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Evaluating the Impact of Ecological Property Rights to Trigger Farmers' Investment Behavior—An Example of Confluence Area of Heihe Reservoir, Shaanxi, China

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Abstract: Property rights of natural resources have been acting as a critical legislative tool for promoting sustainable resource utilization and conservation in various regions of the globe. However, incorporating ecological property rights into the natural resources property rights structure may significantly influence farmers' behavior in forestry investment. It may also trigger forest protection, water conservation, and urban water security. The main aim of the research is to evaluate the impact of ecological property rights and farmers' investment behavior in the economic forest. We have constructed an analytical framework of collective forest rights from two indicators of integrity and stability, by adopting the theory of property rights and ecological capital to fulfill the study's aims. The empirical data has been comprised of the microdata of 708 farmers, collected from the confluence area of the Heihe Reservoir, Shaanxi, China. The study also conducted pilot ecological property rights transactions in the surveyed area. The study utilized the double-hurdle model to test the proposed framework empirically. The results show that forest land use rights, economic products, and eco-product income rights positively affect farmers' forestry investment intensity, and disposal rights (forest land transfer rights) negatively affect farmers' investment intensity. However, in terms of the integrity of property rights, only the right to profit from ecological products affects farmers' forestry investment willingness, and other property rights are insignificant. The study also found that the lower the farmers' forest land expropriation risk is expected, the greater the possibility of investment and the higher the input level. However, we traced that the farmers' forest land adjustment has no significant impact on farmers' willingness to invest. Obtaining the benefits of ecological products has been found as the primary motivation for forestry investment within the surveyed area. The completeness of ownership rights positively impacted farmers' investment intensity. Farmers should realize the ecological value of water conservation forests through the market orientation of the benefit of ecological products. Therefore, the government should encourage farmers and arrange proper training to facilitate a smooth investment. A well-established afforestation program should also be carried out.

Keywords: property rights; ecological property rights; forestry investment; farmers' behavior; reservoir confluence area

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1. Introduction

The world's land and groundwater reserves have become scarce and have already been overused and exploited [1,2]. The proper management of such crucial resources is the main theme of soil and water conservation. Soil and water are the two prime resources essential for human existence, and these resources are becoming increasingly scarce and massively consumed with the sharp growth of the world's populace [3,4]. As a result, the significance of sustaining soil and water and preserving the integrity of both crucial resources should be considered without sacrificing productivity [5]. Agro-forestry can be a possible solution for humankind, as it helps soil and water conservation [6]. Agro-forestry is a method of land management that includes trees and shrubs in farming, allowing for the growing of trees, crops, and cattle on the same plot of land [7,8]. It provides opportunities to obtain profits from booming commodity markets while also improving the land, water resources, and the environment. It is a platform for developing integrated, diversified, and productive land usage patterns by combining agriculture and forestry technology [9]. Trees contribute to lessening the erosive power of raindrops on crops, allowing more water to reach the crop. Moreover, It reduces soil erosion and significantly raises soil fertility, and it helps preserve water by increasing absorption capacity and hydraulic properties [10].

Interestingly, with the development of the social economy in recent years, the problem of urban water shortage has become increasingly prominent, mainly manifested in insufficient water supply and water quality safety risks [11]. Ecological services, such as fresh-water supply and purified water quality, provided by water conservation forests, are the key to ensuring safe water supply and quality [12]. In this regard, the confluence area of reservoirs can play a vital role in supporting various cities, especially in China. The restoration and protection of water conservation forests are the keys to preventing and dissolving the ecological security risks of the river basin and confluence areas of reservoirs, and ensuring freshwater supply in cities. Moreover, the deterioration of the ecological environment of the river basin is currently the main threat in this regard. However, poverty and ecological fragility worsen the situation [13]. Usually, farmers tend to overuse forest resources for their livelihoods, and the lack of proper management and protection frameworks damage the service functions of the forest ecosystem. Due to weak infrastructure and a lack of essential resources, water conservation in forests has become one of the most prominent tactics for sustaining farmers' agro-production and livelihood in the reservoir's confluence area [14]. Existing studies have shown that fostering a well-structured agro-forestry management system relies on the following three basic criteria: (i) farmers' engagement and investment behavior, (ii) property rights support, and (iii) economic viability [15,16].

Farmers' forestry investment responds to economic signals based on family characteristics, natural conditions, and legal frameworks [17,18]. Research on the forestry investment behavior of farmers has been derived from several aspects. Existing research mainly focuses on resource endowment [19,20], business scale [21,22], transition cost cognition [23,24], and risk preference [25,26]. Some researchers derived the forest investment by analyzing the inherent impact of farmers' behavior factors from local governance [27,28], public policy [29,30], village environment [31,32], market environment [33,34], public governance with community tourism [35,36], and other external constraints of farmers' forestry investment behavior [37,38]. Forestry production is always carried out under established industrial policies and institutional frameworks. Among many policies, collective forest rights are an important means of affecting forestry investment [39]. Clear and stable collective forest rights encourage farmers to invest in forestry by enhancing income expectations and clarifying investment returns [40]. The intensity of the property rights system's incentives to farmers' production and investment behaviors depends on the system's degree of consistency between inputs and returns [41]. In addition to forest products, agro-forestry also supplies ecological products, such as water conservation and water purification [42]. Property rights are central concepts of the Coase Theorem [43]. It argues that, within idealized economic circumstances, when property rights conflict, the participants would bargain or enter negotiations that fully represent the actual expenses and fundamental worth of the property rights in concern, eventually culminating in the most effective solution [44]. Therefore, the rental value of the water conservation of forests should be reflected in the financial and ecological product markets, respectively [45]. At present, farmers engaged in forestry production, in the confluence area of the reservoir, not only obtain income from forest products but also from ecological products, in the form of ecological compensation [46,47].

Seemingly, the protection of water sources and the balance of interests between the upstream and downstream of the river basin have become increasingly prominent [48]. The concentrated manifestation is the shortage of urban water resources and the lack of willingness to protect water conservation forests in the confluence area of the reservoir [49]. The water conservation and forest ecosystem can provide hydrological and ecological services, such as water conservation and water purification, which are the key to ensuring water supply and quality safety [50]. Scholars in this field have done much research to reveal the influence of collective forest rights on farmers' investment behavior (such as Zhang et al., 2011 [50], Kashwan [51], and Wu and Zhang [52]). However, few studies incorporate ecological property rights into the property rights structure and analyze the impact of collective forest rights on the forestry investment behavior of farmers in the confluence area of reservoirs (for example, Nichiforel et al. [53], Wen et al. [54] and Yu and Xu [55]). The lack of ecological property rights has caused market failures in ecological governance in the confluence area of reservoirs, resulting in farmers' lack of willingness to invest in forestry or insufficient investment intensity. Therefore, incorporating ecological property rights into the structure of collective forest rights and exploring how it affects farmers' forestry investment decisions in reservoir confluence areas requires further research. The main aims of the study are to incorporate ecological property rights into the collective forest tenure structure, analyze the impact of collective forest tenure on farmers' forestry investment behavior in the reservoir confluence area, from the perspective of ecological property rights, and explore the influencing factors of farmers' forestry investment.

In the absence of ecological property rights, vertical transfer payment is currently the primary method of forest ecological compensation in the confluence area of reservoirs [56]. Although this approach embodies the principle of fairness, it lacks attention to hydrological and ecological service providers and farmers, and their forest reforestation, management, and protection behaviors have not received the economic incentives they deserve [57]. They lack forestry investment willingness or insufficient investment intensity. Seemingly, the subdivision of property rights is a meaningful way to implement complex property rights [58]. By subdividing forest property rights, the economic property rights of water conservation forests can be separated from ecological property rights [59]. By exercising ecological property rights, farmers might realize the ecological value of water conservation forests through the ecological market and redeem the goodness of "clear water and green mountains" into "sustainable water conservations and ecologically sound forest management" [60,61].

In summary, collective forest rights impact farmers' forestry investment behavior [62,63]. Consequently, with forest tenure reforms on their way in many parts of the world, it is an excellent time to reflect on the experiences so far and rectify the following research questions: (i) Do the reforms have the desired outcomes? (ii) How do ecological property rights foster farmer forestry investment behavior? (iii) Are farmers willing to invest in forestry? (iv) To what extent are farmers willing to invest in the forestry ecosystem? (v) How should a measurement system to measure collective forest rights be constructed? Answering the questions mentioned above will be the main innovations of the study. Moreover, few studies incorporate ecological property rights into the property structure and analyze the impact of collective forest rights on farmers' forestry investment behavior in reservoir confluence areas. The study evaluates the impact of collective forest rights on the forestry investment behavior of farmers, based on ecological property rights from two aspects of integrity and stability, by taking the Heihe Reservoir confluence area as an example. The study provides a comprehensive definition of ecological property rights by establishing an ecological market, promoting farmers' forestry investment by guaranteeing farmers' income, and realizing sustainable development of water conservation forests. We incorporate ecological property rights into the structure of collective forest rights, analyze the impact of collective forest rights on the forestry investment behavior of farmers in the confluence area of reservoirs, based on the perspective of ecological property rights, and explore the influencing factors of farmers' forestry investment.

In addition to forest products, the output products of forestry production also include ecological products, such as water conservation and water purification. Therefore, the rental value of water conservation forests should be reflected in the economic and ecological product's market, respectively. The resources attached to ecological products have unique economic characteristics and are the objects of ecological property rights. According to the ecological and economic value of water conservation forests and their market characteristics, the property rights of water conservation forests can be divided into ecological property rights and economic property rights. Among them, ecological property rights refer to the existence of a certain number and quality of forest trees, when the minimum hydrological, ecological service supply required to ensure the water volume of the reservoir and the water environment health and safety standards is guaranteed. Likewise, economic property rights refer to the right to obtain economic benefits on the premise of ensuring positive externalities. The ecological property rights of water conservation forests require a certain number and quality of trees. The ultimate purpose is to obtain hydrological, ecological services, such as water conservation and water purification, and ensure that hydrological and ecological services can meet the needs of reservoir water volume and water environment health and safety. In this way, the right to benefit from water conservation forests is correspondingly subdivided into the right to benefit from ecological and economic products. The study adopted ecological property rights from the prospectives of the rights of use, benefit, and disposal, which may be deviated by adjusting, and expropriation risk expectations.

2. Theoretical Analysis and Research Hypothesis

Farmers' forestry investment decisions result from balancing costs and benefits [64]. The balancing process is affected by both property rights' integrity and stability [65,66]. The scope, benefits, and the degree of exclusivity of the property rights, and whether the benefits can be sustained are getting much more attention from governments, academics, and farmers [67,68]. Interestingly, China has had a unique experience in ownership transformation, as the authority for forestry management transferred from the community (collective) to individual farmers [19]. The ecological and collective property rights may be derived from the two aspects, integrity [69,70] and stability [71,72]. The prospects of integrity highlight the interrelationship between the vitality of authority within forest ecological property rights and the penetration of moral authority to more ecologically friendly behavior [73,74]. Stability denotes the optimality, continuity, and sustainability of the rights, which can be to the long-term benefit of farmers [75,76].

2.1. Integrity of Collective Forest Rights and Forestry Investment Behavior of Farmers in the Confluence Area of Reservoirs

The integrity of property rights refers to the extent to which the subject of property rights excludes other subjects from interfering with the use and disposal of resources independently and, thus, enjoys exclusive benefits [77,78]. It is generally believed that the more complete the property rights, the stronger the investment incentives. Farmers obtain income through the use and disposal of forest resources, so the use, disposal, and profit include the entire process of resource utilization [79,80]. Kashwan [51] analyzed the demand for community forest rights and found a "close relationship between collective forest rights and the farmer's investment behavior". Yi et al. [81] evaluated 3,180 households in eight provinces, from south to north China, and concluded that there is a positive interaction between China's collective forest protection rights and farmer households' perception towards forestry investment. Lee et al. [82] found that more substantial contracted rights affect investment strongly, after exploring 231 counties in eight states of the Central and Southern Appalachian Region of the United States. Hildebrandt and Knok [83] found that when the perceived benefits of complementary objectives increase with economic impact objective, the property right policies of forestland investment are fostered progressively. Therefore, the current study proposed Hypothesis 1, as follows:

Hypothesis 1: *The integrity of collective forest rights positively affects farmers' forestry investment behavior.*

Existing studies have shown that independent selection of tree species, conversion to other forestry uses, and management of non-wood forest products and other forest land use rights sub-items have a significant role in stimulating forestry investment. Generally, obtaining income is the direct purpose of farmers' forestry investment [84]. The degree to which the marginal return of forestry production can be equal to the marginal output determines the degree of exclusivity of farmers' income rights [81]. The output of water conservation forests is a form of forest products supported by ecological products, such as water conservation and water purification. The long-term neglect of the ecological value of water conservation forests has led to the deviation of the marginal return of forestry products [85]. The essence of this is the deprivation and encroachment of farmers' income rights [86]. According to Ji et al. [87] and Irimie and Essmann [88], using only the right can highly impact farmers' forestry investment. The definition of use and disposal rights is necessary for transiting a smooth investment, and obtaining sufficient income is also considered as a prerequisite of farmer's investment [89]. Interestingly, the intensity of property rights ensures the right to use natural resources (such as water conservations), which could be crucial in facilitating investment decisions [90]. Based on these, we have proposed Hypothesis 2.

Hypothesis 2: *The right of use positively affects the forestry investment behavior of farmers.*

The article distinguishes forest economic products and ecological products and seemingly divides the income rights of water conservation forests into economic product income rights [91,92] and ecological product income rights [93,94]. In this way, incorporating ecological property rights into the property rights structure can more comprehensively analyze the impact of income rights on farmers' forestry investment behavior in the reservoir's confluence area. On the contrary, disposal rights measure the degree of exclusivity of forest land and forest tree disposal behavior, including circulation, mortgage, logging, and inheritance [95]. The central aspect of China's agricultural land contracting is that, usually, used household as a unit of rural households ("Rural Land Contract Law" and its judicial interpretation), and the death of a single family member will not cause the problem of contract inheritance [96]. There are many opportunities for farmers and ranchers to introduce agro-forestry practices on their land, which may open up new income possibilities, while adding conservation benefits [97]. Framers may be willing to invest more if the ecological property right satisfies the prime demands of any farmer, such as income and livelihood opportunities. Therefore, the study proposed Hypothesis 3, as follows:

Hypothesis 3: *The right to income positively affects the forestry investment behavior of farmers.*

The confluence area of the reservoir is a quasi-protection area for water source protection, where damage from cropping and vegetation is prohibited, and farmers generally do not have logging rights [98,99]. Therefore, the best option within these areas is an investment in forest and ecosystem restorations [100]. In this regard, the Forestry Bureau of China and the Banking Regulatory Commission of China formulated a new mortgage loan policy. They stated that "Banking financial institutions should not accept water conservation forests and other non-disposable forest rights as mortgage properties". Thus, the ecological property right enjoyed by farmers in the confluence area of the reservoir could act as the only right to transfer forest land [101]. As a result, the right of circulation has a positive impact on farmers' forestry investment, in that the circulation of forest land provides farmers with a way to recover investment and obtain income [102,103]. Understanding patterns of change across disposal rights is essential for farmers that foster healthy and resilient forests for the future. Based on the above discussion, the study proposes Hypothesis 4, as follows:

Hypothesis 4: *The right of disposal positively affects the forestry investment behavior of farmers.*

2.2. The Stability of Collective Forest Rights and the Forestry Investment Behavior of Farmers in the Confluence Area of Reservoirs

The payback period of forestry production investment is prolonged and often influenced by several externalities [104]. Therefore, the long-term stability of collective forest rights is the key to whether farmers can recover their investment and make profits within the term of property rights [105], which has a significant impact on farmers' forestry investment [106]. Stable collective forest rights encourage farmers to invest in forestry through three methods; ensuring that investment income is not encroached with facilitating access to credit funds and promoting the transfer of property rights to recover investment [107]. On the other hand, unstable collective forest rights can reduce farmers' investment recovery expectations [108]. Unpredictable forest land adjustment or collection will take away farmers' long-term investment in forest land, like a random tax, and weaken farmers' investment capabilities [109]. According to Kumar and Kerr [110], well-structured collective laws and regulations should have influenced the investment behavior of Indian forest dwellers' grassroots formations. It is apparent that if the collective forestry rights can be maintained consistently and stably, it may foster a favorable condition for farmers' investment [111,112]. Thus the study proposes Hypothesis 5, as follows:

Hypothesis 5: *Unstable collective forest rights negatively affect farmers' agro-forestry investment behavior.*

Collective forest investment's cash flows come from payment for ecosystem services, land appreciation, land preservation tax credits, the sale of land rights, and other fees, such as hunting or fishing [113]. Therefore, forestry investment willingness considers different risk sources that may impact farmers' forestry investment behavior [114]. The development of agro-forestry to increase its effectiveness requires massive capital and capital is always associated with several markets, policy-related and external risk factors [115]. Increasing risks and uncertainties related to stochastic agro-ecological and institutional factors, and the deterioration of land due to unsustainable farming, are among the significant constraints to agricultural development in developing countries [116]. Perceived risk and risk management strategies could be crucial for the investment facilitation of farmers [117]. Existing studies showed that positive perceived risk expectations and risk management could foster positive responses from the prospects of agro-forestry [115,118,119]. Do et al. [120] identified that adjusting risk perceptions, associated with farmers' time preference, crop yields, and crop prices, appeared to have the most significant influence on whether to invest in agro-forestry. By evaluating family farmers in Brazil, Martinelli et al. [121] found that unpredictable environmental and macroeconomic factors mainly determine the return on investment in agro-forestry. Jerneck and Olsson [122] revealed that small-scale Kenyan farmers' behavior is derived mainly by the degree of expected uncertainty and risk associated with the return on investments. However, it is apparent that if farmers foster any risks associated with a long growth period, they often choose not to invest [123,124]. Therefore, hypotheses 6 and 7 have been proposed, as follows:

Hypothesis 6: *Adjusting risk expectations negatively affects farmers' forestry investment behavior.*

Hypothesis 7: *The expropriation risk expectation negatively affects the forestry investment behavior of farmers.*

3. Materials and Methods

Based on the theory of property rights and ecological capital, an analytical framework of collective forest rights is constructed from two aspects of completeness and stability. Completeness includes three dimensions of use rights, disposal rights, and income rights, and stability includes two dimensions of adjustment expectations and expropriation expectations. According to the characteristics of forest economic and ecological products, the income rights of water conservation forests are divided into economic and ecological product income rights. Based on the perspective of the separation of economic and ecological property rights, the collective forest rights investigate the forestry investment behavior of farmers. Using the micro-data of 708 farmers, in the confluence area of Heihe Reservoir, the double-hurdle model is used to empirically test the differential impact of collective forest rights on farmers' forestry investment willingness and investment intensity.

3.1. Data Source

The sample dataset used in the article has been extracted from a field survey conducted by the research team of well-trained postgraduate-level students in the confluence area of Heihe Jinpen Reservoir from June to July 2019 on the subject of "property rights cognition, perceived value, and forestry investment behavior of farmers". The Jinpen Dam is a rock-fill embankment dam situated in Zhouzhi County of Shaanxi Province, China, where a tributary channel of the Weihe River flows into the Yellow River. It is situated north of the Qinling Mountains, 90 km away from Xi'an City. The Heihe River, which originates from the Qinling mountain, is the main water supply for the Jinpen Reservoir. The Heihe River is a first-level tributary of the Wei River, and the Jinpen Reservoir is the primary water source of Xi'an city [125]. The confluence area of the reservoir covers an area of 1481 km^2, and it mainly flows through the three towns of Chenhe, Banfangzi, and Houzhenzi in Zhouzhi County of Shaanxi Province. According to the geographical distribution and population ratio, stratified and simple random sampling methods selected 13, 8, and 4 administrative villages in Chenhe, Banfangzi, and Houzhenzi Towns. Figure 1 portrays the study area map. After, we randomly selected 27–30 farmers from each village to conduct a household survey with face-to-face interview tactics accompanied by a structured questionnaire. Interviewers asked the farmers about the questionnaire's content and recorded the responses in written form. It includes demographic information (control variables) and the content regarding the dependent and independent variables. A total of 743 responses have been gathered, with 708 valid responses, and the efficiency was 95.29%. Prior to the formal interviews, the interviewers briefly described the aims and content of the questionnaire to the interviewee, which improved the response rate. Moreover, verbal permission was taken before starting the survey. The interviewee was informed that the information collected via the interviews would be used solely for research purposes, and they can opt-out at any time for any responses.

3.2. Pre-Processing of Variables

The study uses the average value of other households' knowledge of property rights in the same village as an instrumental variable to eliminate possible endogenous estimation biases, as suggested by Liu and Jia [126] and Ma et al. [127]. There may be an endogenous problem between farmers' collective forest rights perception and forestry investment behaviour in the formula (1). Because, in the same administrative village, the perception of a farmer's collective forest rights may be affected by other farmers' property rights [128]. At the same time, the perception of property rights of other farmers in the same village is not directly related to the forestry investment behaviour of the sample [129]. In addition, the subdivided property rights indicators affect different aspects of farmers' forestry production decisions. In order to reduce the impact of multicollinearity and avoid the randomness of subjective assignment, the entropy method is used to calculate the index weight as suggested by Luo et al. [130].

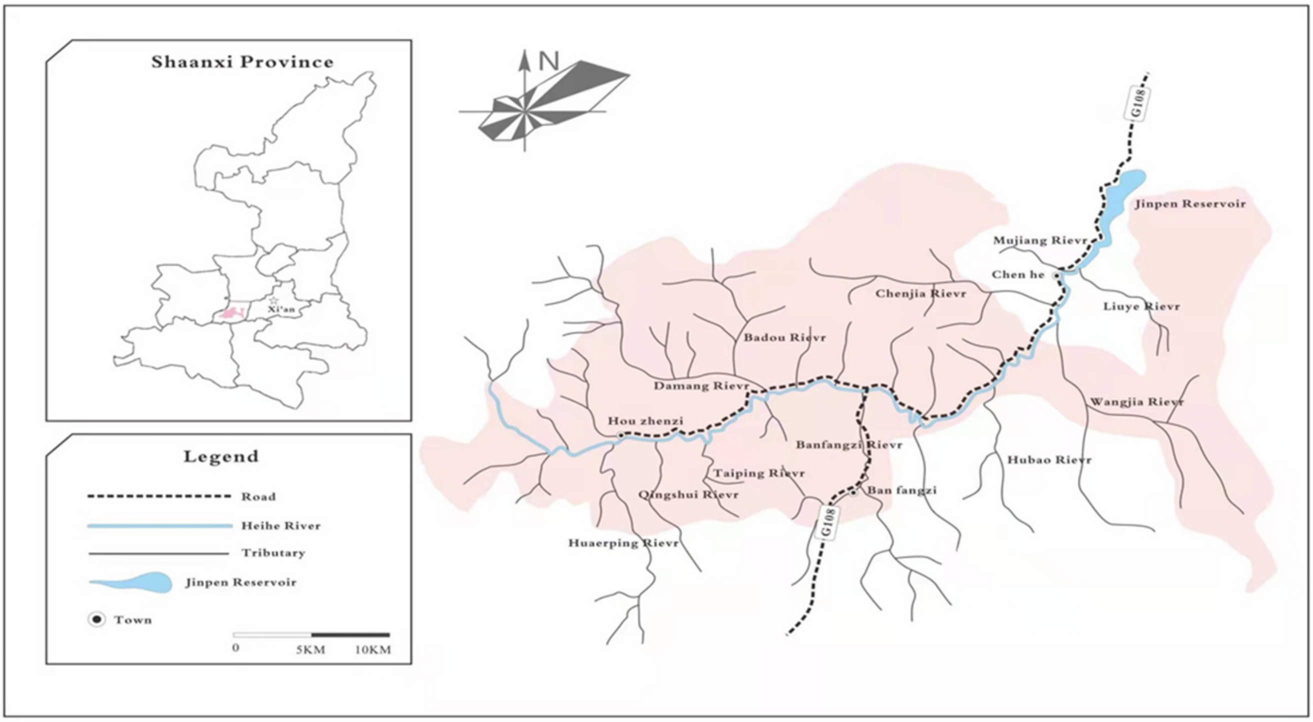

Figure 1. Study area map.

In the study, we have chosen tree species and operating non-wood forest products, which are weighted together to measure the level of use right, and the income of economic products and ecological products are weighted together to measure the level of income right. Finally, the three rights indicators of rights of use, benefits, and disposal are introduced into the model. The independent variables in the study are divided into the following two categories: core independent variable and control variables. Collective forest property rights acted as core independent variables, including property rights of integrity and stability. The study uses age, education level, health status, status as a Communist party member or not (village cadre) to reflect the characteristics of the sampled individuals (control variables). In contrast, we used the family population and the size of fixed assets to reflect the characteristics of the sample households; the average single forest area, forest land distance, forest land quality, and forest trees reflect the characteristics of agro-forestry.

3.3. Variable Selection and Descriptive Statistics

3.3.1. Dependent Variable: Forestry Investment Bbehavior of Farmers

Labor and capital are the main factors of production for farmers' forestry production and operation, and there is a specific time interval for significant forestry capital investment, such as seedlings and fertilizers. The article uses the five-year cumulative sum of funds for farmers' households per unit of forest land from 2015 to 2019 to measure farmers' investment behavior. The factors affecting the willingness of forestry investment and investment intensity of farmers in the reservoir confluence area may not be the same. Therefore, the study divides the forestry investment behavior of farmers in the reservoir confluence area into the following two stages: participation decision-making and quantitative decision-making, as suggested by Assé and Lassoie [131] and Zeng et al. [132]. Participation in decision-making to examine whether farmers are willing to invest in forestry is a binary dummy variable; quantitative decision-making examines how much farmers invest in forestry and is a continuous variable.

Participation in decision-making is used to examine whether farmers are willing to invest in forestry as a dual dummy variable. If the forestry investment during the investigation period is 0, the farmers have no willingness to invest in forestry, and the assumption value is 0. On the contrary, if the farmers have made forestry investments, the value is 1. Quantitative decision-making examines how much farmers invest in forestry as a continuous variable. In the study, the amount of forestry investment incurred by farmers during the investigation period is used to express the forestry investment intensity of farmers.

3.3.2. Core Independent Variable: Collective Forest Rights

For a long time, forestry departments and village administration affected farmers' forestry production directly or indirectly [133]. When farmers exercise property rights such as rights of use, disposal, and income, the actual degree of exclusivity may effectively determine property rights [134]. Therefore, the article refers to the logic of "content of property rights-government (village collective) intervention-degree of exclusivity" proposed by Li et al. [135] and uses farmers' perception of the degree of exclusivity of property rights (government departments and administrative villages) to measure collective forests. The study adopts the definition of property rights from the analysis of Ma et al. [136], van Gelder [137], and Nguyen et al. [138] and constructs a measurement system to assess collective forest rights from two indicators of completeness and stability. Right to use, Usufruct, Right of disposal have been used as indicators of collective forest rights (core independent variable). Right to use means a non-exclusive license for the farmer to access or use the property right services [139]. Fructus (fruit, in a figurative sense) is the right to derive profit from a thing possessed, for instance, by selling crops, leasing immovables or annexed movables, taxing for entry, and so on [140]. The right of disposal of goods, including retention of ownership and retention of the right to sell the goods, might have a crucial impact on farmers' investment behavior [141]. The specific indicators associated with all the variables are stated in Table 1.

3.3.3. Control Variables

The study selects control variables from the following three aspects: individual sample characteristics, sample family characteristics, and woodland tree characteristics. This article uses age, education level, health status, and status as a Communist party member or not (village cadre) to reflect the characteristics of the sampled individuals. In contrast, we used the family population and the size of fixed assets to reflect the characteristics of the sample households; the average single forest area, forest land distance, forest land quality, and forest trees reflect the characteristics of agro-forestry. The meaning and descriptive statistics of the variables are shown in Table 1.

3.4. Model Construction

Water conservation and lack of ecological property rights within forestry have caused market failures in ecological governance in reservoir confluence areas. Incorporating ecological property rights into the property structure to study the impact of collective forest rights on farmers' investment in forestry is significant in rectifying water conservation forest protection and urban water safety. At the same time, subdivisions of property rights are crucial for implementing complex property rights systems [142,143]. The property rights approach suggests that if exclusive property rights are adequately defined, the public good prospects of environmental quality can be transformed into a private good, and optimal environmental allocation will be reached [144]. According to the theory of property rights, a subdivision of property rights is a meaningful way to implement complex property rights [145]. By subdividing forest property rights, the economic property rights of water conservation of forests can be separated from ecological property rights [146], thereby defining ecological property rights. The definition is thereby adopted in the study. When the ecological property rights are clearly defined and farmers are given the right to exchange property rights, farmers can realize the ecological value of water conservation forests through the ecological market and obtain the benefits of ecological products.

Table 1. Variable definition and descriptive statistics.

Variable Type	Variable Name	Meaning And Assignment	Mean	Standard Deviation
Dependent Variable	Willingness to Invest	No Willingness to Invest = 0; Willingness To Invest = 1	0.93	0.26
	Investment Intensity	2015–2019 Cumulative Investment per Unit Area (Yuan)	935.82	615.76
Core Independent Variable	Right to Use			
	Conversion to Other Forestry Uses	No Right = 0; Uncertainty = 1; Right, Subject to Partial Consent of the Village or Government = 2; Right, and Free to Exercise = 3	1.76	0.63
	Choose Tree Species		1.94	0.72
	Operating Non-Wood Forest Products		2.20	1.17
	Usufruct			
	Economic Product Income	No Right = 0; Not Sure = 1; Right but Not Exclusive, Part of the Income Is Invaded by the Village or the Government = 2; Right, and Exclusive Income = 3	2.50	0.79
	Ecological Product Benefits		1.39	0.56
	Right of Disposal			
	Circulation Right	No Right = 0; Uncertainty = 1; Right, Subject to Partial Consent of the Village or Government = 2; Right, and Free to Exercise = 3	2.12	0.57
	Adjustment Risk	Possibility of Adjustment within the Woodland Village: Impossible = 0, Uncertain = 1, Possible = 2	1.40	0.61
	Levy Risk	Possibility of Expropriation of Forest Land: Impossible = 0, Uncertain = 1, Possible = 2	1.38	0.75
Control Variable	Age	Age of Respondents in 2019 (Years)	49.50	11.35
	Education Level	Illiterate (No School) = 1; Elementary School = 2; Junior High School = 3; High School = 4; College = 5; Bachelor's Degree and Above = 6	2.31	0.97
	Health Status	Very Poor = 1; Relatively Poor = 2; General = 3; Relatively Healthy = 4; Very Healthy = 5	3.47	1.13
	Whether or Not a Party Member (Village Cadre)	No = 0; Yes = 1	0.18	0.39
	Family Population	Total Family Population (Person)	4.28	1.23
	Fixed Assets	The Total Value of Family Fixed Assets (Ten Thousand Yuan)	24.50	15.69
	Forest Area	Farmer Households Contracted Forest Land, the Average Area of Single Piece of Forest Land (Mu)	10.67	6.29
	Woodland Distance	The Time Required from Home to Woodland Rounded up to 10 min	96.94	110.56
	Woodland Quality	Very Poor = 1; Poor = 2; General = 3; Better = 4; Very Good = 5	2.50	0.95
	Tree Type	No Forest Land = 1; Pure Timber Forest = 2; Mixed Timber Forest and Economic Forest = 3; Pure Economic Forest = 4	3.61	0.74

Interestingly, obtaining income is the direct purpose of farmers' forestry investment. This article divides forest income rights from economic product and ecological product income rights and analyzes the effect of collective forest rights on farmers' forestry investment behavior. Impact analysis has highlighted the critical role of farmers' forestry investment decision-making. Based on this, we propose to define ecological property rights, establish an ecological property rights trading market, and realize the ecological value of water conservation forests through property rights exchange as an effective way to protect farmers' income rights and encourage farmers to invest in forestry.

In the study, the forestry investment of farmers in the confluence area acts as a dependent variable, and the reservoir is similar to a continuous variable (as the dependent variable, farmers' forestry investment in the confluence area is similar to a continuous variable). However, for this part of the data without forestry investment willingness, the dependent variable is compressed at 0. The dependent variable's probability distribution includes a discrete point of 0 and is based on a continuous distribution. At the same time, the factors that affect farmers' forestry investment willingness and intensity may not be the same as suggested by Duan et al. [25]. Therefore, the production mechanism is set as a dependent variable derived by 0, and the continuous variable may be different. In addition, there may be a correlation between forestry investment willingness and investment intensity, and deciding whether or not an investment has a tail-end effect on investment intensity will lead to selection bias. Thus, the double-hurdle model is more suitable than the tobit model [147]. Therefore, the study uses the Heckman model to estimate the sample selection, and the estimation results show that the inverse Mills ratio is insignificant. The null hypothesis that investment willingness and intensity are independent of each other cannot be rejected. Therefore, the article uses the probit and truncated double-hurdle model to estimate forestry investment willingness and investment intensity independently in two stages. The study sets the basic model as follows:

$$I_i = \alpha + \beta_1 PI_i + \beta_2 PS_i + \gamma X_i + \varepsilon_i \tag{1}$$

Among them, I_i is the forestry input of the i^{th} farmer household in the confluence area of the reservoir (the natural logarithm of the farmer's actual forestry investment), and PI_i and PS_i represent the farmers' complete knowledge and understanding of the collective forest rights they hold, respectively. Seemingly, PI_i and PS_i represent the farmers' integrity cognition and stability cognition of the collective forest rights they hold, respectively and X_i is the control variable, and ε_i is the random disturbance term. There may be an endogenous selection bias problem between farmers' collective forest rights perception and forestry investment behavior in the formula. This study uses the average value of other households' knowledge of property rights in the same village as an instrumental variable to eliminate possible endogenous estimation biases, as suggested by Liu and Jia [126] and Ma et al. [127]. This is because in the same administrative village, the perception of collective forest rights in a sample may be affected by the perception of other farmers' property rights [128]. At the same time, the perception of property rights of other farmers in the same village is not directly related to the forestry investment behavior of the sample [129].

4. Results

Model Estimation Results

Table 2 presents the regression results of the impact of collective forest rights on farmers' forestry investment, and it shows that in terms of completeness, only income rights significantly affect farmers' forestry investment willingness, and other property rights are not significant. Based on farmers' willingness to invest, rights to use and income rights positively impact farmers' forestry investment intensity, while the impact of disposal rights is not significant. In terms of stability, expropriation risk significantly negatively impacts farmers' forestry investment willingness and intensity. Seemingly, adjustment risk also significantly negatively affects farmers' forestry investment intensity but has no significant impact on investment willingness. It could happen as the adjustment of forest land rights is subject to adjustment of land within the village, due to population changes, and the timing of adjustments generally avoids the harvest season. Therefore, adjustment of expectations will not affect farmers' investment participation in decision-making, but when farmers expect that forest land rights may be adjusted, long-term investment will not be recovered, which will reduce the intensity of forestry investment.

Table 2. Regression results of the impact of collective forest rights on farmers' forestry investment.

Project	Investment Willingness (Probit Model)		Investment Intensity (Truncated Model)	
	Coefficient	**Z Value**	**Coefficient**	**Z-Value**
The integrity of property rights				
Right to use	0.320 (0.778)	0.41	1.514 (0.324)	4.68 ***
Usufruct	1.738 (0.867)	2.00 **	1.095 (0.314)	3.49 ***
Right of disposal	−0.767 (0.630)	−1.22	−0.336 (0.206)	−1.63
Stability of property rights				
Redistribution risk	0.6515 (0.828)	0.79	−1.101 (0.347)	−3.17 ***
Expropriation risk	−1.575 (0.693)	−2.27 **	−0.683 (0.291)	−2.35 **
Control variable				
Age	0.0047 (0.008)	0.56	0.016 (0.004)	4.31 ***
education level	−0.355 (0.103)	−3.45 ***	−0.026 (0.045)	−0.59
Health status	0.098 (0.083)	1.18	0.040 (0.037)	1.09
Whether or not a party member (village cadre)	−0.260 (0.229)	−1.14	0.100 (0.104)	0.96
Family population	−0.011 (0.077)	−0.14	0.086 (0.031)	2.77 ***
Family fixed assets	0.377 (0.171)	2.22 **	0.137 (0.093)	1.47
Forest area	0.172 (0.032)	5.26 ***	−0.015 (0.006)	−2.57 **
Woodland distance	−0.002 (0.0008)	−2.63 ***	−0.0007 (0.0003)	−2.09 **
Woodland quality	0.386 (0.103)	3.75 ***	0.225 (0.041)	5.49 ***
Tree type	0.051 (0.130)	0.40	0.054 (0.052)	1.03
LR	116.76 ***			
Wald			134.90 ***	
Sample size	708		657	
Mean VIF	1.53		1.53	

Note: **, *** mean significant at the statistical level of 5%, and 1%, respectively.

The level of education negatively affects the investment willingness of farmers. A higher level of education can foster non-forest employment choices of farmers and lower the willingness to invest in forestry. The age of the household head has a positive impact on the investment intensity. It is generally believed that based on the willingness to invest, as the age increases, the farmer has accumulated more forestry management experience, and at the same time, the opportunities for non-forest jobs are also reduced, and they are more inclined to increase forestry investment. The number of family members has a positive impact on the forestry investment intensity of farmers. As the number of family members increases, more labor will be available for forestry production. Household fixed assets positively impact farmers' willingness to invest in forestry. Similarly, when the forestry production cycle is long, it could bring many uncertainties and investment risks. Therefore, the greater the total fixed assets of farmers, the stronger the ability to resist risks, and the more likely they are to invest in forestry.

Seemingly, the average land plot area positively affects the willingness to invest and negatively affects the investment intensity. With the increase in the land plot area, the increase in the benefits of the scale effect will encourage farmers to invest in forestry. However, if the income level of farmers in the confluence area of the reservoir is low, the funds that can be used for forestry investment are limited and will not increase with the increase in the plot area. Therefore, the investment per unit area will decrease with the increase in the plot area. The distance from forest to home negatively affects forestry investment willingness and intensity. The increase in the distance from home to the forest will lead to an increase in forestry input costs, which will inhibit farmers' willingness and intensity of forestry investment. However, forest quality has a positive impact on investment willingness and intensity. Better forest quality influences the possibility of profitability and higher income, and it will positively influence the willingness of farmers to invest in forestry and eventually increase the investment intensity. The plantation forests in the confluence area of the Heihe Reservoir are mainly economic forests, so the type of tree has no significant impact on farmers' willingness to invest in forestry and investment intensity.

It can be seen from Table 2 that the income right significantly affects the forestry investment willingness of farmers at the 5% significance level and significantly affects the forestry investment intensity of farmers at the 1% significance level. Forestry production by farmers in the confluence area of reservoirs can benefit from both forest products and ecological products. In order to clarify the impact of income rights on farmers' forestry investment decisions, this article further explores the impact of farmers' forestry investment from the perspective of the separation of economic and ecological property rights. Table 3 denotes the regression results of decision-making factors. It can be seen from Table 3 that, in terms of the integrity of property rights, only the right to earn from ecological products affects the willingness of farmers to invest in forestry, and other property rights are not significant. However, based on the willingness of farmers to invest, the right to use forest land, economical products, and ecological product income rights positively affects farmers' forestry investment intensity, and disposal rights (forest land transfer rights) negatively affect farmers' forestry investment intensity.

Table 3. Regression results of the impact of collective forest rights on farmers' forestry investment, based on separation of economic property rights and ecological property rights.

Project	Investment Willingness (Probit Model)		Investment Intensity (Truncated Model)	
	Coefficient	**Z Value**	**Coefficient**	**Z-Value**
The integrity of property rights				
Right to use	0.280 (0.787)	0.36	1.556 (0.323)	4.81 ***
Economic product income	0.5450 (0.643)	0.85	0.904 (0.258)	3.50 ***
Ecological product benefits	1.201 (0.632)	1.90 *	0.484 (0.219)	2.22 **
Right of disposal	−0.775 (0.631)	−1.23	−0.414 (0.208)	−1.99 **
Stability of property rights				
Redistribution risk	0.606 (0.838)	0.72	−0.980 (0.351)	−2.79 ***
Expropriation risk	−1.470 (0.836)	−1.76 *	−1.048 (0.337)	−3.11 ***
Control variable				
Age	0.005 (0.008)	0.54	0.016 (0.004)	4.23 ***
Education level	−0.355 (0.103)	−3.45 ***	−0.027 (0.044)	−0.60
Health status	0.098 (0.083)	1.17	0.038 (0.037)	1.01
Whether or not a party member (village cadre)	−0.263 (0.230)	−1.15	0.113 (0.104)	1.09
Family population	−0.011 (0.077)	−0.15	0.084 (0.031)	2.72 ***
Family fixed assets	0.385 (0.172)	2.24 **	0.148 (0.093)	1.60
Forest area	0.172(0.033)	5.26 ***	−0.015 (0.006)	−2.48 **
Woodland distance	−0.002 (0.001)	−2.64 ***	−0.001 (0.000)	−2.19 **
Woodland quality	0.386 (0.103)	3.74 ***	0.217 (0.041)	5.27 ***
Tree type	0.054 (0.132)	0.41	0.031 (0.053)	0.58
LR	117.08 ***			
Wald			140.58 ***	
Sample size	708		657	
Mean VIF	1.59		1.59	

Note: *, **, *** mean significant at the statistical level of 10%, 5%, and 1%, respectively.

5. Discussion

With the development of society and economy, the problems of water resource protection and the balance of benefits between upstream and downstream of the river basin have become increasingly prominent. The forest basin in the reservoir's confluence area is considered a crucial source of clean water. China's socio-economic growth depends on efficient watershed stewardship. While having immense investments in watershed governance and infrastructures, relatively stronger and integrated water governance at the municipal and federal tiers should be required to formulate practical and innovative water resources protection trends. Vital strategies for supporting the sharply expanding economy include offering more water for environmental usage, intensifying market instruments to foster water use efficiency, and accepting transformative behavioral measures to fight against water contamination. In this regard, farmers' involvement via active participation and collectiveness, in the forms of ecological property rights, can act as sophisticated approaches. However, the lack of forest ecological property rights in the confluence area of reservoirs has caused the externalities of hydro-ecological services to be unable to be internalized, leading to market failures in ecological governance and farmers lacking forestry investment willingness or insufficient investment intensity.

The forestry production of farmers in the confluence area of the Heihe Reservoir originated from the return of farmland to forests in 1998. Before that, traditional agriculture was the primary livelihood for farmers in this area, and there were few forestry producers [148]. In 1998, farmers in this area returned farmland to forests, to obtain ecological compensation, and started forestry production [149]. The confluence area of the reservoir is a quasi-protection area for water source protection, and the right to use forest land is more restricted than in general areas. The forestry production behavior of farmers is mainly to implement the policies of the local forestry department, and there is not much room for independent decision-making. At the same time, due to the geographical environment of the mountainous area, it is not favorable to use machinery. All the core farming work, such as preparing soil, sowing, weed and pest control, and harvesting, are done manually, and the income of forest products is limited. Therefore, obtaining ecological compensation is the primary motivation of farmers' forestry investment in this area, which is consistent with the ecological value of the forest trees in the reservoir confluence area.

The current trends and assessment of ecological property rights in contemporary policy-oriented literature, by legislative bodies and other researchers, are inadequate. There is an emergent need for an innovative assessment of ecological property rights within the aspects of farmers' agroforestry investment behavior. The impact of ecological property rights is being emphasized greatly in developmental and ecological programs because of its importance in responsible natural resource stewardship, effective governance, and impoverished community empowerment. Thus, the study evaluates the potential role of ecological property rights within the core concepts of property rights. Ecological property rights may also influence land-use strategies, including identifying various motivating factors or drivers and managing arrangements in agroforestry systems, as well as facilitating greater ecological systems. Seemingly, developmental organizations progressively recognize the importance of ecological property rights as a key role in deciding how land and natural resources are utilized and maintained, and how the benefits of those resources are dispersed. The study also formulates a pilot transactions framework to rectify the on-hand effects and provide an overview of the critical ecological property rights concepts involved in designing and implementing natural resource management programs. As the confluence area of the Heihe Reservoir is restricted for usual farming, farmers' investment in forestry within the area can facilitate proper usage of the land, livelihood facilities, and economic solvency of farmers. Thus, the current study design rectifies the innovativeness and significance of this crucial topic.

The key factor that affects the willingness of farmers to invest in forestry in the confluence area of the reservoir is whether it is "profitable". Based on the farmers' decision to invest, the integrity of the right to use, and other owners, will affect the amount of investment. Therefore, it is necessary to define forest ecological property rights and protect farmers' right to income. There was no significant effect on willingness to invest, and thus, Hypotheses 2–4 are partially verified. This research conclusion contradicts the theoretical hypothesis that farmers obtain benefits through the use and disposal of forest resources, and the more complete the property rights, the stronger the investment incentives. However, it is consistent with the fact that farmers in the confluence area of the reservoir invest in economic forestry. The forest land use and disposal rights in this area are strictly restricted, and the benefits of forest products are meager [149]. Obtaining ecological compensation is the main purpose of farmers participating in ecological projects, such as returning farmland to forests [150]. Based on obtaining reasonable ecological compensation, other rights, such as rights to use and disposal rights, will impact the investment intensity of farmers. The results show that farmers are likely to give up forestry investment directly if reasonable ecological compensation is not guaranteed. Therefore, the following assumptions could be made:

Assumption 1: *The integrity of collective forest tenure positively affects the forestry investment behavior of farmers (Accepted).*

Assumption 2: *The right of use positively affects the forestry investment behavior of farmers (partially accepted, only affects investment intensity and has no significant impact on investment willingness).*

Assumption 3: *The right to income positively affects the forestry investment behavior of farmers (partially accepted, the right to benefit from ecological products has a significant impact on investment willingness and intensity, while the right to benefit from economic products only affects investment intensity and has no significant impact on investment willingness).*

Assumption 4: *The right of disposal positively affects the forestry investment behavior of farmers (partially accepted, only affects investment intensity and has no significant impact on investment willingness).*

In the confluence area of reservoirs, obtaining the benefits of ecological products is the primary motivation for farmers' forestry investment and has a significant positive impact on the intensity of farmers' forestry investment. It is different from the research conclusions of Ji et al. [87], Yi et al. [81], Holden and Otsuka [151]. The forestry investment intensity of farmers does not significantly impact investment willingness. This research conclusion contradicts the theoretical hypothesis that farmers obtain income through the use and disposal of forest resources. The exclusive property rights found fostering, the stronger the investment incentives. However, these findings are consistent with the fact that the right to use, and disposal of, forests in the confluence area of the reservoir is stringently restricted, the income of forest products is meager, and the ecological compensation based on the extent of farmers' participation in environmental projects, such as returning farmland to forests is insufficient. The outcome is consistent with the results reported by Suleiman et al. [152] and Nerfa et al. [153].

However, due to the geographical environment of the mountainous area, it is impossible to use heavy machinery, and the income by-product is limited, not even enough to cover the cost in many cases. However, farmers in this area generally receive ecological product benefits in ecological compensation [154]. In the confluence area of the Heihe Reservoir, only 34.04% of the rural households in the sample participated in the survey, received income from forest products in 2018, and the households receiving ecological compensation income accounted for 98.73% of the total sample. In the absence of ecological property rights, vertical transfer payment is currently the primary method for forest ecological compensation in the confluence area of reservoirs. Although this approach embodies the principle of fairness, it lacks attention to the farmers as ecological service providers and does not reflect the supply and demand relationship of ecological products. As a result, farmers' forest reforestation and management behaviors do not receive the economic incentives they deserve. The findings show that the adjustment risk has a significant negative impact on farmers' forestry investment intensity but impacts investment willingness. The effect of adjusting risk expectations on farmers' forestry investment willingness is insignificant, inconsistent with the existing research that generally found that property rights security significantly impacts investment willingness and intensity [155,156]. It may be because the adjustment of forest land is the adjustment of land within the village, due to population changes in administrative villages, and the adjustment implementation time node generally avoids the harvest season. Therefore, adjusting expectations will not affect farmers' investment participation in decision-making, but when farmers expect that forest land may be adjusted, long-term investment will not be recovered, which will reduce the input intensity of forestry investment. Thus, the following assumptions could be made:

Assumption 5: *Unstable collective forest rights negatively affect farmers' agro-forestry investment behavior (Accepted).*

Assumption 6: *Adjusting risk expectations negatively affects farmers' forestry investment behavior (partially accepted, negatively affects investment intensity and has no significant impact on investment willingness).*

Assumption 7: *The expropriation risk expectation negatively affects the forestry investment behavior of farmers (accepted, has a significant negative impact on investment willingness and investment intensity).*

6. Conclusions

The study uses the survey data of farmers in the confluence area of the Heihe Jinpen Reservoir, based on the perspective of ecological property rights, to study the impact of collective forest rights on the forestry investment behavior of farmers in the reservoir area. Because water source protection restricts farmers' production and livelihood in the confluence area, farmers require ecological compensation. Although the current vertical ecological compensation reflects the principle of fairness, it ignores the efficiency of resource allocation and does not reflect the supply–demand relationship of ecological products. Therefore, based on the divisibility of property rights, the income rights of water conservation forests are divided into economic product income rights and ecological product income rights. Moreover, a well-structured pilot test of ecological property rights transactions is carried out in the confluence areas of reservoirs, where conditions permit, and farmers can realize the benefits of water conservation forests through the ecological market. Ecological value encourages farmers to invest in forestry, carry out afforestation and reforestation, and realize water conservation forests' sustainable development.

The study portrays the following outcomes: (i) Incentive received for forestry, profitable forestry investment, and obtaining ecological product income and rights act as the primary motivation for farmers' forestry investment within the reservoir confluence area. (ii) The rights to use and disposal were the central assumptions for farmers' willingness to invest. The completeness of property rights of other owners impacted the investment amount intensity. Specifically, in terms of the integrity of property rights, the right to profit and income rights from ecological products affect farmers' willingness to invest in forestry, and other property rights are insignificant, whereas the income right has a positive impact and the disposal right (forest land circulation right) negatively affects the forestry investment intensity of farmers. (iii) Regarding property rights stability, the lower the farmers' expectation of forest land acquisition risk, the greater the possibility of investment and the higher the input level. Since the forest land adjustment usually avoids the harvesting period, the farmers' forest land adjustment expectation will only negatively affect the input level and, therefore, affect investment willingness negatively. (iv) In contrast, forest land use rights, financial products, and ecological products are crucial for farmers' willingness to invest. The income right positively affects the forestry investment intensity of farmers, and the disposal right (forest land circulation right) negatively affects the forestry investment intensity of farmers. (v) Regarding the stability of property rights, the lower the farmers' forest land expropriation risk is expected, the greater the possibility of investment and the higher the input level. The right of use, right of income, and rights to disposal are the necessary conditions for farmers' forestry investment.

Based on the above research conclusions, the study puts forward the following policy suggestions: (i) Sustainable development of water conservation forests should be highlighted, to encourage farmers to invest in forestry. (ii) However, farmers' subjective perception of collective forest tenure affects their forestry investment behavior. Therefore, more attention should be paid to improving farmers' subjective cognition, where agricultural extension offices and demonstration zones should extend their support. (iii) The government should carry out collective forest rights publicity, by arranging frequent visits by village cadres, village meetings, and technical training, which could effectively improve farmers' awareness of property rights and promote forestry investment. (iv) In addition, subjective perception of farmers' collective forest rights affects their forestry investment behavior. Therefore, while improving collective forest rights in reservoir confluence areas at the legal level, attention should be paid to farmers' subjective perceptions of collective forest rights. (v) Government should realize the actual demand for the sustainability of natural resources and ensure well-balanced conservations. In contrast, they should simplify obtaining property rights within the context of ecological property rights.

However, the following issues still need further consideration: (i) The study included a limited area, which may hinder the application of the model and validity of the outcomes for other forest regions. Thus, future research should use multiple areas to test the ecological property rights transactions for better reliability and valid assumptions (ii) Issues like ecological property rights policies, regulations, and ecological ethics support should be explored further. (iii) The establishment and effective operation of the ecological market guarantee framework should be explored critically, with different forest zones. (iv) Future studies should include the issue of the behavioral capacity of the farmers' ecological property rights transactions within the confluence area of the reservoir, to get more robust results. (v) The potential studies should present the key variable of interest within separate results subsections to provide more comprehensive outlines.

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