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The Impact of Technical Training on Farmers Adopting Water-Saving Irrigation Technology: An Empirical Evidence from China

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Abstract: Farmers' adoption of water-saving irrigation technology (WSIT) is essential for achieving high-quality agricultural development. An in-depth analysis of the impact of risk aversion, technical training and their interaction on farmers' adoption of WSIT will help the government to promote WSIT to facilitate agricultural resource conservation and sustainable development. The study takes 707 farmers who grow watermelons and muskmelon in Yuncheng and Xian City of Shanxi and Shaanxi provinces as the research object to analyse the influence of risk aversion and technical training and their interaction terms on farmers' WSIT adoption behaviour. The study uses the Probit and moderating effect models to outline the findings. The empirical analysis reveals the following outcomes: (i) 27.44% of the sample farmers adopt water-saving irrigation technology, indicating that the current adoption rate and the enthusiasm for adoption are relatively low; (ii) risk aversion has a significant negative impact on farmers' adoption of WSIT; (iii) both online and offline technical training have a significant positive impact on farmers' adoption of WSIT; (iv) significant group differences exist in the effects of risk aversion, online technical training, offline technical training and interaction items on farmers' WSIT adoption behaviour. Therefore, the study proposes to strengthen the role of technical training in the diffusion of WSIT and implement differentiated technical training for different types of farmers to reduce the degree of risk aversion of farmers.

Keywords: risk aversion; offline technical training; online technical training; farmers' water-saving irrigation technology adoption behaviour; moderating effect

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1. Introduction

Water scarcity is now emerging as an underappreciated challenge to the integrity of China's comprehensive development goals [1]. China's per capita water resources are one-fourth of the world's average level [2], and day by day, it is decreasing at an alarming rate [3,4]. With the significant development of China's overall economy, and high water consumption trends by manufacturing industries, the contradiction between the supply and demand of water resources will further intensify [5,6]. As a dominant user of water resources, China's agricultural sector consumes a significant proportion of the existing water resources. According to the Bulletin of the Ministry of Water Resources of China, the agricultural water consumption in 2021 will be 235 billion m^3, accounting for 74% of the total water consumption [7]. However, the effective utilization coefficient of China's farmland irrigation water is only 0.6, which is still far behind the average level of 0.7–0.8 in developed countries [8,9], further exacerbating the contradiction between the supply and demand of water resources for agricultural production. Under the combined effects of the widespread shortages of water resources and poor agricultural irrigation conditions, China's high-quality agricultural development and green transformation face significant bottlenecks.

Moreover, the contradiction between the supply and demand of water resources has severely impacted farmers' agricultural production and livelihood and poses a severe threat to their future sustainable development [10,11]. Compared with traditional irrigation methods, high-efficiency water-saving irrigation technologies such as channel seepage, droppers, micro-sprinkler and drip irrigation systems can improve water resource utilization efficiency, effectively improve cultivated land quality and increase planting intensity [12]. Those systems can also foster the dual effects of improving the ecology and increasing agricultural income [13]. Therefore, supporting farmers to adopt high-efficiency water-saving irrigation technology and improving farmers' cognitive prospects to reduce water loss has become an inevitable choice to solve the above contradictions [14,15]. However, farmers' adoption of water-saving irrigation technology is not optimistic, and they are not very aware of water-saving irrigation technology and even less motivated to adopt it [16]; especially in developing countries, the situation is even worse [17,18]. Even rural farmers resist water-saving irrigation technology and technology adoption, and average household sizes are low [19,20]. Given this, how to effectively promote farmers to adopt water-saving irrigation technology has become a practical problem to be solved urgently by the government and academia. It is generally believed that farmers' production technology selection behaviour is closely related to internal factors and external factors [21]. Regarding internal factors, it mainly analyses the effects of family demographic characteristics, economic endowment characteristics, differences in socioeconomic status, social capital and production risks on farmers' adoption of water-saving irrigation technology [22,23]. Regarding the external environment, the impact of technical attributes, market environment, natural environment, policy environment and land property rights may be crucial to the adoption behaviour of farmers' water-saving irrigation technology [24].

According to the development economics theory, high-risk aversion is an essential characteristic of small farmers. Some studies (such as Grové et al. [25], Hu et al. [26] and Adere et al. [27]) indicate that higher risk aversion of farmers will lead to slow technology diffusion. Logically, it will make them less motivated to adopt water-saving irrigation technology. Therefore, it is necessary to pay attention to the impact of technical training in the external environment on farmers' water-saving irrigation technology adoption to solve the problem of low water-saving irrigation technology adoption due to farmers' risk aversion [28]. On the one hand, technical training is an essential channel for farmers to understand and adopt risk avoidance measures [29,30]. On the other hand, technical training can efficiently transmit information and increase the availability of new technologies [31]. It is helpful for farmers to learn agricultural knowledge and technology and use the experience to continuously accumulate and improve the structure of agricultural technology knowledge [32,33]. It also plays a leading role in technology demonstration to increase the diffusion speed of water-saving irrigation technology and to increase the speed of water-saving irrigation for farmers' technology adoption rate [34].

In the existing literature, risk aversion and the impact of technical training have been explored separately. Very limited literature has integrated these two into an integrated framework on farmers' water-saving irrigation technology adoption behaviour has not been analysed sufficiently. However, most studies only start from the perspective of offline technical training, such as government or cooperatives. Few studies include online technical training in analysing farmers' water-saving irrigation technology adoption behaviour. The study aims to analyse how risk avoidance and online and offline technical training work together for farmers adopting water-saving irrigation technology. To the best of our knowledge, the study will be one of the first attempts to explore the impact of online and offline training in farmers' water-saving irrigation technology adoption. Moreover, using a behavioural analysis framework, the study also provides a comparative analysis of the impact of online technical training on farmers' risk aversion behaviour, which is of prime significance to the study. The empirical setup of the study comprised a data set of 707 melon farmers in Yuncheng and Xian City of Shanxi and Shaanxi provinces, China. Specifically, the researchers utilized the Probit and moderating effect models to analyse the influence of risk aversion, technical training, and interaction items on farmers' water-saving irrigation technology adoption behaviour. The study will comprehensively explain the behavioural logic of Chinese farmers' water-saving irrigation technology adoption and provide a decision-making reference for relevant governmental departments to promote farmers' water-saving irrigation technology adoption and the sustainable use of water resources.

2. Theoretical Analysis and Research Hypotheses

2.1. Influence of Risk Aversion on Farmers' Adoption Behavior of Water-Saving Irrigation Technology

Technically, as a core economic entity, farmers are risk-sensitive and tend to avoid risk [34], especially in adopting novel approaches or tactics [35]. Moreover, various studies (such as Zhou et al. [36], Mooney et al. [37] and Ojo et al. [38]) outline that farmers have very limited risk-taking and coping capabilities in the process of agricultural production and operation. They must consider profit maximization and risk minimization when adopting production technology. Therefore, the motivation of farmers' risk preference is the key to slow technology diffusion [39], and risk aversion leads to a low adoption rate of farmers' water-saving irrigation technology, which inhibits farmers' enthusiasm for adoption [40]. This is because the higher the degree of risk aversion of farmers, the more generally they maintain a scrutinous and cautious attitude in the production process and rational thinking to avoid risks and shocks. In agriculture economics, water-saving irrigation technology can play an irreplaceable role in land–water resource utilization efficiency, improving cultivated land quality, increasing yield per hectare and promoting sustainable agricultural development [41]. Specifically in China, various factors influence farmer's behaviour in adopting water-saving irrigation technology, such as, for farmers, the risk of uncertain returns of agricultural products, the frequent fluctuations in the price of agricultural products, the weak bargaining power of marginal farmers, the poor market price information and the high requirements for input costs in the early stage of water-saving irrigation technology adoption [42]. However, there are still more significant risks in adopting water-saving irrigation technology. According to the study of Wang et al. [43], the cost invested in water-saving irrigation technology may not bring the corresponding expected return, inhibiting farmers' adoption of water-saving irrigation technology. Existing literature (such as Tian et al. [44], Yang et al. [45] and Bakhshi et al. [46]) highlighted the potential risk of the improper application of water-saving irrigation technology and found that there are dual attributes of knowledge-intensive and capital-intensive at play, which requires high-quality knowledge of the subject of technology adoption. When farmers have a relative deprivition of risk regarding the technical know-how of new technology, they are more likely to avoid it [47,48]. Therefore, it can be argued that the higher the degree of risk aversion of farmers, the lower the framer's enthusiasm for water-saving irrigation technology, which eventually hinders the adoption rate. Accordingly, this study proposes the first research hypothesis:

H1. *Risk aversion has a negative impact on farmers' adoption of water-saving irrigation technology.*

2.2. Effects of Technical Training on Farmers' Water-Saving Irrigation Technology Adoption Behavior

Agricultural technology training is a scientific, structured and promotional activity that takes farmers as the training objects [49,50] and may improve farmers' agricultural technology cognition, information acquisition ability and agricultural literacy through various channels including knowledge sharing and demonstration [51,52]. Water-saving irrigation technology is an exogenous technology with knowledge-intensive attributes [53]. Therefore, according to the existing literature, technical training mainly affects farmers' water-saving irrigation technology adoption through the following two channels: First, technical training helps farmers break down information barriers, increases farmers' information and understanding of water-saving irrigation technologies, improves farmers' agricultural technical literacy, and deepens their knowledge of water-saving irrigation technologies to improve the quality of cultivated land, increase crop yield and income per hectare and save energy [54,55]. The degree of awareness of water resources and other benefits makes them more active in adopting water-saving irrigation technology [56,57], which promotes the adopters to obtain relevant information actively and helps farmers break information barriers [58]. Second, technical training can help obtain product, market and policy information to promote the deepening and expansion of knowledge and experience of farmers and further rationally optimize the endowment of agricultural production resources [59,60]. Moreover, it may ease the factor endowment constraints of farmers adopting water-saving irrigation technology so that farmers can actively adopt it without significantly impacting the current family business situation [61,62]. With the promotion and use of infrastructure and digital technology, technical training can be divided into two categories: (i) offline and (ii) online technical training, according to different training forms [63,64].

Offline technical training refers to the publicity, promotion of technical knowledge and transfer of relevant information by agricultural technicians or experts by distributing agricultural information materials, broadcasting, classroom explanations and field demonstrations. Online technical training refers to relying on the internet and digital technology, using computers and smartphones as a platform for public accounts or web pages, and using short videos to help farmers obtain relevant technical knowledge and information. Online technical training can break time and regional boundaries and transmit information to more farmers at a lower cost, break down information barriers, and reduce farmers' information asymmetry [65]. Due to the different emphases of offline and online technical training, these two may impact the adoption behaviour of farmers' water-saving irrigation technology [66]. Compared with online technical training, offline technical training can alleviate the contradiction between the knowledge- and capital-intensive attributes of water-saving irrigation technology and farmers' technical cognition and application ability and help promote the adoption of water-saving irrigation technology [67]. Accordingly, the study proposes the second and third research hypotheses:

H2. *Participating in technical training positively impacts farmers' adoption of water-saving irrigation technologies.*

H3. *Unlike online technical training, offline technical training has a more substantial positive effect on farmers' adoption of water-saving irrigation technology.*

2.3. Mitigation Effect of Technical Training on Risk Aversion Inhibiting Farmers' Adoption of Water-Saving Irrigation Technology

Farmers' risk preference is the key to technology diffusion and can significantly alter the behavioural factors of farmers [68,69]. In order to solve the "dilemma" of farmers' risk aversion and technology adoption, technical training is regarded as promoting the adoption of production technology by farmers and saving agricultural production [70]. The impact of risk aversion on farmers' behaviour is not static but changes with the external environment [71,72]. As a typical form of the external environment, technical training can effectively change the endowment constraints of farmers and enhance farmers' confidence and skills in using technology effectively [73]. Therefore, it is essential to alleviate the inhibitory effect of risk aversion on farmers' adoption of water-saving irrigation technology. This is mainly reflected in two aspects: First, technical training can correct the information asymmetry between farmers' risk aversion and water-saving irrigation technology adoption by introducing external technical knowledge and confidence and prompt farmers to evaluate water-saving irrigation correctly and rationally [74]. The risks faced by technology adoption form a positive expected return and reduce the negative impact of risk aversion on farmers' water-saving irrigation technology adoption behaviour. Second, technical training can improve farmers' awareness of water-saving irrigation technology [75]. Farmers can learn standardized technical operation knowledge through online and offline technical training and are familiar with various water-saving irrigation technical facilities and their use and maintenance [76]. It can also enhance the confidence and application ability of water-saving irrigation technology adoption, reduce farmers' concerns about the risk of unsuitable technology or improper operation and effectively resolve the negative impact of risk aversion on farmers' water-saving irrigation technology adoption behaviour [77]. Accordingly, this paper proposes a fourth research hypothesis.

H4. *Technical training can alleviate the inhibitory effect of risk aversion on farmers' adoption of water-saving irrigation technology.*

3. Materials and Methods

3.1. Data Sources

The study's empirical data comprised a face-to-face survey of farmer's households in the central melon-producing region of Shanxi and Shaanxi Province, China, in December 2020. At the same time, the responses were recorded with a structured questionnaire covering the risk aversion test experiment, technical training situation, individual characteristics of the head of household, family situation, external environmental characteristics and water-saving irrigation technology adoption of farmers. The study adopted multistage sampling criteria to ensure the rationality of the selection of sample farmers, while the researchers adopted typical random sampling tactics to identify the potential respondents. First, the study consulted with the local agricultural extension officers to determine the major melon-producing region of the selected provinces and the associated characteristics of the farmer's water usage mechanism. Yuncheng City, Shanxi Province, and Xi'an City, Shaanxi Province, were selected based on the agriculture extension officers' inputs. The selected two cities belong to the Yellow River Irrigation Area and the Fen River Irrigation Area, respectively, where farmers usually use the traditional flood irrigation method. The method is considered water resources intensive and can lead to severe soil erosion and a sharp decline in soil quality. Therefore, the region was suitable for fulfilling the prime research objectives. Second, the researchers randomly selected Yanhu and Xia County from Yuncheng City, Shanxi Province, and Yanliang County from Xi'an City, Shanxi Province. In the third stage, 3–5 towns were randomly selected from each of the selected districts/counties, providing 19 towns. After that, the researchers randomly selected 2–5 villages from this township, comprising 35 villages. Finally, 19–25 farmers who grow watermelons and muskmelon were randomly selected in each sample village as the research objects.

Before conducting the formal survey, the study utilized a pilot test with randomly selected 20 farmers from four villages from two provinces to test the instrument, and according to the inputs, the study adjusted the instrument accordingly, which we believe improved the accuracy of the instruments. Moreover, we chose the respondent household head to be the priority (if not present, we choose the immediate farming decision maker), which we believe ensured the quality of the information we have gathered. During the final survey process, 731 farmers were consulted. Among them, 707 valid questionnaires were obtained for further analysis, and the effective rate of the survey was 96.715%. We eliminated 24 responses as they gave up midway or there was missing information regarding the core variables required for performing the analysis. As the prime respondents of the study are farmers, we acknowledge that potentially biased responses may occur. Therefore, the study adopted a two-stage strategy to reduce the potentially biased responses, as suggested by Podsakoff et al. [78]. First, before asking questions, the research team discussed all the variables and essential information with the respondent to reduce this issue. Second, the team ensured the questionnaire was well equipped with neutrally worded questions and answer options were not leading. Moreover, the study performs a robustness test to depict the reliability of the outcomes.

Table 1 summarizes the essential characteristics of the sample farmers. In terms of the age of household heads, 18–30, 31–45, 46–60 and over 61 accounted for 1%, 17.96%, 66.05%, and 14.99% of the respondents, respectively, indicating that the current rural households are relatively older, mainly middle-aged and older adults. Regarding the education level of the household heads, the proportions of households with an education of 6 years or less, 6–9 years, 9–12 years and more than 12 years were 34.80%, 53.32%, 11.46 and 0.42%, respectively. At present, the education level of farmers is generally low, and most of them are at the level of junior high school or below. Regarding cooperative participation, 230 farmer's households are participating in cooperatives, accounting for only 32.53% of the total sample, indicating that the current participation in cooperatives is low. In terms of the planting scale, farmers with less than 1 hectare, 1–2 hectare, 2–3 hectare and more than 3 hectares were 56.58%, 36.63%, 5.09% and 1.70% of the respondents, respectively, indicating that the surveyed farmers mainly focus on small-scale planting. Regarding the proportion of income from farming, farming income accounting for less than 10%, 10–30%, 30–50%, and 50–100% of farmers' income was reported by 2.97%, 22.49%, 24.75% and 49.79% of respondents, respectively, indicating that farming is an essential source of income for most farmers. Regarding market prospect expectations, 633 farmers (89.53%) were optimistic about the prospects of the melon and fruit market, indicating that most farmers are optimistic about the development of the melon and fruit industry.

Table 1. Descriptive analysis of sample farmers.

Feature	Options	No.	Proportion (%)	Feature	Options	Frequency	Proportion (%)
Age of head of the household	18–30 years old	7	1	Planting scale	Less than 1 hectare	400	56.58
	31–45 years old	127	17.96		1–2 hectare	259	36.63
	46–60 years old	467	66.05		2–3 hectare	36	5.09
	61 years old and above	106	14.99		More than 3 hectares	12	1.70
Head of the household education level	Under 6 years	246	34.80	The proportion of planting income	10% or less	twenty one	2.97
	6–9 years	377	53.32		10–30%	159	22.49
	9–12 years	81	11.46		30–50%	175	24.75
	12 years or more	3	0.42		50–100%	352	49.79
Cooperative participation	Participate/Not involved	230	32.53	Market outlook	Yes/No	633	89.53

3.2. Variable Selection

3.2.1. Explained Variables

The adoption behaviour of farmers' water-saving irrigation technology is the explanatory variable in the study. Drawing on existing literature (such as Ho et al. [79], Zhang et al. [13] and Mushtaq et al. [19]) and consulting with experts from the agricultural machinery industry, water-saving irrigation technologies such as a dropper, channel seepage irrigation, micro-sprinkler irrigation and film-covered irrigation were determined to be research objects. When farmers adopt any of them or when there are multiple technologies adopted, the value of farmers' water-saving irrigation technology adoption behaviour is 1; otherwise, this value is 0.

3.2.2. Core Explanatory Variables

Risk aversion and technical training refer to the study's core explanatory variables. The experimental economic method was chosen as the experimental measurement of risk aversion, as recommended by Qiu et al. [80] and Xu et al. [81]. The experiment was completed in three stages: first, the "lottery draw" game rules were introduced to the respondents, and the game plan was pre-tested. Second, ten sets of game questions were provided to the respondents, and each question included option A (low-risk option) and option B (high-risk option). Each option corresponds to a different cash reward to let the respondents know that the choice of the risk option will affect their final income. Finally, the respondents from the first questions were selected one by one. Only after the respondent had completed the selection of each question did the researcher allow the respondent to see the next question. In the step-by-step selection process of each question, as long as the respondent chose option B, he can no longer choose option A in subsequent games. This experiment links the final reward of the respondents with the experimental results to ensure that the acquisition of the degree of risk aversion of the respondents is authentic and reliable and to avoid data bias. Respondents can obtain a reward of 10 yuan within 20 min, which can stimulate the enthusiasm of respondents to participate in the lottery game. Table 2 shows the specific content of the experimental design.

Table 2. The experimental design and experimental results of the degree of risk aversion of farmers.

Question Number	Low-Risk Program (Option A)		High-Risk Program (Option B)		The Proportion of Choosing High-Risk Options
	30% Chance	70% Chance	10% Chance	90% Chance	
1	Exchange 200 yuan	Exchange 50 yuan	Exchange 3 00 yuan	Exchange 25 yuan	12.87
2	Exchange 200 yuan	Exchange 50 yuan	Exchange 330 yuan	Exchange 25 yuan	20.50
3	Exchange 200 yuan	Exchange 50 yuan	Exchange 370 yuan	Exchange 25 yuan	32.24
4	Exchange 200 yuan	Exchange 50 yuan	Exchange 420 yuan	Exchange 25 yuan	43.13
5	Exchange 200 yuan	Exchange 50 yuan	Exchange 480 yuan	Exchange 25 yuan	49.35
6	Exchange 200 yuan	Exchange 50 yuan	Exchange 580 yuan	Exchange 25 yuan	56.24
7	Exchange 200 yuan	Exchange 50 yuan	Exchange 700 yuan	Exchange 25 yuan	62.18
8	Exchange 200 yuan	Exchange 50 yuan	Exchange 900 yuan	Exchange 25 yuan	67.83
9	Exchange 200 yuan	Exchange 50 yuan	Exchange 1100 yuan	Exchange 25 yuan	72.07
10	Exchange 200 yuan	Exchange 50 yuan	Exchange 1400 yuan	Exchange 25 yuan	76.45

As the amount exchanged from the first question to the tenth question gradually increases, the possibility of respondents choosing high returns and risks also increases. Option A has a 30% possibility of a bonus of 200 yuan and a 70% possibility of a bonus of 50 yuan. Option B has a 10% possibility of a bonus of 300 yuan, and there is a 90% probability that the bonus will be reached by 25 yuan. According to the experimental results and referring to the risk aversion index formula of Xu et al. [81], the risk aversion degree of farmers can be calculated as the following: risk aversion index = 1(number of high-risk schemes/10). If the number of times the farmer chose high risk was 0, this is extreme risk aversion. On the contrary, if the number of times the farmer chose high risk was 10, this is extreme risk preference.

Offline technical training means agricultural technical experts or personnel disseminate knowledge and information about water-saving irrigation technology to farmers at a fixed time and place through conference lectures and on-site training, most of which take place via the face-to-face medium. If farmers participate in offline technical training, the value is 1; otherwise, they are assigned a value of 0. Online technical training means farmers use the internet, various online apps, WeChat and Weibo official accounts or web browsing, voice, video and other forms to obtain knowledge and information related to water-saving irrigation technology. If farmers use online technical training, the assigned value is 1; otherwise, the assigned value is 0.

3.2.3. Control Variables

The adoption behaviour of farmers' water-saving irrigation technology depends on individual or family internal factors and the external environment. Therefore, along with household head characteristics (age of household head and education level of household head), household management characteristics (family planting years, the proportion of planting income, planting area and number of family workers) and social capital (participation in cooperatives and social network), the study chose the external environment (market outlook and natural disasters) to be the core control variable. In addition, to ensure the estimation effect, regional variables were controlled. The specific meaning and assignment of each variable are shown in Table 3.

Table 3. Variable description and descriptive statistical analysis.

Variable Name		Variable Meaning and Assignment	Average	Standard Deviation
Explained variable				
Adoption behaviour of farmers' water-saving irrigation technology		Whether to use water-saving irrigation technology: adopted = 1, not adopted = 0	0.274	0.447
Core explanatory variable				
Risk Aversion		Risk aversion degree value (between 0 and 1): 0 means extreme risk preference type, 1 means extreme risk aversion type	0.508	0.365
Technical training	Offline technical training	Whether you have received offline technical training: Yes = 1, No = 0	0.226	0.419
	Online technical training	Whether you have received online technical training: Yes = 1, No = 0	0.495	0.501
Control variable				
Age of Head of household		Respondent's age (years)	52.301	8.866
Head of the household education level		Respondents' years of education (years)	7.854	2.720
Family Planting Years		Family planting years (years)	26.266	11.141
The proportion of planting income		The proportion of melon and fruit income in household income (%)	0.544	0.996
planting scale		Family watermelons and muskmelon planting area (hectare)	0.979	0.601
Land levelness		The flatness of the land where the crop is planted: very uneven = 1, uneven = 2, normal = 3, relatively flat = 4, very flat = 5	3.777	0.779
Number of migrant workers		Number of family workers (person)	1.147	0.995
cooperative participation		Whether to participate in cooperatives: yes = 1, no = 0	0.325	0.469
social network		Number of mobile phone contacts (number)	129.484	111.346
market outlook		Whether the respondents are optimistic about the prospects of the melon and fruit market: Yes = 1, No = 0	0.898	0.307
natural disaster situation		Number of natural disasters in the past three years (times)	1.164	1.203
Regional location		Location: Shanxi Province = 0, Shaanxi Province = 1	0.506	0.501

The 707 farmers of the sample were divided into two groups according to the age of the household head, planting scale and education level to grasp the adoption of water-saving irrigation technology more simply and accurately. The specific distribution is shown in Table 4. These groups of farmers included: (i) the first group, based on age (18–50 years old), was more substantial than that of the second one (50 years or more); (ii) regarding the farming scale of the farmers, the second group (more than 0.667 hectares) was more substantial than the first group (0.667 hectares and below); (iii) regarding the education level of the head of the household, the first group (9 years and below) was more substantial than the second group (over 9 years).

Table 4. Adoption of water-saving irrigation technology by sample farmers (%).

Adoption Behaviour	Age of Head of Household		Farming Scale		Head of the Household Education Level	
	18 to 50 (Group A)	Over 50 Years old (Group B)	0.667 Hectares and Below (Group A)	More than 0.667 Hectares (Group B)	9 Years and Below (Group A)	Over 9 Years (Group B)
Adopted	49.49%	50.51%	23.19%	76.81%	84.54%	15.46%
Not adopted	41.72%	58.28%	48.54%	51.46%	89.47%	10.53%

3.3. Model Building

3.3.1. Benchmark Regression Model

The explanatory variable in this paper is "the adoption behaviour of farmers' water-saving irrigation technology", which is a binary classification variable. Therefore, this paper uses the binary Probit model for empirical analysis. Specifically, the model of Formula (1) is as follows:

$$Z = \ln(\frac{p_i}{1-p_i}) = \beta_0 + \beta_1 RA_i + \beta_2 TT_i + \beta_3 MT_i + \sum_{k=1} \beta_{4k} C_i + D_i + \varepsilon_i \quad (1)$$

where P_i represents the probability of farmers adopting water-saving irrigation technology, $1 - P_i$ represents the probability that farmers do not adopt water-saving irrigation technology, $P_{1i}/1 - P_i$ is the probability ratio or relative risk, RA_{1i} represents the degree of risk aversion of farmers, T_i represents offline technical training, MT_i represents the line C_i represents the control variable, D_i represents the dummy variable in the area where farmer i is located, β_0 is the intercept item of the model, B_k is the regression coefficient corresponding to the independent variable and ε_i is the random disturbance item.

3.3.2. Modulation Effect Model

In order to explore the influence mechanism of risk aversion, technical training and farmers' water-saving irrigation technology adoption behaviour, drawing on the research of Wen et al. [82], the following adjustment effect model was constructed:

$$Z = \ln(\frac{p_i}{1-p_i}) = \beta_0 + \beta_1 RA_i + \beta_2 TT_i + \beta_1 RA \times \beta_2 TT_i + \sum_{k=1} \beta_{4k} C_i + D_i + \varepsilon_i \quad (2)$$

$$Z = \ln(\frac{p_i}{1-p_i}) = \beta_0 + \beta_1 RA_i + \beta_2 TT_i + \beta_1 RA \times \beta_3 MT_i + \sum_{k=1} \beta_{4k} C_i + D_i + \varepsilon_i \quad (3)$$

$$Z = \ln(\tfrac{p_i}{1-p_i}) = \beta_0 + \beta_1 RA_i + \beta_2 TT_i + \beta_3 MT_i + \beta_1 RA \times \beta_2 TT_i + \beta_1 RA \times \beta_3 MT_i + \sum_{k=1} \beta_{4k} C_i + D_i + \varepsilon_i \quad (4)$$

In (2), $\beta_1 RA \times \beta_2 TT_i$ represents the interaction term between risk aversion and offline technical training. Meanwhile, (3) represents the interaction term between risk aversion and online technical training; $\beta_1 RA \times \beta_3 MT_i C$ represents the interaction term between risk aversion and online technical training; C represents the control variable; D_i represents the dummy variable of the area where farmer i is located; β_0 is the intercepted item of the model; β_k is the regression coefficient corresponding to the independent variable; ε_i is the random disturbance item.

4. Results

The results of the multicollinearity diagnosis showed that the variance inflation factor (VIF) values of each variable were less than 2, indicating no multicollinearity problem among variables. Stata15.0 [William Gould, StataCorp, https://www.stata.com (accessed on 23 January 2023, Texas, United States] was used for regression, and the estimated results were as follows.

4.1. Benchmark Model Results and Analysis

Table 5 shows the regression results of the model with core explanatory variables introduced in turn. Model (1), model (2), model (3) and model (4) were all tested using the Wald test, and all of them reached a significance level of 1%, indicating that the overall fitting degree of the model is good. The following analysis is mainly based on the estimated results of model (4).

Table 5. Benchmark model regression results.

Variable		Model (1)	Model (2)	Model (3)	Model (4)
Risk Aversion		−0.3061 * (0.1630)			−0.4841 ** (0.1950)
Technical Training	Offline technical training		1.2784 *** (0.1525)		1.2821 *** (0.1635)
	Online technical training			1.1819 *** (0.1337)	1.2056 *** (0.1463)
age of Head of household		0.0155 * (0.0083)	0.0191 ** (0.0088)	0.0154 * (0.0087)	0.0178 * (0.0095)
Head of the household's education level		0.0487 ** (0.0237)	0.0419 * (0.0247)	0.0490 * (0.0254)	0.0312 (0.0274)
Planting years		−0.0156 ** (0.0064)	−0.0184 *** (0.0067)	−0.0127 * (0.0069)	−0.0159 ** (0.0074)
The proportion of farming income		1.6409 *** (0.2648)	1.3707 *** (0.2836)	1.5358 *** (0.2888)	1.2868 *** (0.3145)
Farming scale		0.4665 *** (0.1035)	0.4065 *** (0.1095)	0.3720 *** (0.1110)	0.3030 ** (0.1185)
Land levelness		0.3804 *** (0.0807)	0.1796 ** (0.0858)	0.3367 *** (0.0851)	0.2009 ** (0.0948)
Number of migrant workers		0.0837 (0.0754)	0.0462 (0.0792)	0.0506 (0.0831)	0.0370 (0.0896)
Cooperative participation		0.4696 *** (0.1338)	0.2454 * (0.1454)	0.5595 *** (0.1438)	0.3572 ** (0.1584)
social network		0.0009 * (0.0005)	0.0010 * (0.0006)	0.0007 (0.0006)	0.0008 (0.0006)
Market outlook		0.8430 *** (0.2286)	0.6627 *** (0.2357)	0.7529 *** (0.2399)	0.6411 ** (0.2571)
Natural disaster shock		−0.0668 (0.0496)	−0.0760 (0.0528)	−0.0804 (0.0539)	−0.0789 (0.0589)
Regional location		YES	YES	YES	YES
_cons		−5.3421 *** (0.6899)	−4.7211 *** (0.7283)	−5.8278 *** (0.7380)	−5.1322 *** (0.8055)
Pseudo R 2		0.2580 _	0.3418 _	0.3588 _	0.4420
L R chi 2		2 13.88	283.35	297.40	366.35
Prob > chi 2		0.0000 _	0.0000 _	0.0000 _	0.0000 _
Wald value		163.21 ***	204.56 ***	196.31 ***	208.94 ***

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; the robust standard errors are in brackets.

4.1.1. Core Explanatory Variables

The estimated coefficient of risk aversion to farmers' water-saving irrigation technology adoption behaviour is negative and passed the 5% significance test. This indicates that risk aversion has a significant negative impact on farmers' water-saving irrigation technology adoption behaviour. The higher the degree of farmers' risk aversion, the less likely they are to adopt water-saving irrigation technology, because it is both knowledge-intensive and capital-intensive. For farmers, the cost and risk of adoption are high. Failure to do so will seriously affect the continuous operation of farmers' agricultural production. Therefore, when the degree of risk aversion of farmers is high, they are less willing to bear the potential risks and costs of adopting water-saving irrigation technology, so risk aversion has a significant negative impact on the adoption of water-saving irrigation technology by farmers. Based on this, Hypothesis H1 is verified.

Water irrigation technology adopts risk and costs to encourage farmers to adopt water-saving irrigation technology. In terms of technical training, the estimated coefficients of offline technical training and online technical training on the adoption behaviour of farmers' water-saving irrigation technologies were positive and passed the 1% significance test regarding the effect of offline technical training on farmers' adoption of water-saving irrigation technologies. The influence coefficient is more significant, indicating that obtaining online or offline technical training can significantly promote farmers' adoption of water-saving irrigation technology. The effect of obtaining offline technical training is relatively more substantial because technical training can save farmers' information search costs and improve their cognition level regarding water-saving irrigation technology. It also assists in alleviating the factor endowment constraints of farmers' adoption of water-saving irrigation technology, optimizing household resource allocation, and reducing energy-saving costs. In addition, compared with online technical training, the form and content of offline technical training are relatively more targeted, and the concepts, knowledge and technologies taught are easier to be understood and accepted by farmers. The positive effect of technology adoption behaviour is relatively more substantial. Therefore, Hypotheses H2 and H3 are verified.

4.1.2. Other Explanatory Variables

Among the household head characteristics, the age of the head is significant, at the 10% level, and the coefficient is positive, indicating that older farmers are more likely to adopt water-saving irrigation technology. The possible reason is that water-saving irrigation technology is a resource-saving technology. Older farmers pay more attention to resource conservation and the ecological environment than young farmers, so they tend to adopt water-saving irrigation technology. The effect of planting years on farmers' water-saving irrigation technology adoption is significant, at the 5% significance level, and the coefficient is positive, indicating that farmers with longer planting years are more likely to adopt water-saving irrigation technologies. The possible reason is that the longer the planting years, the more sufficient the agricultural production skills of farmers and the easier it is to adopt water-saving irrigation technologies. Therefore, the planting years significantly positively impact the adoption behaviour of farmers' water-saving irrigation technologies. Market prospect expectations positively impact farmers' adoption of water-saving irrigation technology at a significance level of 5%, indicating that farmers who are more optimistic about market prospects are more likely to adopt water-saving irrigation technology. This is because the more optimistic the market prospect is, the more optimistic the farmers are about adopting water-saving irrigation technology, thus encouraging farmers to adopt water-saving irrigation technology actively.

Regarding family characteristics, the impact of the planting income on farmers' adoption of water-saving irrigation technology is significant at the 1% level, and the coefficient is positive, indicating that the higher the proportion of planting income, the higher the contribution and importance of melon and fruit planting income to farmers' families. In this situation, farmers' adoption of water-saving irrigation technology can significantly improve production stability and obtain stronger income protection; planting income has a significant positive effect on farmers' adoption of water-saving irrigation technology. Participation in cooperatives has a significant positive impact on farmers' adoption of water-saving irrigation technologies at the 5% significance level, indicating that farmers participating in cooperatives are more inclined to adopt water-saving irrigation technologies. This is because the participation of cooperatives can significantly improve the degree of organization of farmers, help them obtain core agricultural information and improve the bargaining power of farmers.

Therefore, the participation of cooperatives can promote the adoption of water-saving irrigation technology by farmers. The planting scale significantly affects farmers' adoption of water-saving irrigation technology at the significance level of 1%, indicating that farmers with large planting scales are more likely to adopt water-saving irrigation technology. The possible reasons are as follows: on the one hand, the larger the planting scale, the less willing farmers are to bear the huge potential losses caused by drought and the more willing they are to adopt water-saving irrigation technology. On the other hand, the larger the planting scale, the lower the average cost of water-saving irrigation technology. Therefore, the planting scale can significantly promote farmers' adoption of water-saving irrigation technology. Land levelness has a significant positive impact on farmers' adoption of water-saving irrigation technology at a significance level of 5%, indicating that the more level the household land is, the more farmers will adopt water-saving irrigation technology. The high land level can reduce the labour and material cost of farmers' water-saving irrigation technology and encourage farmers to adopt water-saving irrigation technology actively.

Regarding external environmental characteristics, the estimated coefficient of natural disaster impact is negative but has not passed the significance test. The reason for this is that the impact of natural disasters in the study area is dominated by strong wind and hail, which will destroy water-saving irrigation facilities and inhibit farmers from adopting water-saving irrigation technology. The geographical location variable passed the significance test at the statistical level of 1%, indicating that farmers in Shaanxi Province are more inclined to adopt water-saving irrigation technology. The possible reason is that, compared with Yuncheng City in Shanxi Province, Xi'an City in Shaanxi Province has a faster economic development. The population is large and concentrated, and a better sales market encourages farmers to adopt water-saving irrigation technology.

4.2. Moderation Effect Results and Analysis

The interaction term between risk aversion and offline technical training and the interaction item between risk aversion and online technical training were added based on the benchmark model regression and the measurement to further analyse the moderating effect of technical training on risk aversion and inhibition of farmers' adoption of water-saving irrigation technology. Table 6 presents the regression results. From the estimated results of model (5) to model (7), it can be seen that the interaction term between offline technical training and risk aversion has a significant positive impact on the adoption behaviour of farmers' water-saving irrigation technology at the significance level of 1%. It indicates that offline technical training can effectively alleviate the negative effect of risk aversion on farmers' water-saving irrigation technology adoption.

Table 6. Test of the moderating effect.

Variable		Model (5)	Model (6)	Model (7)
Risk Aversion		−0.9001 *** (0.2187)	−1.8028 *** (0.4426)	−2.3222 *** (0.5555)
Technical Training	Offline technical training	0.4711 ** (0.2381)		0.6019 ** (0.2495)
	Online technical training		0.4754 ** (0.2111)	0.5761 *** (0.2209)
interaction term	Risk avoidance × offline technical training	1.7565 *** (0.4042)		1.5437 *** (0.4712)
	Risk Avoidance × Online Technical Training		1.9048 *** (0.4859)	1.8018 *** (0.5763)
control variable		YES	YES	YES
Constant term		YES	YES	YES
Pseudo R 2		0.3720	0.3876	0.4702
L R chi 2		308.32	321.32	389.75
Prob > chi 2		0.0000	0.0000	0.0000
Wald value		2 02.87 ***	1 67.81 ***	1 70.83 ***

Note: ** $p < 0.05$, *** $p < 0.01$; the robust standard errors are in brackets.

The interaction term between online technical training and risk aversion has a significant positive impact on the adoption behaviour of farmers' water-saving irrigation technologies at the 1% significance level, indicating that online technical training can also effectively alleviate the impact of risk aversion on farmers' adoption of water-saving irrigation technologies. As the two primary components of technical training, whether offline or online, it can quickly and effectively transmit relevant technical knowledge and information on water-saving irrigation technology to reduce the degree of information asymmetry in farmers' water-saving irrigation. It can also reduce farmers' relative knowledge deprivation about the uncertainty and risk of the water-saving irrigation technology adoption process, thereby increasing the possibility of farmers adopting water-saving irrigation technology. At the same time, technical training can improve farmers' agricultural production resource and risk management levels and optimize family income. Finally, the allocation of agricultural production resources increases farmers' water-saving irrigation technology adoption rate. Therefore, Hypothesis H4 is verified.

4.3. Robustness Test

The method of replacing the core model is used for verification to test the robustness of the baseline regression results and the moderation effect. In this study, model (8) and model (9) were used for regression in the binary Logit model, and the results are shown in Table 7. It can be seen that risk aversion has a negative impact on farmers' water-saving irrigation technology adoption behaviour 5% level of significance. Offline and online technical training and their interaction items significantly impact farmers' water-saving irrigation technology. A positive impact was that the estimated results are consistent with the regression results of the binary Probit model, in terms of significance and impact direction, proving that the regression and the moderating effect test are relatively robust.

Table 7. Robustness test of the regression results.

Variable Name		Model (8)	Model (9)
Risk Aversion		−0.8157 ** (0.3473)	−4.2843 *** (1.0080)
Technical Training	Offline technical training	2.2113 *** (0.2913)	0.9965 ** (0.4366)
	Online technical training	2.1584 *** (0.2753)	0.9648 ** (0.3894)
interaction term	Risk avoidance × offline technical training		2.7235 *** (0.8510)
	Risk Avoidance × Online Technical Training		3.4010 *** (1.0389)
Age of Head of household		0.0354 ** (0.0177)	0.0325 * (0.0178)
Head of the household education level		0.0614 (0.0497)	0.0492 (0.0500)
Family Planting Years		−0.0313 ** (0.0135)	−0.0296 ** (0.0135)
The proportion of planting income		2.2535 *** (0.5699)	2.2300 *** (0.5781)
Planting scale		0.5895 *** (0.2145)	0.5475 ** (0.2175)
Land levelness		0.3590 ** (0.1671)	0.3794 ** (0.1700)
Number of migrant workers		0.0423 (0.1635)	0.0573 (0.1678)
Cooperative participation		0.6242 ** (0.2852)	0.6281 ** (0.2895)
Social network		0.0014 (0.0011)	0.0015 (0.0011)
Market outlook		1.2104 ** (0.4743)	1.2056 ** (0.4811)
Natural disaster shock		−0.1559 (0.1040)	−0.1597 (0.1082)
Regional location		YES	YES
_cons		−9.3351 *** (1.4979)	−7.9467 *** (1.5166)
Pseudo R 2		0.4414	0.4691 _
L R chi 2		365.92	388.82
Prob > chi 2		0.0000	0.0000 _

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; the robust standard errors are in brackets.

5. Further Socio-Demographics

Differential analysis was carried out on the age, education level, and planting scales to further clarify the mechanism of risk aversion and technical training on farmers' water-saving irrigation technology adoption. The main reason for considering these three aspects is that age and years of education can reflect farmers' views and understanding of new technologies to a certain extent. Farmers of different age groups and educational levels will have specific differences in their risk aversion and information acquisition capabilities, so the influence of risk aversion and technical training on the adoption behaviour of water-saving irrigation technology of farmers of different ages and educational levels may be different. The planting scale represents the endowment of land resources of farmers, and the more land resources there are, the stronger farmers' dependence on the land. Similarly, risk aversion and technical training may have differential effects on farmers with different planting scales' adoption behaviour of water-saving irrigation technology. The specific results are shown in Table 8.

Table 8. Regression results of the impact of risk aversion and technical training on different types of farmers' adoption of water-saving irrigation technology.

Variable Name		Age		Education Level		Business Scale	
		50 and under	Over 50 years old	9 years and below	Over 9 years	0.667 hectare and below	More than 0.667 hectare
Risk Aversion		−2.0699 *** (0.6037)	−6.0150 ** (3.0233)	−6.7048 ** (2.9787)	−1.7876 *** (0.5767)	−3.6654 ** (1.4970)	−1.9302 *** (0.6515)
Technical Training	Offline technical training	0.6411 ** (0.2796)	0.5380 (0.7399)	1.1508 ** (0.5015)	0.3616 (0.3156)	0.7269 (0.6421)	0.6748 ** (0.2932)
	Online technical training	0.7524 *** (0.2555)	0.7124 (0.6516)	0.5691 (0.4850)	0.6632 ** (0.2699)	0.5044 (0.4832)	0.7391 *** (0.2693)
Interaction term	Risk avoidance × offline technical training	1.5630 *** (0.5168)	2.5312 (1.8631)	1.1955 (1.0048)	1.8408 *** (0.5711)	0.9511 (1.2405)	1.6222 *** (0.5613)
	Risk Avoidance × Online Technical Training	1.3315 ** (0.6287)	5.6601 * (3.0643)	6.3843 ** (2.9987)	1.0701 * (0.6268)	2.4685 (1.5404)	1.5155 ** (0.6699)
Control variable		YES	YES	YES	YES	YES	YES
Constant term		YES	YES	YES	YES	YES	YES
Pseudo R 2		0.4757	0.6198	0.5542	0.4745	0.3349	0.5207
L R chi 2		323.36	91.64	159.50	255.07	52.50	330.67
Prob > chi 2		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; the robust standard errors are in brackets.

5.1. The Influence of Risk Aversion and Technical Training on the Adoption Behaviour of Farmers' Water-Saving Irrigation Technology under the Age Difference

It can be seen from Table 8 that risk aversion has a significant negative effect on the adoption of water-saving irrigation technology by farmers of different age groups. The absolute value of the coefficient of the group over 50 years old is greater than that of the group under 50 years old, indicating that risk aversion significantly impacts farmers' adoption of water-saving irrigation technology. The inhibitory effect of technology adoption behaviour increases with the age of farmers. This is because, with increasing age, farmers are more cautious about investment in agricultural production, avoid investment risks and adopt prudent management strategies to obtain a safer investment return to stabilize their livelihoods. Therefore, as age increases, the inhibitory effect of risk aversion on farmers' water-saving irrigation technology adoption becomes stronger.

In technical training, both online and offline technical training have a positive impact on the adoption of water-saving irrigation technology by farmers of different age groups, and only the coefficient of the group aged 50 and below passed the significance test, indicating that technical training has a positive effect on the adoption of water-saving irrigation technology of farmers aged 50 and below. This is because, on the one hand, farmers aged 50 and below are less dependent on traditional technologies and have more channels to acquire new agricultural technologies, which are more modern. It is easy to break the path dependence of technology diffusion and obtain water-saving irrigation technologies at the minimum cost. Information prompts farmers to adopt water-saving irrigation technology; on the other hand, farmers aged 50 and below are more adventurous and innovative and are more willing to take risks and adopt water-saving irrigation technology with innovative attributes; therefore, as age increases, the promotion effect of technical training on the adoption of water-saving irrigation technology by farmers is gradually weakened. The interaction term of risk aversion and offline technical training positively impact the adoption behaviour of water-saving irrigation technology for farmers in different age groups, and only the group aged 50 and below passed the significance test, indicating the interaction between risk aversion and offline technical training. The item has a stronger effect on promoting the adoption of water-saving irrigation technology by farmers aged 50 and below. The interaction term of risk aversion and online technical training has a significant positive impact on the adoption behaviour of water-saving irrigation technology by farmers in different age groups. The absolute value of the coefficient of the group over 50 years old is greater than the absolute value of the coefficient of the group under 50 years old, indicating that, regarding risk aversion, compared with online technical training, the effect of promoting the adoption of water-saving irrigation technology by farmers aged 50 and below is stronger.

5.2. The Impact of Risk Aversion and Technical Training on the Adoption Behaviour of Farmers' Water-Saving Irrigation Technology under the Difference of Educational Level

It can be seen in Table 8 that risk aversion has a negative and significant effect on the water-saving irrigation technology adoption behaviour of farmers with different educational levels, and the absolute value of the coefficient of the group with an education level of 9 years or less is greater than the absolute value of the group with an education level of 9 years or more. This indicates that risk aversion positively affects the inhibitory effect of irrigation technology adoption weakens with farmers' educational level improvement. Farmers' cognitive ability and cognitive level are significantly improved with the increase in education level. They can more objectively evaluate technical risks and personal technical capabilities and reduce unnecessary worries and concerns in adopting water-saving irrigation technologies. The higher the degree, the weaker the inhibitory effect of risk aversion on farmers' adoption of water-saving irrigation technology. In technical training, offline technical training has a positive impact on the adoption of water-saving irrigation technology by farmers with different levels of education, and only the coefficient of the group of 9 years of education and below passed the significance test, indicating that offline technical training has a positive impact on the adoption of water-saving irrigation technology by farmers in the group of 9 years of education and below. The promotion effect of water-saving irrigation technology adoption is relatively substantial. Online technical training positively impacts the adoption of water-saving irrigation technology by farmers with different educational levels, and only the coefficient of the group of more than 9 years of education passed the significance test. This indicates that the promotion effect on the adoption of water-saving irrigation technology by farmers in the group is relatively more robust.

The study also found that a higher education level significantly enhances farmers' preferences and dependence on technical training. More specifically, the farmers with 9 years of education and below depend more on specific, visual, and face-to-face offline training, while those with more than 9 years of education depend more on multiple forms and content. The interaction term of risk aversion and offline technical training positively impacted the adoption of water-saving irrigation technology by farmers with different educational levels, and only the group with more than 9 years of education passed the significance test. This indicates that the interaction term of risk aversion and offline technical training positively impacts the promotion effect of the water-saving irrigation technology adoption behaviour of farmers in the group (group B). Interestingly, the interaction term of risk aversion and online technical training has a significant positive impact within group A (9 years of education or less). The absolute value of the coefficient of group A is more significant than Group B, indicating that the relationship between risk aversion and online technical training has a more substantial effect on promoting the adoption of water-saving irrigation technology by farmers in group A.

5.3. The Impact of Risk Aversion and Technical Training on the Adoption Behaviour of Farmers' Water-Saving Irrigation Technology under the Difference of Planting Scale

It can be seen from Table 8 that risk aversion has a significant negative effect on the adoption of water-saving irrigation technology by farmers with different planting scales. The absolute coefficient value of group A is greater than that of group B, indicating that the inhibitory effect of technology adoption weakens with farmers' planting scale expansion. The possible reason for this is that farmers' management ability, technical cognition level and management confidence have significantly improved with the increase in planting scale. They can objectively evaluate technical risks and reduce unnecessary worries and concerns while adopting water-saving irrigation technologies. Therefore, the larger the scale, the weaker the inhibitory effect of risk aversion on farmers' adoption of water-saving irrigation technology. Both offline and online technical training positively affects farmers' adoption of water-saving irrigation technology with different planting scales. The promotion effect of adopting water-saving irrigation technology by farmers in the above group is relatively more substantial. With the expansion of planting scale, the average cost of technology adoption by farmers is decreasing, and the economies of scale in adopting water-saving irrigation technologies are gradually emerging. Therefore, the impact of offline and online technical training on the adoption behaviour of farmers' water-saving irrigation technology is gradually increasing if the planting scale is expanded and increased.

6. Conclusions

Based on the empirical data of 707 watermelon and muskmelon farmers in Shanxi and Shaanxi provinces, this study analyses the effects of risk aversion, technical training (online and offline) and their interaction on farmers' water-saving technology adoption behaviour. We further conducted a robustness test and provide an in-depth comparison between the two forms of technical training. Based on the findings, the following conclusions were made: (i) The impact of risk aversion on farmers' adoption of water-saving irrigation technology is significant at the 5% statistical level, and the estimated coefficient is positive. The estimated coefficients of offline and online technical training are positive and significant at the 1% statistical level. (ii) Offline and online technical training have a positive regulatory effect between risk aversion and farmers' water-saving irrigation technology adoption behaviour, which can alleviate the inhibitory effect of risk aversion on water-saving irrigation technology adoption behaviour. (iii) The effects of risk aversion, technical training and interaction items on farmers' water-saving irrigation technology adoption behaviours have noticeable inter-group differences regarding age, education level and planting scale.

Based on the above conclusions, the following specific policy recommendations are drawn: (i) Alleviate farmers' degree of risk aversion and actively promote farmers to adopt water-saving irrigation technology: In this notion, the interaction of various risk-sharing networks and organizations should be strengthened. (ii) The government should facilitate innovative water-saving irrigation technology with easy conditions and relatively lower costs. Moreover, financial and technical support should also be strengthened. Optimize the agricultural technology training system and improve farmers' ability to acquire and apply technical information. (iii) Agricultural technology demonstration bodies and extension offices should act more responsibly to disseminate up-to-date knowledge and technical know-how by implementing "learning by seeing" and "learning by doing" prospectives. (iv) Awareness-building campaigns and technical dissemination platforms should be strengthened to enhance the farmers' cognitive level. A well-structured "water-saving irrigation model" should be established at the national level to effectively guide farmers to confidently use the water-saving irrigation technology and alleviate farmers' negative concerns about the risks of adopting water-saving irrigation technology. (v) Private and public partnerships and agricultural cooperatives should also be more responsible and enhance the social promotion system. Increase investment in agricultural offline technical training, optimize the content of water-saving irrigation technology-related training and expand the coverage of water-saving irrigation technology-related training. (vi) Moreover, farmers should be guided to use modern agricultural digital media such as websites and mobile apps to receive online technical training and improve their ability to obtain technical information. This has great potential to provide farmers with timely information on water-saving irrigation technologies. Innovate the form of agricultural technology training, combine online and offline technical training, actively expand the channels for farmers to receive technical training, provide farmers with more credible and more innovative training methods and improve the effectiveness of technical training. (vii) Implement differentiated guidance methods to meet the needs of different types of farmers. Different types of farmers have different objectives in pursuit of agricultural production management, so they also have different focus points in adopting water-saving irrigation technology. Therefore, training methods with different emphases can be adopted according to different types of farmers.

This study has some limitations. First, using cross-sectional data, this paper cannot analyse the dynamic impact of risk aversion and technical training on farmers' water-saving irrigation technology adoption behaviour. Second, this article only considers water-saving irrigation technology in agricultural resource conservation technology. Further research is needed to evaluate the impact of risk avoidance and technical training on farmers' adoption behaviour of different types of resource conservation technologies. Finally, for farmers, the cost of technology adoption is one of the critical factors affecting the adoption behaviour of water-saving irrigation technology. This article considered the possibility of potential measurement errors and did not include them in the model analysis. Whether this impacts the estimation results of this article still needs further testing.

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References

1. Chai, Q.; Gan, Y.; Turner, N.C.; Zhang, R.-Z.; Yang, C.; Niu, Y.; Siddique, K.H.M. Chapter Two—Water-Saving Innovations in Chinese Agriculture. In *Advances in Agronomy*; Sparks, D.L., Ed.; Academic Press: Cambridge, MA, USA, 2014; Volume 126, pp. 149–201.
2. Wang, H.; Huang, J.; Zhou, H.; Deng, C.; Fang, C. Analysis of Sustainable Utilization of Water Resources Based on the Improved Water Resources Ecological Footprint Model: A Case Study of Hubei Province, China. *J. Environ. Manag.* **2020**, *262*, 110331. [CrossRef] [PubMed]

3. Wang, H.X.; Liu, C.M.; Zhang, L. Water-Saving Agriculture in China: An Overview. In *Advances in Agronomy*; Sparks, D.L., Ed.; Elsevier Academic Press Inc.: San Diego, CA, USA, 2002; Volume 75, pp. 135–171, ISBN 978-0-12-000793-6.
4. Xinchun, C.; Mengyang, W.; Xiangping, G.; Yalian, Z.; Yan, G.; Nan, W.; Weiguang, W. Assessing Water Scarcity in Agricultural Production System Based on the Generalized Water Resources and Water Footprint Framework. *Sci. Total Environ.* **2017**, *609*, 587–597. [CrossRef] [PubMed]
5. Zhang, C.; Zhong, L.; Fu, X.; Zhao, Z. Managing Scarce Water Resources in China's Coal Power Industry. *Environ. Manag.* **2016**, *57*, 1188–1203. [CrossRef] [PubMed]
6. Heilig, G.K.; Fischer, G.; van Velthuizen, H. Can China Feed Itself? *Int. J. Sustain. Dev. World Ecol.* **2000**, *7*, 153–172. [CrossRef]
7. Meng, X.; Wu, L. Prediction of per Capita Water Consumption for 31 Regions in China. *Environ. Sci. Pollut. Res.* **2021**, *28*, 29253–29264. [CrossRef] [PubMed]
8. Shi, R.; Wang, G.; Zhang, X.; Xu, Y.; Wu, Y.; Wu, W. Determination of the Effective Utilization Coefficient of Irrigation Water Based on Geographically Weighted Regression. *Front. Earth Sci.* **2022**, *16*, 401–410. [CrossRef]
9. Zhang, J.; Guan, K.; Peng, B.; Pan, M.; Zhou, W.; Jiang, C.; Kimm, H.; Franz, T.E.; Grant, R.F.; Yang, Y.; et al. Sustainable Irrigation Based on Co-Regulation of Soil Water Supply and Atmospheric Evaporative Demand. *Nat. Commun.* **2021**, *12*, 5549. [CrossRef]
10. Lu, W.; Sarkar, A.; Hou, M.; Liu, W.; Guo, X.; Zhao, K.; Zhao, M. The Impacts of Urbanization to Improve Agriculture Water Use Efficiency—An Empirical Analysis Based on Spatial Perspective of Panel Data of 30 Provinces of China. *Land* **2022**, *11*, 80. [CrossRef]
11. Burnham, M.; Ma, Z.; Zhu, D. The Human Dimensions of Water Saving Irrigation: Lessons Learned from Chinese Smallholder Farmers. *Agric. Hum. Values* **2015**, *32*, 347–360. [CrossRef]
12. Larson, N.; Sekhri, S.; Sidhu, R. Adoption of Water-Saving Technology in Agriculture: The Case of Laser Levelers. *Water Resour. Econ.* **2016**, *14*, 44–64. [CrossRef]
13. Zhang, B.; Fu, Z.; Wang, J.; Zhang, L. Farmers' Adoption of Water-Saving Irrigation Technology Alleviates Water Scarcity in Metropolis Suburbs: A Case Study of Beijing, China. *Agric. Water Manag.* **2019**, *212*, 349–357. [CrossRef]
14. Yang, G.; Gong, G.; Gui, Q. Exploring the Spatial Network Structure of Agricultural Water Use Efficiency in China: A Social Network Perspective. *Sustainability* **2022**, *14*, 2668. [CrossRef]
15. Xu, Y.; Ge, J.; Tian, S.; Li, S.; Nguy-Robertson, A.L.; Zhan, M.; Cao, C. Effects of Water-Saving Irrigation Practices and Drought Resistant Rice Variety on Greenhouse Gas Emissions from a No-till Paddy in the Central Lowlands of China. *Sci. Total Environ.* **2015**, *505*, 1043–1052. [CrossRef]
16. Yuan, S.; Linquist, B.A.; Wilson, L.T.; Cassman, K.G.; Stuart, A.M.; Pede, V.; Miro, B.; Saito, K.; Agustiani, N.; Aristya, V.E.; et al. Sustainable Intensification for a Larger Global Rice Bowl. *Nat. Commun.* **2021**, *12*, 7163. [CrossRef]
17. Biagini, B.; Kuhl, L.; Gallagher, K.S.; Ortiz, C. Technology Transfer for Adaptation. *Nat. Clim. Chang.* **2014**, *4*, 828–834. [CrossRef]
18. Xu, Z.; Chen, X.; Liu, J.; Zhang, Y.; Chau, S.; Bhattarai, N.; Wang, Y.; Li, Y.; Connor, T.; Li, Y. Impacts of Irrigated Agriculture on Food–Energy–Water–CO2 Nexus across Metacoupled Systems. *Nat. Commun.* **2020**, *11*, 5837. [CrossRef]
19. Mushtaq, S.; Khan, S.; Hafeez, M.; Hanjra, M.A. Does Reliability of Water Resources Matter in the Adoption of Water-Saving Irrigation Practices? A Case Study in the Zhanghe Irrigation System, China. *Water Policy* **2009**, *11*, 661–679. [CrossRef]
20. Yuan, K.; Yang, Z.; Wang, S. Water Scarcity and Adoption of Water-Saving Irrigation Technologies in Groundwater over-Exploited Areas in the North China Plain. *Irrig. Sci.* **2021**, *39*, 397–408. [CrossRef]
21. Lampayan, R.M.; Rejesus, R.M.; Singleton, G.R.; Bouman, B.A.M. Adoption and Economics of Alternate Wetting and Drying Water Management for Irrigated Lowland Rice. *Field Crops Res.* **2015**, *170*, 95–108. [CrossRef]
22. Tang, J.; Folmer, H.; Xue, J. Adoption of Farm-Based Irrigation Water-Saving Techniques in the Guanzhong Plain, China. *Agric. Econ.* **2016**, *47*, 445–455. [CrossRef]
23. Yamaguchi, T.; Tuan, L.M.; Minamikawa, K.; Yokoyama, S. Assessment of the Relationship between Adoption of a Knowledge-Intensive Water-Saving Technique and Irrigation Conditions in the Mekong Delta of Vietnam. *Agric. Water Manag.* **2019**, *212*, 162–171. [CrossRef]
24. Cui, M.; Zhang, J.; Xia, X. The Relationship between Child Rearing Burden and Farmers' Adoption of Climate Adaptive Technology: Taking Water-Saving Irrigation Technology as an Example. *Agriculture* **2022**, *12*, 854. [CrossRef]
25. Grové, B.; Nel, F.; Maluleke, H.H. Stochastic Efficiency Analysis of Alternative Water Conservation Strategies. *Agrekon* **2006**, *45*, 50–59. [CrossRef]
26. Hu, L.; Channa, A.; Liu, X.; Lakhan, G.R.; Meraj, M.; Lu, Q.; Wang, Q. Risk Characteristics, Government Subsidies and Farmers' Willingness to Adopt Water-Saving Irrigation Techniques. *Irrig. Drain.* **2022**, *71*, 255–267. [CrossRef]
27. Adere, T.H.; Mertens, K.; Maertens, M.; Vranken, L. The Impact of Land Certification and Risk Preferences on Investment in Soil and Water Conservation: Evidence from Southern Ethiopia. *Land Use Policy* **2022**, *123*, 106406. [CrossRef]
28. Wang, G.; Lu, Q.; Capareda, S.C. Social Network and Extension Service in Farmers' Agricultural Technology Adoption Efficiency. *PLoS ONE* **2020**, *15*, e0235927. [CrossRef]
29. Genius, M.; Koundouri, P.; Nauges, C.; Tzouvelekas, V. Information Transmission in Irrigation Technology Adoption and Diffusion: Social Learning, Extension Services, and Spatial Effects. *Am. J. Agric. Econ.* **2014**, *96*, 328–344. [CrossRef]
30. Darouich, H.; Gonçalves, J.M.; Muga, A.; Pereira, L.S. Water Saving vs. Farm Economics in Cotton Surface Irrigation: An Application of Multicriteria Analysis. *Agric. Water Manag.* **2012**, *115*, 223–231. [CrossRef]

31. Uddin, M.d.T.; Dhar, A.R. Assessing the Impact of Water-Saving Technologies on Boro Rice Farming in Bangladesh: Economic and Environmental Perspective. *Irrig. Sci.* **2020**, *38*, 199–212. [CrossRef]
32. Chen, Z.; Sarkar, A.; Rahman, A.; Li, X.; Xia, X. Exploring the Drivers of Green Agricultural Development (GAD) in China: A Spatial Association Network Structure Approaches. *Land Use Policy* **2021**, *112*, 105827. [CrossRef]
33. Sarkar, A.; Wang, H.; Rahman, A.; Qian, L.; Memon, W.H. Evaluating the Roles of the Farmer's Cooperative for Fostering Environmentally Friendly Production Technologies-a Case of Kiwi-Fruit Farmers in Meixian, China. *J. Environ. Manag.* **2022**, *301*, 113858. [CrossRef]
34. Wang, J.; Liu, L.; Zhao, K.; Wen, Q. Farmers' Adoption Intentions of Water-Saving Agriculture under the Risks of Frequent Irrigation-Induced Landslides. *Clim. Risk Manag.* **2023**, *39*, 100484. [CrossRef]
35. Li, M.; Sarkar, A.; Wang, Y.; Khairul Hasan, A.; Meng, Q. Evaluating the Impact of Ecological Property Rights to Trigger Farmers' Investment Behavior—An Example of Confluence Area of Heihe Reservoir, Shaanxi, China. *Land* **2022**, *11*, 320. [CrossRef]
36. Zhou, S.; Herzfeld, T.; Glauben, T.; Zhang, Y.; Hu, B. Factors Affecting Chinese Farmers' Decisions to Adopt a Water-Saving Technology. *Can. J. Agric. Econ./Rev. Can. D'agroeconomie* **2008**, *56*, 51–61. [CrossRef]
37. Mooney, D.F.; Hoag, D.L.K.; Rasul, Z.I.; Gao, S. More Risk, More Money: When Are Payments for Water Savings from Limited Irrigation Profitable for Farmers? *Water Resour. Econ.* **2022**, *40*, 100212. [CrossRef]
38. Ojo, T.O.; Baiyegunhi, L.J.S.; Adetoro, A.A.; Ogundeji, A.A. Adoption of Soil and Water Conservation Technology and Its Effect on the Productivity of Smallholder Rice Farmers in Southwest Nigeria. *Heliyon* **2021**, *7*, e06433. [CrossRef]
39. Lybbert, T.J.; Sumner, D.A. Agricultural Technologies for Climate Change in Developing Countries: Policy Options for Innovation and Technology Diffusion. *Food Policy* **2012**, *37*, 114–123. [CrossRef]
40. Koundouri, P.; Nauges, C.; Tzouvelekas, V. Technology Adoption under Production Uncertainty: Theory and Application to Irrigation Technology. *Am. J. Agric. Econ.* **2006**, *88*, 657–670. [CrossRef]
41. Pino, G.; Toma, P.; Rizzo, C.; Miglietta, P.P.; Peluso, A.M.; Guido, G. Determinants of Farmers' Intention to Adopt Water Saving Measures: Evidence from Italy. *Sustainability* **2017**, *9*, 77. [CrossRef]
42. Mi, Q.; Li, X.; Li, X.; Yu, G.; Gao, J. Cotton Farmers' Adaptation to Arid Climates: Waiting Times to Adopt Water-Saving Technology. *Agric. Water Manag.* **2021**, *244*, 106596. [CrossRef]
43. Wang, F.; Yu, C.; Xiong, L.; Chang, Y. How Can Agricultural Water Use Efficiency Be Promoted in China? A Spatial-Temporal Analysis. *Resour. Conserv. Recycl.* **2019**, *145*, 411–418. [CrossRef]
44. Tian, Z.; Fan, Y.; Wang, K.; Zhong, H.; Sun, L.; Fan, D.; Tubiello, F.N.; Liu, J. Searching for "Win-Win" Solutions for Food-Water-GHG Emissions Tradeoffs across Irrigation Regimes of Paddy Rice in China. *Resour. Conserv. Recycl.* **2021**, *166*, 105360. [CrossRef]
45. Yang, Q.; Zhu, Y.; Wang, J. Adoption of Drip Fertigation System and Technical Efficiency of Cherry Tomato Farmers in Southern China. *J. Clean. Prod.* **2020**, *275*, 123980. [CrossRef]
46. Bakhshi, A.; Cecchini, L.; Ghanian, M.; Pour, B.K.; Santucci, F.M. Sustainable Irrigation Management and Farmers' Knowledge in South Khorasan, Iran. *Int. J. Sustain. Soc.* **2019**, *11*, 318–335. [CrossRef]
47. Wang, L.; Zhao, Y. Will Social Network Relationship Significantly Enhance Farmers' Participation in the Supply of Small Water-Saving Irrigation and Water Conservancy Facilities in China? *Agriculture* **2023**, *13*, 216. [CrossRef]
48. Lang, X.; JinJin, L. Influencing factors of farmers choice behaviour for water-saving irrigation techniques. *China Rural Surv.* **2013**, *2*, 45–51.
49. Biggs, S.D. A Multiple Source of Innovation Model of Agricultural Research and Technology Promotion. *World Dev.* **1990**, *18*, 1481–1499. [CrossRef]
50. Cañadas, M.; Ibáñez, J.S.; Leite, N. A Novice Coach's Planning of the Technical and Tactical Content of Youth Basketball Training: A Case Study. *Int. J. Perform. Anal. Sport* **2015**, *15*, 572–587. [CrossRef]
51. Gao, Y.; Zhao, D.; Yu, L.; Yang, H. Influence of a New Agricultural Technology Extension Mode on Farmers' Technology Adoption Behavior in China. *J. Rural Stud.* **2020**, *76*, 173–183. [CrossRef]
52. Bhan, S.; Behera, U.K. Conservation Agriculture in India—Problems, Prospects and Policy Issues. *Int. Soil Water Conserv. Res.* **2014**, *2*, 1–12. [CrossRef]
53. Dai, X.; Chen, J.; Chen, D.; Han, Y. Factors Affecting Adoption of Agricultural Water-Saving Technologies in Heilongjiang Province, China. *Water Policy* **2015**, *17*, 581–594. [CrossRef]
54. Kassam, A.; Derpsch, R.; Friedrich, T. Global Achievements in Soil and Water Conservation: The Case of Conservation Agriculture. *Int. Soil Water Conserv. Res.* **2014**, *2*, 5–13. [CrossRef]
55. Valizadeh, N.; Bijani, M.; Abbasi, E. Farmers Active Participation in Water Conservation: Insights from a Survey among Farmers in Southern Regions of West Azerbaijan Province, Iran. *J. Agric. Sci. Technol.* **2018**, *20*, 895–910.
56. Ramírez, O.A.; Ward, F.A.; Al-Tabini, R.; Phillips, R. Efficient Water Conservation in Agriculture for Growing Urban Water Demands in Jordan. *Water Policy* **2011**, *13*, 102–124. [CrossRef]
57. Knox, J.W.; Kay, M.G.; Weatherhead, E.K. Water Regulation, Crop Production, and Agricultural Water Management—Understanding Farmer Perspectives on Irrigation Efficiency. *Agric. Water Manag.* **2012**, *108*, 3–8. [CrossRef]

58. Sun, L.; Yang, Y.; Hu, J.; Porter, D.; Marek, T.; Hillyer, C. Reinforcement Learning Control for Water-Efficient Agricultural Irrigation. In Proceedings of the 2017 IEEE International Symposium on Parallel and Distributed Processing with Applications and 2017 IEEE International Conference on Ubiquitous Computing and Communications (ISPA/IUCC), Guangzhou, China, 12–15 December 2017; pp. 1334–1341.
59. Lynne, G.D.; Franklin Casey, C.; Hodges, A.; Rahmani, M. Conservation Technology Adoption Decisions and the Theory of Planned Behavior. *J. Econ. Psychol.* **1995**, *16*, 581–598. [CrossRef]
60. Ngwira, A.; Johnsen, F.H.; Aune, J.B.; Mekuria, M.; Thierfelder, C. Adoption and Extent of Conservation Agriculture Practices among Smallholder Farmers in Malawi. *J. Soil Water Conserv.* **2014**, *69*, 107–119. [CrossRef]
61. Lu, C.; Ji, W.; Hou, M.; Ma, T.; Mao, J. Evaluation of Efficiency and Resilience of Agricultural Water Resources System in the Yellow River Basin, China. *Agric. Water Manag.* **2022**, *266*, 107605. [CrossRef]
62. Sharma, B.C.; Kumar, R.; Slathia, P.S.; Puniya, R.; Vaid, A. Evaluation of Refresher Training Programme on Conservation Agriculture Practices. *Indian J. Ext. Educ.* **2022**, *58*, 49–52. [CrossRef]
63. Selim, T.; Eltarabily, M.G. Impact of COVID-19 Lockdown on Small-Scale Farming in Northeastern Nile Delta of Egypt and Learned Lessons for Water Conservation Potentials. *Ain Shams Eng. J.* **2022**, *13*, 101649. [CrossRef]
64. Zheng, Y.; Zhu, T.; Jia, W. Does Internet Use Promote the Adoption of Agricultural Technology? Evidence from 1 449 Farm Households in 14 Chinese Provinces. *J. Integr. Agric.* **2022**, *21*, 282–292. [CrossRef]
65. Enkvetchakul, P.; Surinta, O. Effective Data Augmentation and Training Techniques for Improving Deep Learning in Plant Leaf Disease Recognition. *Appl. Sci. Eng. Prog.* **2022**, *15*, 3810. [CrossRef]
66. Zhu, X.; Xiang, C.; Wang, M.; Luo, Z.; Xiang, X.; Li, H. Research on Business Model Construction and Innovation of Smartphone Training for Farmers in Rural Areas. In Proceedings of the Fifth International Conference on Economic and Business Management (FEBM 2020), Online, 10–17 October 2020; Atlantis Press: Amsterdam, The Netherlands, 2020; pp. 176–184.
67. Van Mele, P.; Okry, F.; Wanvoeke, J.; Fousseni Barres, N.; Malone, P.; Rodgers, J.; Rahman, E.; Salahuddin, A. Quality Farmer Training Videos to Support South–South Learning. *CSIT* **2018**, *6*, 245–255. [CrossRef]
68. Eitzinger, A.; Binder, C.R.; Meyer, M.A. Risk Perception and Decision-Making: Do Farmers Consider Risks from Climate Change? *Clim. Chang.* **2018**, *151*, 507–524. [CrossRef]
69. Sabbagh, M.; Gutierrez, L. Micro-Irrigation Technology Adoption in the Bekaa Valley of Lebanon: A Behavioural Model. *Sustainability* **2022**, *14*, 7685. [CrossRef]
70. Senapati, AK Evaluation of Risk Preferences and Coping Strategies to Manage with Various Agricultural Risks: Evidence from India. *Heliyon* **2020**, *6*, e03503. [CrossRef]
71. Zeweld, W.; Van Huylenbroeck, G.; Tesfay, G.; Speelman, S. Impacts of Socio-Psychological Factors on Smallholder Farmers' Risk Attitudes: Empirical Evidence and Implications. *Agrekon* **2019**, *58*, 253–279. [CrossRef]
72. Neisi, M.; Bijani, M.; Abbasi, E.; Mahmoudi, H.; Azadi, H. Analyzing Farmers' Drought Risk Management Behavior: Evidence from Iran. *J. Hydrol.* **2020**, *590*, 125243. [CrossRef]
73. Bagheri, A.; Emami, N.; Damalas, C.A. Farmers' Behavior towards Safe Pesticide Handling: An Analysis with the Theory of Planned Behavior. *Sci. Total Environ.* **2021**, *751*, 141709. [CrossRef]
74. Mariano, M.J.; Villano, R.; Fleming, E. Factors Influencing Farmers' Adoption of Modern Rice Technologies and Good Management Practices in the Philippines. *Agric. Syst.* **2012**, *110*, 41–53. [CrossRef]
75. Lamm, A.J.; Warner, L.A.; Martin, E.T.; White, S.A.; Fisher, P. Enhancing Extension Programs by Discussing Water Conservation Technology Adoption with Growers. *J. Agric. Educ.* **2017**, *58*, 251–266. [CrossRef]
76. Jha, S.; Kaechele, H.; Sieber, S. Factors Influencing the Adoption of Water Conservation Technologies by Smallholder Farmer Households in Tanzania. *Water* **2019**, *11*, 2640. [CrossRef]
77. Hoang-Thi, H.; Fahad, S.; Ahmad Shah, A.; Nguyen-Huu-Minh, T.; Nguyen-Anh, T.; Nguyen-Van, S.; To-The, N.; Nguyen-Thi-Lan, H. Evaluating the Farmers' Adoption Behavior of Water Conservation in Mountainous Region Vietnam: Extrinsic and Intrinsic Determinants. *Nat. Hazards* **2023**, *115*, 1313–1330. [CrossRef]
78. Podsakoff, P.M.; MacKenzie, S.B.; Podsakoff, N.P. Sources of Method Bias in Social Science Research and Recommendations on How to Control It. *Annu. Rev. Psychol.* **2012**, *63*, 539–569. [CrossRef]
79. Ho, T.Q.; Hoang, V.-N.; Wilson, C. Sustainability Certification and Water Efficiency in Coffee Farming: The Role of Irrigation Technologies. *Resour. Conserv. Recycl.* **2022**, *180*, 106175. [CrossRef]
80. Qiu, H.G.; Su, L.; Zhang, Y.; Tang, J. Risk Preference, Risk Perception and Farmers' Adoption of Conservation Tillage. *Chin. Rural Econ.* **2020**, *7*, 59–79.
81. Xu, L.; Jin, W.; Chen, K. Risk Preference, Information Acquisition and Pig-Breeding Pollution Exposure Behaviors: An Empirical Analysis Based on 1489 Pig Breeders Survey Data. *China Rural Obs.* **2020**, *4*, 129–144.
82. Wen, Z.L.; Hou, J.T.; Zhang, L. Comparison and Application of Moderating Effect and Mediating Effect. *Acta Psychol. Sin.* **2005**, *37*, 268–274.