation modes and criteria. Meanwhile, it is also essential that DSF participation mechanism can address the barriers to farmers' livelihood endowments. Farmers' cooperatives can serve as an intermediary platform to tackle the participation constraints of group capacity. Farmers can join the cooperative by the ways of land equity or product mortgage. According to the contract agreement, the cooperative can participate in DSF standing for the farmers. Current studies have also shown that PBC was a critical determinant (Wilson et al., 2018). In Daxinis' study, PBC-related questions were set in terms of the level of easiness and self-confidence of farmers to follow the nutrient management plan (NMP) (Daxini et al., 2019). EFAPP activities in DSF and NMP are technical management practices requiring specialist knowledge, skill, and attention to detail. Education could enhance farmers' familiarity and skill with the technology, improve their self-confidence to use technical innovations, and avoid relying on intuitive judgement instead of using formalized EFAPP (Burton, 2014; Nuthall and Old, 2018; Zhang et al., 2017). Thus, the findings of similar studies were considered comprehensively. In formulating policies, technical guidance should be provided by advisors in the agricultural production process, and cooperation between farmers and advisors should be promoted (Madden et al., 1992).

SN was identified as another key independent predictor, implying that farmers' INT was sensitive to social pressure. Previous studies have found SN to be an important determinant of farmers' intentions towards adopting, for example, improved agricultural system (Li et al., 2021), multifaceted agricultural production (Senger et al., 2017) and grazing management measures (Schaak and Mußhoff, 2018). In fact, the finding explained that individuals did not make decisions without considering their actions in relation to that of others, nor were individuals independent of social and cultural influences (Burton, 2014).Therefore, it was most likely since they could be perceived as having an unfavorable experience and would be rejected by social relations if they were reluctant to participate in the action (Ru et al., 2019). In terms of the variance contribution of the *OVs*, the actions of other villagers in SN accounted for the enormous contribution to influencing farmers' decisions, followed by the concern of village committee, and next by the support of families. In contrast, pressure from the government accounted for the most negligible contributions. Most farmers may hold a skeptical attitude about the cost, benefit, and technical difficulty of EFAPP. They consider more about communication and cooperation with others around them and farmers' participation in DSF requires their labor and financial inputs. Supposing that neighbors have a positive attitude and a high level of attention from the village committee toward DSF, it will be able to avoid villagers' "free-riding" behavior in using infrastructure and agricultural elements. It explained why they hoped to reach a consensus with a highly respected village committee as the most direct regulator of collective action. It enlightened that if a platform was provided for villagers to interact, the scope and speed of DSF information dissemination among villagers could be increased by interpersonal networks. Extensive studies recognized the vital role of facilitating or intermediary organizations in "bringing farmers together, providing information, building trust and acting as mediators between farmers and government" (Emery and Franks, 2012; Martinovska Stojcheska et al., 2016).

AT's effect showed that the transformation of farmers' intention was based on increased agricultural benefits, production conditions, productivity, and improved ecological functions by SF. The economic value and psychological satisfaction of providing a conducive environment were relatively more important to farmers, while ecological aspects received little attention. The government probably focused on its economic revenue while neglecting to introduce the ecological functions on promoting farmland development-related activities. It was worth noting that the principal grain-production regions (Shandong and Henan) had been maintaining intense cropping with a large quantity of chemical inputs, and adopted a single way of managing waste agriculture plastics, which led to severe consequences of farmland pollution. Therefore, it was suggested to focus on publicizing and demonstrating the ecological benefits of DSF and guide farmers adopting precision fertilization and green plant protection to restore healthy soil structure and improve soil fertility.

5.3. How to strengthen the TPB construct

5.3.1. The role of the current state of APCs

APCs were critical variables for influencing farmers' INT. The most notable CLQ dilemmas were soil hardening and inadequate nutrient supply. Consequently, policymakers should prioritize initiatives to improve CLQ in the region. The findings of CLQ suggested that farmers' INT to participate in DSF was reduced by healthier cultivated land. Among them, CLQ contributed the most to regulating the AT-INT relationship. It was probably attributed to agricultural production dependent on resource factors such as land supply. On one hand, the excellent resource endowments limited the possibility for economic and ecological improvement, and the supply of current resource elements had already satisfied farmers' expectations. On the other hand, long-term exposure to excellent resource endowments also delivers better capital and technical capacity for farmers. As a response, the first step for policymakers was to benchmark SF standards and perform DSF activities in a result-led and site-specific way to ensure the efficient utilization of agriculture resource. Besides that, the government should broaden the scope of DSF propaganda. The differences between current farmland and SF should be contrasted, and the various benefits of DSF should be precisely publicized, which would help strengthen farmers' belief in DSF and thus change their behavior.

The negative moderating effect of FIC was confirmed in the pathway relationship test. Infrastructure was regarded as a crucial component in increasing productivity and income. Farmers in the FIC superiority region would consider the current conditions near SF standard. They have little motivation to invest in farmland improvement. For this reason, they pay the slightest attention to the obstacles to farmland utilization, making AT-INT and PBC-INT more sensitive to FIC intervention. Improving farmers' perceptions of farmland barriers contributes to enhance beliefs about INT. Consequently, the government should inform and train farmers about the benefits of updated infrastructure, particularly the ability to mitigate climate change and develop ecological functions, increase farmers' awareness of pro-environmental, and motivate them to participate in DSF.

Farmers' demand for farmland building generally follows the "dynamic growth - dynamic equilibrium" pattern, indicating that farmland construction activities' marginal efficiency decreases under farmers' psychological expectations. The findings of the study could well be applied to improve farmers' cognition so as to promote farmland development through publicity, guidance, training, and incentives. However, when the farmland development has evolved to meet farmers' preconceptions sufficiently, the marginal efficiency of farmland construction activities approaches 0 for farmers. Then, it is challenging to continue intervening in farmers' efforts on higher standards of farmland development. In particular, there remains a disconnect between the farmers' predicted state of farmland and SF standards. Therefore, it will face challenges how to bridge and allocate the gap in the future study for academia and policymakers.

5.3.2. Impact of the current policy

Current studies had found that institutional variables encourage farmers to engage in collective action and adopt EFAPP (He et al., 2019; Huang et al., 2020) . According to the results, PE had a positive moderating effect on the AT-INT, SN-INT, and PBC-INT pathways. Conducting DSF entailed costs and had externality that subsequently affected farmers' motivation. The attitude of the others was related to the cost allocation of DSF, while the efficacy of the government as DSF main party was more noticeable. Farmers' sufficient knowledge of DSF policy helps them understand and appreciate the relative benefits. It could motivate them to participate in DSF. Farmland system improvement with ecological benefit and positive externality had slow payoffs and high investments. Farmers, as rational decision-makers, had little incentive to participate in such activities (Dai et al., 2020; Houessionon et al., 2017; Qian and Ying, 2014). The government was expected to provide the reasonable investment in infrastructure development and subsidies for farmers to adopt EFAPP. It helps stimulate farmers' awareness of the responsibility to sustainably apportion the cost of public goods supply and promote technology adoption. It was consistent with present agriculture development policy. For example, the latest plan for HFC was proposed to positively guide the farmers to participate in farmland development, encourage innovative investment patterns, and reasonably increase the proportion of social capital.[13] However, the current policy has not provided detailed plans for the participation of stakeholders in DSF. What are the different stakeholders' participation contents, forms, and standards? How should they be integrated into a satisfactory participation mechanism? All these need to be discussed in depth. However, the paper presents the new insights and viewpoints. Because it clarified the activities of farmers' participation and explored the benchmarks of their contribution based on different forms. Furthermore, it revealed the influence path of farmers' decisions, which helps provide a more precise reference for policymaker.

It was noticeable that the impact of the study extends beyond the specific circumstances under examination. It also had critical implications for academia and policymaker. First, a paucity of literature explored the improvement of farmland system and benefits with farmer participation by utilizing ETPB. Second, the paper's empirical method could be copied and used for other evaluations of farmer decisions. Finally, the findings and policy implications were applied to other areas in China as well as locations with similar agricultural system around the world.

6. Conclusions

The fragmented mode of developing sustainable agriculture has resulted in inefficient resource utilization. The lack of participation from stakeholders has caused an imbalance between the supply and demand of construction actions and the lower utilization of resources. The continuous investment had brought rather financial pressure on the Chinese central government. In order to achieve functional synergy and value enhancement of farmland ecosystem, promoting farmers' participation in DSF is considered the better option. Behavior economic study has mainly focused on elements in farmers' decision-making, such as the desire for environmental public goods, altruism's intrinsic drive, social expectations, and individual and family assets. There were few studies on farmer psychology, so the study contributes to the knowledge. First, it successfully verified the suitability of the TPB framework, which introduces APCs and PE as moderating variables in the analysis of farmers' contribution to DSF. Subsequently, it empirically investigated the drivers of farmer participation in DSF and further tested the moderating effects of QLC, FIC, and PE on TPB construct. Based on the results, farmers' INT to engage in DSF is affected by PBC, especially the control beliefs regarding capacity restriction. Therefore, relevant departments should organize special training and formulate supporting policies to improve farmers' understanding of relevant policies and technical skills. As for SN, especially those derived from interpersonal relationships emerged as another critical, independent predictor of farmers' participation in DSF. The observation for policymakers implied that strengthening the interpersonal social network could be essential to increase farmers' INT to contribute. APCs were the vital moderator in shaping behavior INT, so development programs and farmer participation rates should be adequately planned in different region. Institutional variables were also shown to impact intention by moderating farmers' beliefs, which the degree of intention could be significantly enhanced. Therefore, the study identified a policy tool to promote farmers' engagement in DSF.

However, the study's limitations should be recognized. First, the *LVs* in the SEM were determined by the farmer's self-reporting responses, and there was a probability of social pressures or self-presentational bias, which means that respondents may answer questions to please or impress the interviewers, resulting in overstated positive consciousness (Armitage and Conner, 2001; Juan and Royal, 2006; Meijer et al., 2015b). Farmers' evaluation of the APCs was just their subjective perception, and the combination of monitoring data in future research would provide more precise modification of the model and more detailed information for decision-makers. Second, the transformation relationship between intention and behavior had not been examined due to the actual participation behavior had not yet occurred by farmers. As DSF mechanism gradually being improved, the study can follow up on the participants' actual behavior, expand and modify the model to provide more closely supports for policy formulation. Finally, the study was limited by the solidification of the TPB and did not examine the effects of farmers' livelihood endowments on the construct. Future research can be conducted as a multi-group comparative analysis based on farmers' socioeconomic characteristics or directly examine the effects of various factors on farmers' participation decisions.

Fund

This research was funded by The National Social Science Fund on Major Program of China (18ZDA048), Central Non-profit Scientific Institution (G202101-12), and Asian Development Bank (TA-6626).

CRediT authorship contribution statement

Yanshu Yin: Conceptualization, questionnaire development, Methodology, Data curation, Software, Formal analysis, Writing – original draft, Visualization, Writing – review & editing, Validation. **Yingnan Zhang:** Data curation, Writing – review & editing. **Fuduo Li:** Data curation, Software, Writing – review & editing. **Jian Jiao:** Formal analysis, Writing – review & editing, Visualization. **Philippe Lebailly:** Supervision, co-supervision, Project administration, Validation. **Yang Zhang:** fund acquisition, Validation. **Changbin Yin:** Supervision, Investigation, Writing – original draft, Resources, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgment

The research was funded by Major Program of National Social Science Foundation of China (18ZDA048), Central Non-profit Scientific Institution: Green Farmland Construction and Agricultural High-Quality Development in the Yellow River Basin (G202101-12), and Green Farmland Construction and Agricultural High-Quality Development in the Yellow River Basin (TA 6626). Especially, the authors are grateful to editors and anonymous reviewers for their insightful and constructive comments.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2022.134895.

[13] http://www.moa.gov.cnhdzbft_newsqggbzntjsghxgxw_28866202109P0202 10916554589968975.pdf)">China High-Standard Farmland Construction Plan (2021–2030) (http://www.moa.gov.cn/hd/zbft_news/qggbzntjsgh/xgxw_28866/202109/P020210916554589968975.pdf).

References

Abubakari, Z., van der Molen, P., Bennett, R.M., Kuusaana, E.D., 2016. Land consolidation, customary lands, and Ghana's Northern Savannah Ecological Zone: an evaluation of the possibilities and pitfalls. Land Use Pol. 54, 386–398.

Adam, A.A., Shauki, E.R., 2014. Socially responsible investment in Malaysia: behavior framework in evaluating investors' decision making process. J. Clean. Prod. 80, 224–240.

Adnan, N., Nordin, S.M., bin Abu Bakar, Z., 2017. Understanding and facilitating sustainable agricultural practice: a comprehensive analysis of adoption behaviour among Malaysian paddy farmers. Land Use Pol. 68, 372–382.

Agidew, A., Singh, K.N., 2018. Factors affecting farmers'participation in watershed management programs in the Northeastern highlands of Ethiopia:a case study in the Teleyayen sub-watershed. Ecological Process 7 (1), 15.

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50 (2), 179–211.

Ajzen, I., Madden, T.J., 1986. Prediction of goal-directed behavior: attitudes, intentions, and perceived behavior control. J. Exp. Soc. Psychol. 22 (5), 453–474.

Andow, D.A., Resende Filho, M.A., Carneiro, R.G., Lorena, D.R., Sujii, E.R., Alves, R.T., 2017. Heterogeneity in intention to adopt organic strawberry production practices among producers in the federal district, Brazil. Ecol. Econ. 140, 177–189.

Armitage, C.J., Conner, M., 2001. Efficacy of the theory of planned behaviour: a meta-analytic review. Br. J. Soc. Psychol. 40 (4).

Ashworth, P., Bradbury, J., Wade, S., Ynke Feenstra, C.F.J., Greenberg, S., Hund, G., Mikunda, T., 2012. What's in store: lessons from implementing CCS. Int. J. Greenh. Gas Control 9, 402–409.

Atinkut, H.B., Yan, T., Arega, Y., Raza, M.H., 2020. Farmers' willingness-to-pay for eco-friendly agricultural waste management in Ethiopia: a contingent valuation. J. Clean. Prod. 261, 121211.

A, J.M.P., B, R.I.I., C, A.M., 2018. Understanding consumer motivations for buying sustainable agricultural products at Romanian farmers markets. J. Clean. Prod. 184, 586–597.

Bagheri, A., Emami, N., Damalas, C.A., Allahyari, M.S., 2019. Farmers' Knowledge, Attitudes, and Perceptions of Pesticide Use in Apple Farms of Northern Iran: Impact on Safety Behavior. Environmental Science and Pollution Research.

Bao, H., Deng, S., Xu, S., Peng, Y., 2017. Conspicuous consumption behavior of land-lost farmers: a perspective of social identity. Cities 66, 81–90.

Basanayak, R.T., Manjunath, L., Yadav, V.S., 2013. An Analysis of Farmer's Opinion and Their Adaptation Behavior to Climate Change in Bidar District. Environment & Ecology, pp. 1300–1302.

Bondori, A., Bagheri, A., Damalas, C.A., Allahyari, M.S., 2018. Retracted: use of personal protective equipment towards pesticide exposure: farmers' attitudes and determinants of behavior. Sci. Total Environ. 639, 1156–1163.

Borges, J.A.R., Oude Lansink, A.G.J.M., Ribeiro, C.M., Lutke, V., 2014. Understanding farmers' intention to adopt improved natural grassland using the theory of planned behavior. Livest. Sci. 169, 163–174.

Burton, R.J.F., 2014. The influence of farmer demographic characteristics on environmental behaviour: a review. J. Environ. Manag. 135, 19–26.

Cao, Y., Zhang, X., 2018. Are they satisfied with land taking? Aspects on procedural fairness, monetary compensation and behavior simulation in China's land expropriation story. Land Use Pol. 74, 166–178.

Carrington, M.J., Neville, B.A., Whitwell, G.J., 2010. Why ethical consumers don't walk their talk: towards a framework for understanding the gap between the ethical purchase intentions and actual buying behaviour of ethically minded consumers. J. Bus. Ethics 97 (1), 139–158.

Chen, Y.-h., Wen, X.-w., Wang, B., Nie, P.-y., 2017. Agricultural pollution and regulation: how to subsidize agriculture? J. Clean. Prod. 164, 258–264.

Chen, S., Hou, D., Fan, Y., 2020. An empirical study on influencing factors of farmers' land transfer willingness in Heilongjiang province. J. Ch. Agric. Resour. Reg. Plann. 41 (4), 68–73.

Cowie, A.L., Orr, B.J., Castillo Sanchez, V.M., Chasek, P., Crossman, N.D., Erlewein, A., Louwagie, G., Maron, M., Metternicht, G.I., Minelli, S., Tengberg, A.E., Walter, S., Welton, S., 2018. Land in balance: the scientific conceptual framework for Land Degradation Neutrality. Environ. Sci. Pol. 79, 25–35.

Dai, Z., Zeng, Q., Pan, W., 2020. Analysis of the influence of social capital on farmers' willingness to participate in the supply of public goods in villages. Res. Agric. Modernization 41 (2), 303–311.

Daxini, A., Ryan, M., O'Donoghue, C., Barnes, A.P., 2019. Understanding farmers' intentions to follow a nutrient management plan using the theory of planned behaviour. Land Use Pol. 85, 428–437.

de Leeuw, A., Valois, P., Ajzen, I., Schmidt, P., 2015. Using the theory of planned behavior to identify key beliefs underlying pro-environmental behavior in high-school students: implications for educational interventions. J. Environ. Psychol. 42, 128–138.

Dubey, R.K., Tripathi, V., Dubey, P.K., Singh, H.B., Abhilash, P.C., 2016. Exploring rhizospheric interactions for agricultural sustainability: the need of integrative research on multi-trophic interactions. J. Clean. Prod. 115, 362–365.

Emery, S.B., Franks, J.R., 2012. The potential for collaborative agri-environment schemes in England: can a well-designed collaborative approach address farmers' concerns with current schemes? J. Rural Stud. 28 (3), 218–231.

Fan, X., Thompson, B., Wang, L., 1999. Effects of sample size, estimation methods, and model specification on structural equation modeling fit indexes. Struct. Eq. Model. A. Multidisciplin. J. 6 (1), 56–83.

Fang, L., Yin, C., Fang, Z., Zhang, Y., 2021. The path of promoting high-quality agricultural development in the Yellow River Basin. Agric. Resour. Zoning Ch. 42 (12), 16–22.

Floress, K., de Jalon, S.G., Church, S.P., Babin, N., Ulrich-Schad, J.D., Prokopy, L.S., 2017. Toward a theory of farmer conservation attitudes: dual interests and willingness to take action to protect water quality. J. Environ. Psychol. 53, 73–80.

Fornell, C., Larcker, D.F., 1981. Evaluating structural equation models with unobservable variables and measurement error. J. Mark. Res. 18, 39–50. https://doi.org/10.2307/3151312.

Fu, H., Peng, Y., Zheng, L., Liu, Q., Zhou, L., Zhang, Y., Kong, R., Turvey, C.G., 2022. Heterogeneous choice in WTP and WTA for renting land use rights in rural China: choice experiments from the field. Land Use Pol. 119.

Gao, J., Peng, C., Shi, Q.H., 2019. The study of high-level fertilizer application and fertilization behavior of the smallholders in China–based on data of China fixed rural observation sites in 1995 - 2016. Manag. World 35 (10), 120–132.

Gruber, K., 2017. Agrobiodiversity: the living library. Nature 544 (7651), S8–S10.

Grzelak, A., Guth, M., Matuszczak, A., Czyżewski, B., Brelik, A., 2019. Approaching the environmental sustainable value in agriculture: how factor endowments foster the eco-efficiency. J. Clean. Prod. 241, 118304.

Gu, B., Ju, X., Chang, J., Ge, Y., Vitousek, P.M., 2015. Integrated reactive nitrogen budgets and future trends in China. Proc. Natl. Acad. Sci. U.S.A. 112 (28), 8792.

Guagnano, G.A., Stern, P.C., Dietz, T., 1995. Influences on Attitude-Behavior Relationships: A Natural Experiment with Curbside Recycling. Environment & Behavior.

Hair, J., Black, W., Babin, B., Anderson, R., 2010. Multivarite Data Analysis, seventh ed.

Han, H., Zhang, X., 2020. Static and dynamic cultivated land use efficiency in China: a minimum distance to strong efficient frontier approach. J. Clean. Prod. 246, 119002.

Han, H., Li, H., Zhao, L., 2018. Determinants of factor misallocation in agricultural production and implications for agricultural supply-side reform in China. China World Econ. 26 (3), 21.

Hayduk, L., Cummings, G., Boadu, K., Pazderka-Robinson, H., Boulianne, S., 2007. Testing! testing! one, two, three – testing the theory in structural equation models! Pers. Indiv. Differ. 42 (5), 841–850.

He, K., Zhang, J., Zeng, Y., 2019. Knowledge domain and emerging trends of agricultural waste management in the field of social science: a scientometric review. Sci. Total Environ. 670, 236e244. https://doi.org/10.1016/j.scitotenv.2019.03.184.

Hernandez-Espallardo, M., Arcas-Lario, N., Marcos-Matas, G., 2013. Farmers satisfaction and intention to continue membership in agricultural marketing co-operatives: neoclassical versus transaction cost considerations. Eur. Rev. Agric. Econ. 40 (2), 239–260.

Houessionon, P., Fonta, W.M., Bossa, A.Y., Sanfo, S., Thiombiano, N., Zahonogo, P., Yameogo, T.B., Balana, B., 2017. Economic valuation of ecosystem services from small-scale Agricultural management interventions in Burkina Faso: a discrete choice experiment approach. Sustainability 9 (9).

Hu, Q., Li, X., Gonçalves, J.M., Shi, H., Tian, T., Chen, N., 2020. Effects of residual plastic-film mulch on field corn growth and productivity. Sci. Total Environ. 729, 138901.

Huang, W., Chen, F., Tan, Y., 2017. The effect of grain production purpose on the disparity of farmers' land transferring willingness price. Resour. Sci. 39 (10), 1844–1857.

Huang, X., Huang, X., He, Y., Yang, X., 2017. Assessment of livelihood vulnerability of land-lost farmers in urban fringes: a case study of Xi'an, China. Habitat Int. 59, 1–9.

Hui, L., Siyu, C., 2012. An empirical analysis of influencing factors on farmers' willingness to participate in smallscale water conservancy construction–based on a survey of 475 farmers in the main grain-producing areas of Hunan Province. Ch. Rural Surv. 54–66, 02.

Hung Anh, N., Bokelmann, W., Thi Nga, D., Van Minh, N., 2019. Toward sustainability or efficiency: the case of smallholder coffee farmers in Vietnam. Economies 7 (3).

Icek, A., Driver, B.L., 1992. Application of the theory of planned behavior to leisure choice. J. Leisure Res. 24 (3), 207–224.

Jd, A., Vr, A., Fc, B., 2019. Factors affecting farmers' adoption of integrated pest management in Serbia: an application of the theory of planned behavior. J. Clean. Prod. 228, 1196–1205.

Jia, Y., Cheng, S., Shi, R., 2021. Decision-making behavior of rural residents' domestic waste classification in Northwestern of China ——analysis based on environmental responsibility and pollution perception. J. Clean. Prod. 326, 129374.

Jiang, L., Zhang, J., Wang, H.H., Zhang, L., He, K., 2018. The impact of psychological factors on farmers' intentions to reuse agricultural biomass waste for carbon emission abatement. J. Clean. Prod. 189, 797–804.

Johnson, K.A., Dalzell, B.J., Donahue, M., Gourevitch, J., Johnson, D.L., Karlovits, G.S., Keeler, B., Smith, J.T., 2016. Conservation Reserve Program (CRP) lands provide ecosystem service benefits that exceed land rental payment costs. Ecosyst. Serv. 18, 175–185.

Juan, V.O., Royal, G.J., 2006. Conflicts, perceptions, and expectations of indigenous communities associated with natural areas in Chile. Nat. Area J. 26 (2), 215–220.

Kline, R., Kline, R.B., Kline, R., 2011. Principles and practice of structural equation modeling. J. Am. Stat. Assoc. 101 (12).

Li, J., Feng, S., Luo, T., Guan, Z., 2020. What drives the adoption of sustainable production technology? Evidence from the large scale farming sector in East China. J. Clean. Prod. 257, 120611.

Li, M., Wang, J., Chen, K., Wu, L., 2020a. Willingness and behaviors of farmers' green disposal of pesticide packaging waste in henan, China: a perceived value formation mechanism perspective. Int. J. Environ. Res. Publ. Health 17 (11), 3753.

Li, M., Wang, J., Chen, K., Wu, L., 2020b. Willingness and behaviors of farmers' green disposal of pesticide packaging waste in henan, China: a perceived value formation mechanism perspective. Int. J. Environ. Res. Publ. Health 17 (11).

Li, M., Wang, J., Zhao, P., Chen, K., Wu, L., 2020c. Factors affecting the willingness of agricultural green production from the perspective of farmers' perceptions. Sci. Total Environ. 738, 140289.

Li, F., Zhang, K., Ren, J., Yin, C., Zhang, Y., Nie, J., 2021. Driving mechanism for farmers to adopt improved agricultural systems in China: the case of rice-green manure crops rotation system. Agric. Syst. 192, 103202.
Li, W., Ruiz-Menjivar, J., Zhang, L., Zhang, J., 2021. Climate change perceptions and the adoption of low-carbon agricultural technologies: evidence from rice production systems in the Yangtze River Basin. Sci. Total Environ. 759, 143554.
Lili, H., zonglu, Y., Lixin, Z., Luojuan, Peizhen, Z., 2022. Contribution and potential of comprehensive utilization of straw in GHG emission reduction and carbon sequestration. Trans. Chin. Soc. Agric. Mach. 53, 349–359, 01.
Liu, H., Chen, S., 2012. An empirical analysis of factors influencing farmers' willingness to participate in farmland small-water conservancy construction–based on a survey of 475 farmers in the main grain-producing areas of Hunan Province. China Rural Observation 54–66, 02.
Liu, M., Ji, Y., 2020. Determinants of agricultural infrastructure construction in China: based on the "participation of beneficiary groups" perspective. Land 9 (1).
Liu, L., Tan, X., 2006. Analysis of the willingness of county and township governments and farmers to invest in the construction of farmland small-water conservancy facilities in major grain-producing areas. Ch. Rural Econ. (12), 32–36+54.
Liu, C., Zheng, H., 2021. How social capital affects willingness of farmers to accept low-carbon agricultural technology (LAT)? A case study of Jiangsu, China. Int. J. Clim. Change Strat. Manag. 13 (3), 286–301.
Liu, Y., Li, J., Yang, Y., 2018. Strategic adjustment of land use policy under the economic transformation. Land Use Pol. 74, 5–14.
Liu, B., Xu, Y., Yang, Y., Lu, S., 2021. How public cognition influences public acceptance of CCUS in China: based on the ABC (affect, behavior, and cognition) model of attitudes. Energy Pol. 156, 112390.
Livote, E.E., Wyka, K.E., 2009. Introduction to structural equation modeling using SPSS and AMOS. Struct. Equ. Model. 16 (3), 556–560.
Lu, H., Xie, H., 2018. Impact of changes in labor resources and transfers of land use rights on agricultural non-point source pollution in Jiangsu Province, China. J. Environ. Manag. 207, 134–140.
Luu, T.D., 2020. Factors influencing Farmers€ adoption of climate-smart agriculture in rice production in Vietnam€s Mekong Delta. Asian J. Agric. Dev. 17.
Madden, T.J., Ellen, P.S., Ajzen, I., 1992. A comparison of the theory of planned behavior and the theory of reasoned action. Pers. Soc. Psychol. Bull. 18 (1), 3–9.
Malawska, A., Topping, C.J., Nielsen, H.Ø., 2014. Why do we need to integrate farmer decision making and wildlife models for policy evaluation? Land Use Pol. 38, 732–740.
Maleksaeidi, H., Keshavarz, M., 2019. What influences farmers' intentions to conserve on-farm biodiversity? An application of the theory of planned behavior in fars province, Iran. Glob. Ecol. Conserv. 20, e00698.
Maris, S.C., Teira-Esmatges, M.R., Arbonés, A., Rufat, J., 2015. Effect of irrigation, nitrogen application, and a nitrification inhibitor on nitrous oxide, carbon dioxide and methane emissions from an olive (Olea europaea L.) orchard. Sci. Total Environ. 538, 966–978.
Martinovska Stojcheska, A., Kotevska, A., Bogdanov, N., Nikolić, A., 2016. How do farmers respond to rural development policy challenges? Evidence from Macedonia, Serbia and Bosnia and Herzegovina. Land Use Pol. 59, 71–83.
Mbaga-Semgalawe, Z., Folmer, H., 2000. Household adoption behaviour of improved soil conservation: the case of the North Pare and West Usambara Mountains of Tanzania. Land Use Pol. 17 (4), 321–336.
Mcintosh, C.N., 2012. A review of eight software packages for structural equation modeling. Am. Statistician 66 (4).
Meijer, S.S., Catacutan, D., Ajayi, O.C., Sileshi, G.W., Nieuwenhuis, M., 2015a. The role of knowledge, attitudes and perceptions in the uptake of agricultural and agroforestry innovations among smallholder farmers in sub-Saharan Africa. Int. J. Agric. Sustain. 13 (1), 40–54.
Meijer, S.S., Catacutan, D., Sileshi, G.W., Nieuwenhuis, M., 2015b. Tree planting by smallholder farmers in Malawi: using the theory of planned behaviour to examine the relationship between attitudes and behaviour. J. Environ. Psychol. 43, 1–12.
Midden, C.J.H., Huijts, N.M.A., 2009. The role of trust in the affective evaluation of novel risks: the case of CO2 storage. Risk Anal. 29 (5), 743–751.
Nuthall, P.L., Old, K.M., 2018. Intuition, the farmers' primary decision process. A review and analysis. J. Rural Stud. 58, 28–38.
Paulraj, A., Lado, A.A., Chen, I.J., 2008. Inter-organizational communication as a relational competency: antecedents and performance outcomes in collaborative buyer–supplier relationships. J. Oper. Manag. 26 (1), 45–64.
Pousette, A., Hanse, J.J., 2002. Job characteristics as predictors of ill-health and sickness absenteeism in different occupational types–a multigroup structural equation modelling approach. Work. Stress 16 (3), 229–250.
Pratt, O.J., Wingenbach, G., 2016. Factors affecting adoption of green manure and cover crop technologies among Paraguayan smallholder farmers. J. Sustain. Agric. 40 (10), 1043–1057.
Qian, W., Ying, Y., 2014. Farmer households' willingness to participate the provision of agricultural infrastructure. Chinese Rural Economy (11), 39–51.
Ru, X., Wang, S., Yan, S., 2018. Exploring the effects of normative factors and perceived behavior control on individual's energy-saving intention: an empirical study in eastern China. Resour. Conserv. Recycl. 134, 91–99.
Ru, X., Qin, H., Wang, S., 2019. Young people's behaviour intentions towards reducing PM2.5 in China: extending the theory of planned behaviour. Resour. Conserv. Recycl. 141, 99–108.
Savari, M., Gharechaee, H., 2020. Application of the extended theory of planned behavior to predict Iranian farmers' intention for safe use of chemical fertilizers. J. Clean. Prod. 263, 121512.
Schaak, H., Mußhoff, O., 2018. Understanding the adoption of grazing practices in German dairy farming. Agric. Syst. 165, 230–239.
Senger, I., Borges, J.A.R., Machado, J.A.D., 2017. Using the theory of planned behavior to understand the intention of small farmers in diversifying their agricultural production. J. Rural Stud. 49, 32–40.
Seroa da Motta, R., Ortiz, R.A., 2018. Costs and perceptions conditioning willingness to accept payments for ecosystem services in a Brazilian case. Ecol. Econ. 147, 333–342.
Spash, C.L., Urama, K., Burton, R., Kenyon, W., Shannon, P., Hill, G., 2009. Motives behind willingness to pay for improving biodiversity in a water ecosystem: economics, ethics and social psychology. Ecol. Econ. 68 (4), 955–964.
Stephens, E.C., Jones, A.D., Parsons, D., 2018. Agricultural systems research and global food security in the 21st century: an overview and roadmap for future opportunities. Agric. Syst. 163, 1–6.
Tabachnick, B.G., Fidell, L.S., 2007. Using Multivariate Statistics, fifth ed. Using multivariate statistics (5th ed.
Tabri, N., Elliott, C.M., 2012. Principles and practice of structural equation modeling. Can. Graduate J. Sociol. Criminol. 1 (1), 305.
Tama, R., Ying, L., Yu, M., Hoque, M.M., Sarker, S.A., 2020. Assessing farmers' intention towards conservation agriculture by using the Extended Theory of Planned Behavior. J. Environ. Manag.
Tama, R.A.Z., Ying, L., Yu, M., Hoque, M.M., Adnan, K.M.M., Sarker, S.A., 2021. Assessing farmers' intention towards conservation agriculture by using the Extended Theory of Planned Behavior. J. Environ. Manag. 280, 111654.
Tao, Y., Duan, M., Deng, Z., 2021. Using an extended theory of planned behaviour to explain willingness towards voluntary carbon offsetting among Chinese consumers. Ecol. Econ. 185, 107068.
Thinda, K.T., Ogundeji, A.A., Belle, J.A., Ojo, T.O., 2020. Understanding the adoption of climate change adaptation strategies among smallholder farmers: evidence from land reform beneficiaries in South Africa. Land Use Pol. 99, 104858.
Vignola, R., Koellner, T., Scholz, R.W., McDaniels, T.L., 2010. Decision-making by farmers regarding ecosystem services: factors affecting soil conservation efforts in Costa Rica. Land Use Pol. 27 (4), 1132–1142.
Vukina, T., Zheng, X., Marra, M., Levy, A., 2008. Do farmers value the environment? Evidence from a conservation reserve program auction. Int. J. Ind. Organ. 26 (6), 1323–1332.
Wang, L., 2022. A Preliminary Study on Green Farmland Construction. China Comprehensive Agricultural Development, pp. 43–47, 06.
Wang, D., Liu, J., 2019. Modern agricultural infrastructure investment mechanism and model in rural revitalization. Rural Economy 80–87, 03.
Wang, S., Fan, J., Zhao, D., Yang, S., Fu, Y., 2016. Predicting consumers' intention to adopt hybrid electric vehicles: using an extended version of the theory of planned behavior model. Transportation 43 (1), 123–143.
Wang, Y., Liu, J., Chen, M., Du, T., Duan, C., Gao, G., Yang, H., 2016. The novel mechanism of rotenone-induced α-synuclein phosphorylation via reduced protein phosphatase 2A activity. Int. J. Biochem. Cell Biol. 75, 34–44.
Wang, Y., Chen, L., Long, K., 2018a. Farmers' identity, property rights cognition and perception of rural residential land distributive justice in China: findings from Nanjing, Jiangsu Province - ScienceDirect. Habitat Int. 79, 99–108.
Wang, Y., Yang, J., Liang, J., Qiang, Y., Fang, S., Gao, M., Fan, X., Yang, G., Zhang, B., Feng, Y., 2018b. Analysis of the environmental behavior of farmers for non-point source pollution control and management in a water source protection area in China. Sci. Total Environ. 633, 1126–1135.
Wang, Y., Liang, J., Yang, J., Ma, X., Li, X., Wu, J., Yang, G., Ren, G., Feng, Y., 2019. Analysis of the environmental behavior of farmers for non-point source pollution control and management: an integration of the theory of planned behavior and the protection motivation theory. J. Environ. Manag. 237, 15–23.
Wang, Z., Geng, Y., Liang, T., 2020a. Optimization of reduced chemical fertilizer use in tea gardens based on the assessment of related environmental and economic benefits. Sci. Total Environ. 713, 136439.
Wang, Z., Mao, X., Zeng, W., Xie, Y., Ma, B., 2020b. Exploring the influencing paths of natives' conservation behavior and policy incentives in protected areas: evidence from China. Sci. Total Environ. 744, 140728.
Wang, Y.B., Wang, J.J., Wang, X.Y., Li, Q., 2021. Does Policy Cognition Affect Livestock Farmers' Investment in Manure Recycling Facilities? Evidence from China, 795. Science of The Total Environment.
Wang, Z., Wang, J., Chen, H., Guan, B., Deng, H., 2021. Trends in irrigation investment in northern China since the 8th Five-Year Plan period and factors influencing new irrigation investment in villages. Ch. Rural Econ. 103–124, 08.
Wanger, T.C., DeClerck, F., Garibaldi, L.A., Ghazoul, J., Kleijn, D., Klein, A.-M., Kremen, C., Mooney, H., Perfecto, I., Powell, L.L., Settele, J., Solé, M., Tscharntke, T., Weisser, W., 2020. Integrating agroecological production in a robust post-2020 Global Biodiversity Framework. Nat. Ecol. Evol. 4 (9), 1150–1152.
Wauters, E., Mathijs, E., 2013. An investigation into the socio-psychological determinants of farmers' conservation decisions: method and implications for policy, extension and research. J. Agric. Educ. Ext. 19 (1), 53–72.
Wei, C., Ren, S., Yang, P., Wang, Y., He, X., Xu, Z., Wei, R., Wang, S., Chi, Y., Zhang, M., 2021. Effects of irrigation methods and salinity on CO2 emissions from farmland soil during growth and fallow periods. Sci. Total Environ. 752, 141639.
Wei, X., Khachatryan, H., Zhu, H., 2021. Poyang lake wetlands restoration in China: an analysis of farmers' perceptions and willingness to participate. J. Clean. Prod. 284, 125001.
Wilson, R.S., Schlea, D.A., Boles, C.M.W., Redder, T.M., 2018. Using models of farmer behavior to inform eutrophication policy in the Great Lakes. Water Res. 139, 38–46.
Wu, C.H., Yao, G., 2006. Analysis of factorial invariance across gender in the Taiwan version of the satisfaction with life scale. Pers. Indiv. Differ. 40 (6), 1259–1268.
Xie, H., Cheng, L., Lu, H., 2018. Farmers' responses to the winter wheat fallow policy in the groundwater funnel area of China. Land Use Pol. 73, 195–204.

Xu, W., Zhao, W., 2019. Effects of political efficacy and social capital on farmers' participation willingness to rural land consolidation. China Land Science 33 (3), 105–113.
Xu, H., Paerl, H.W., Zhu, G., Qin, B., Hall, N.S., Zhu, M., 2017. Long-term nutrient trends and harmful cyanobacterial bloom potential in hypertrophic Lake Taihu, China. Hydrobiologia 787 (1), 229–242.
Yazdanpanah, M., Hayati, D., Hochrainer-Stigler, S., Zamani, G.H., 2014. Understanding farmers' intention and behavior regarding water conservation in the Middle-East and North Africa: a case study in Iran. J. Environ. Manag. 135, 63–72.
Yu, W., Luo, X., Li, R., Xue, l., Huang, L., 2017. A study on farmers' willingness to adopt green technologies and behavior deviations from a green cognitive perspective. Resour. Sci. 39, 1573–1583, 08.
Yu, Z., Wu, C., Tan, Y., Zhang, X., 2018. The dilemma of land expansion and governance in rural China: a comparative study based on three townships in Zhejiang Province. Land Use Pol. 71, 602–611.
Zhang, Y., Wang, Y., 2021. Analysis of influencing factors of farmer's willingness in inner Mongolian to participate in land transfer under the "three powers separation. J. Ch. Agric. Resour. Reg. Plann. 42 (4), 204–208.
Zhang, X., Geng, G., Ping, S., 2017. Determinants and implications of citizens' environmental complaint in China: integrating theory of planned behavior and norm activation model. J. Clean. Prod. 166, 148–156.
Zhang, J., Zhuang, M., Shan, N., Zhao, Q., Li, H., Wang, L., 2019. Substituting organic manure for compound fertilizer increases yield and decreases NH3 and N2O emissions in an intensive vegetable production systems. Sci. Total Environ. 670, 1184–1189.
Zhang, Y., Xiao, C., Zhou, G., 2020. Willingness to pay a price premium for energy-saving appliances: role of perceived value and energy efficiency labeling. J. Clean. Prod. 242, 118555.
Zhang, X., Jin, X., Liang, X., Ren, J., Han, B., Liu, J., Fan, Y., Zhou, Y., 2022. Implications of land sparing and sharing for maintaining regional ecosystem services: an empirical study from a suitable area for agricultural production in China. Sci. Total Environ. 820, 153330.
Zhao, G., Chen, L., 2018. Influence factors and administrative intervention of farmers' willingness to transfer land resources in Hengshui. J. Ch. Agric. Resour. Reg. Plann. 39 (10), 213–218.
Zhou, J., Cao, X., 2020. What is the policy improvement of China's land consolidation? Evidence from completed land consolidation projects in Shaanxi Province. Land Use Pol. 99, 104847.
Zhu, H., Weng, Z., Kang, L., 2010. Theoretical and empirical analysis of factors influencing farmers' willingness to participate in farmland water conservancy construction–based on micro-survey data of 619 large grain-growing households in Jiangxi Province. J. Nat. Resour. 25, 539–546, 04.