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Labor Endowment, Cultivated Land Fragmentation, and Ecological Farming Adoption Strategies among Farmers in Jiangxi Province, China

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Abstract: A deeper understanding of the factors that influence the ecological farming adoption strategies of farmers can help in developing effective adaptation measures to mitigate the degradation of cultivated land quality and ecological degradation. This study used a stratified random sampling technique to select 1488 households in Jiangxi Province, while the double-hurdle model was used to analyze the influence of labor endowments (LEs) and cultivated land fragmentation (CLF) on ecological farming decision-making. The results indicate that LEs and CLF play important roles in farmers' decision-making with regard to ecological farming. To be more specific, the total household population and CLF have negative effects on adoption willingness, while the number of laborers has a positive effect. For the degree of adoption, the total household population has a negative effect, while the number of laborers and part-time employment have positive effects. In addition, farmers' ecological farming behavior is also influenced by factors such as education, agricultural income, cooperatives, and agricultural subsidies. Overall, farmers have a high willingness to adopt ecological farming, but the degree of actual adoption is low. This is not conducive to the promotion of ecological farming techniques and the sustainable development of agriculture in China. The study proposes that the government should further improve financial investment and provide relevant technical services. In addition, a temporary work platform should be set up for farmers to encourage them to find other work during the agricultural low season.

Keywords: ecological farming; labor endowment; cultivated land fragmentation; double-hurdle model; farmers; China

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1. Introduction

Cultivated land is the most important material basis of agricultural production, which plays an important role in ensuring food security and maintaining the stable development of the country's society [1–4]. There is a consensus among scientists that the decline of cultivated land quality and ecological environment due to surface pollution and other causes have great harmful effects on sustainable agricultural development [5–7]. Studies have noted that some agricultural production behaviors that violate the laws of cultivated ecosystems are one of the main reasons for the continuous deterioration of the ecological environment of cultivated land. Examples include the excessive application of chemical fertilizers and pesticides, the low recycling rate of agricultural films, and continuous tillage [8–10]. In particular, the long-term excessive use of pesticides and fertilizers has damaged the original ecosystems of cultivated land. This is not only triggering the acidification of farmland soil and destroying the soil structure but is also causing the nutrient

system to lose its balance [11]. Ecological farming is agricultural production behavior that abides by the basic principles of the ecosystem, which is considered to be an effective way of reducing the negative impacts on cultivated land quality and the ecological environment. It is also an important way to achieve sustainable agricultural development.

Research related to ecological farming has become more mature in China [12,13], and the concept is gradually being accepted internationally. Ecological farming is characterized by following the principle of the ecosystem, avoiding the irreversible disturbance to the cultivated land system, and helping to protect and improve the agricultural ecological environment. Specifically, ecological farming includes conservation tillage methods, such as soil testing and formula fertilization, the recycling of agricultural films, straw return, and crop rotation. It also includes green agricultural production behaviors, such as planting green manure, using organic fertilizers, and reducing the application of chemical fertilizers. Ecological farming can well reduce the waste and misuse of agricultural resources, such as chemical fertilizers and pesticides. At the same time, scientific farming methods can improve agricultural output and reduce environmental damage to cultivated land. Overall, ecological farming has tremendous economic and ecological benefits [14]. Ecological farming, environmentally friendly technologies, low-carbon behaviors, and green production technologies all help to reduce environmental damage during production [15,16], but ecological farming encompasses a more comprehensive approach to cultivated land conservation and green production, with a greater focus on the former as well as sustainable agricultural development. The adoption of ecological farming is of great strategic significance in terms of the protection of cultivated land, the promotion of sustainable agricultural development, the guarantee of world food security, and the stability of international food prices [17].

With the development of industrialization and urbanization, numerous young and middle-aged rural laborers have moved to cities, and the aging and structural homogenization of rural households has become a global problem. Since the reform and opening up, the livelihood of Chinese farmers has been massively divided. The structure of labor endowments (LEs) has undergone tremendous changes; particularly, the structural scarcity of labor forces has become normal [18,19]. Agricultural production requires a large amount of labor, and the declining and aging labor force has made the old labor-intensive and production material-intensive agricultural production methods obsolete [20,21]. Traditional agricultural production methods have been transformed, affecting the willingness and degree of farmers to adopt new agricultural production methods. China's smallholder production model will persist over a period. The implementation of the household joint production responsibility contracting system has ensured the fairness of land distribution. However, it has also ultimately caused the prominent fragmentation of cultivated land and has made the land a bottleneck constraint on China's agricultural development [22]. The more cultivated land is fragmented, the more difficult it is for farmers to carry out agricultural production, which will cause a waste of production materials and is not conducive to the application of new technologies and equipment. This greatly reduces production efficiency and largely affects farmers' willingness to adopt, and the degree to which farmers adopt, new technologies [23].

Farmers are the most direct and major participants in agricultural farming, and their choice of farming methods directly affects the sustainability of cultivated farmland use and thus the development and direction of modern agriculture [24,25]. Research shows that farmers' decision-making is influenced by many factors [26,27]. The ecological farming decision-making that farmers engage in is a complicated process. In general, in the face of the ecological deterioration of cultivated land, rational farmers are more willing to adopt ecological farming, i.e., reduce the application of pesticides and fertilizers, recycle agricultural film, and so on [28,29], to reduce the negative impacts. LEs and the basic condition of cultivated land are important influencing factors of farmers' decision regarding agricultural production behavior [30–33]. Farmers adopt various ecological farming methods based on their endowments and cultivated land. Therefore, LEs and cultivated land fragmen-

tation (CLF) are important factors affecting farmers' decision-making, and studying the relationship among these factors is the key to increasing the adoption of ecological farming.

Farmers' ecological farming and their decision-making are complex cognitive and social processes [34,35]. A deeper understanding of the vital factors influencing ecological farming decision-making is of great importance for policy-makers to design more effective policies. There have been some attempts to analyze the factors that influence farmers' decision-making [36,37]. However, relevant studies based on LEs and CLF perspectives are still not sufficient. Moreover, most of the existing studies only study the willingness to adopt or the degree of adoption alone, and research on the complete decision-making process of farmers is lacking, resulting in an inability to fully grasp the mechanism of factors affecting farmers' decisions. In fact, farmers' ecological farming adoption behavior is a series of decision-making processes, including two interrelated and sequential processes of "whether they are willing to adopt" and "the degree to which they will adopt". This study seeks to fill this gap by investigating the influence of LEs and CLF on ecological farming decision-making practices and by refining the farmer's decision-making process through two stages with the double-hurdle model.

Therefore, the key research questions in this paper include how LEs and CLF influence ecological farming adoption behavior and how farmers' decision-making has changed in two stages. This study contributes to the existing research on farmers' decision-making with respect to ecological farming as follows: (1) We study the effects of LEs and CLF on ecological farming decision-making; (2) we simultaneously explore the influence of the two mainstream social phenomena of LEs and CLF on farmers' decision-making; (3) by using the double-hurdle model, we divide the decision-making of farmers into two stages, adoption willingness and adoption degree, to better analyze the impact on farmers. The results from this paper can provide relevant policy references for China and other developing countries.

The remainder of this paper is organized as follows: The second section describes the action mechanism and puts forward the corresponding research hypothesis. This is followed by descriptions of our study areas, survey design, data collection, research method, variables, and measurements. The fourth section provides the empirical results, and a discussion follows. The last section provides the conclusions and policy recommendations.

2. Mechanism of Farmers' Actions and Research Hypotheses

Ecological farming decision-making regards the decisions to carry out ecological farming and, to a certain extent, put into practice the specific behaviors included in ecological farming [38]. According to farmer behavior theory, ecological farming decision-making can be understood as both a willingness to adopt it and the degree of its adoption. The willingness to adopt ecological farming determines the enthusiasm farmers have to adopt ecological farming, while the degree of adoption reflects the extent to which farmers adopt specific behaviors of ecological farming [39,40]. According to the willingness to adopt, farmers can be divided into two types: willing to adopt ecological farming and unwilling to adopt ecological farming. The extent to which farmers have adopted ecological farming is reflected by the number of specific behaviors they have adopted.

The decision-making of farmers is influenced by many factors, among which labor endowment and the fragmentation of cultivated farmland are important factors. With the deepening of China's market-oriented reform and the continuous improvement in the land transfer system, urbanization has been able to develop rapidly, resulting in structural changes in agricultural production. Guided by market demand, the labor allocation of farm households has been adjusted. At the same time, the differences in LEs have led to increasingly significant differences in farmers' decision-making [41,42]. In this paper, based on existing studies [43], the labor endowment of farm households is divided into the total household population size, the number of laborers, the number of permanent farm laborers, and the degree of part-time employment. CLF is a comprehensive indicator reflecting the area, distance, and distribution status of cultivated land. The size of CLF has a great impact on the scale and mechanization of agricultural production, the use of new technologies and

equipment, and the efficiency of the intensive use of cultivated land [44]. Therefore, this research enriches the existing research by establishing a conceptual framework of ecological farming decision-making process (Figure 1).

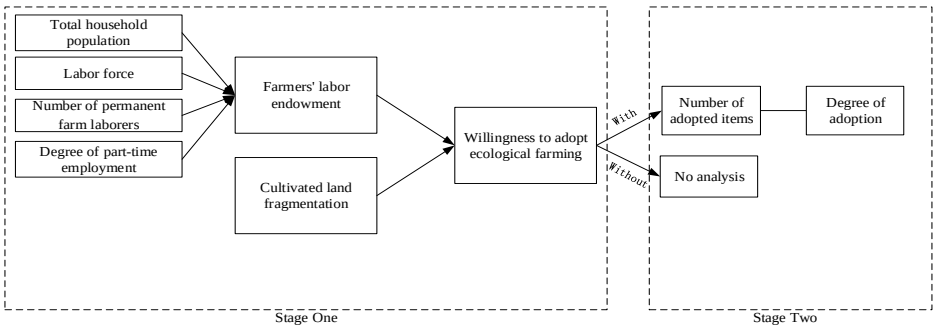

Figure 1. Ecological farming decision-making process.

2.1. Impact of LEs on Farmers'Ecological Decision-Making

Scholars generally agree on the importance of LEs in the process of transforming agricultural production methods or adopting new agricultural technologies, and believe that LEs have a great influence on farmers' production decisions and technology adoption decisions. Farmers' LEs refer to all labor resources and the capabilities of individual farmers and their entire households, including the number of laborers and the share of input labor [45]. In studies on labor endowment, usually, only the total household population size and the total number of laborers are considered. In this paper, considering the dependence of agricultural labor engagement on the labor force, the number of permanent farming laborers, and the degree of part-time employment are also considered. The number of household populations can reflect the human resource reserve of a household. In general, the larger the total number of household members, the more likely a farming household is to adopt conservative, traditional agricultural production methods and the less likely they are to adopt ecological farming. Under the premise that China's smallholder economy is still the mainstay, the more laborers they are, the stronger their ability to implement ecological farming, and the more likely they are to choose ecological farming. The number of permanent farm workers is a reflection index of the importance of, and the dependence on, the agricultural production of farming households. The more permanent farm workers there are, the greater their dependence on agriculture, and the more their adoption of ecological farming can increase income and protect cultivated farmland. The higher the degree of part-time employment, the more time can be spent working outside the home, and the higher the non-farm income can be. The more exposure farmers have to the relevant information, the more likely they are to adopt ecological farming. Based on this, this paper puts forward the following hypotheses:

Hypotheses 1 (H1). *LEs have a significant effect on decision-making of farm households in ecological farming.*

2.2. Impact of CLF on Farmers'Ecological Decision-Making

Cultivated land is the most basic element of agricultural production and is the basis for conducting agricultural production. The fragmentation of cultivated land is one of the most important factors affecting agricultural production, and it is also an important factor affecting farmers' technology adoption decisions. The reasons for this are as follows: On the one hand, moderate CLF is conducive to the diversity of agricultural cultivation and the allocation of natural risks, which not only disperses labor intensity and improves labor efficiency but also reduces natural risks in agricultural production, thus improving the overall benefit of agriculture and facilitating farmers' long-term investment in cultivated land; on the other hand, the fragmentation of cultivated land makes it difficult for farmers to carry out a mechanized production and large-scale operations, which greatly increases

the difficulty of agricultural production [46]. However, based on the current agricultural production in Jiangxi Province, which is dominated by a smallholder production model, the more fragmented the cultivated land is, the more difficult it is for farmers to carry out agricultural production, and the less motivated they are to adopt ecological farming, to any degree. Based on the above study, the following hypotheses are proposed.

Hypotheses 2 (H2). *CLF has a significant negative effect on ecological farming decision-making.*

3. Data and Methods

3.1. Study Area

Jiangxi Province is located in Southeastern China on the south bank of the middle and lower reaches of the Yangtze River (Figure 2). It covers an area of 166,900 km^2 and lies between 24°29′–30°04′ N and 113°34′–118°28′ E. It has a population of 46.661 million. Jiangxi Province belongs to subtropical monsoon climate, and the average precipitation is 1700–1943 mm, with a mean temperature of 16.3–19.5 °C. The terrain is mainly hilly and mountainous and includes the Poyang Lake Plain, the Jitai Basin, the Ganzhou Basin, the Qingjiang Basin, and other landforms. According to the Statistics Communique of National Economic and Social Development of Jiangxi Province, in 2019, the cultivated area of grain of the whole province was 36,651 ha, and the annual grain output reached 21.574 million tons. Jiangxi Province is an important grain-producing area in the south of China, and the area sown with grain crops accounts for 60–70% of the total area sown with crops. Rice accounts for about 85–90% of the area sown year-round with grain crops. The distribution of wheat is mainly in Northern Jiangxi, while sweet potatoes are most abundant in Central Jiangxi and Southern Jiangxi, and soybeans are mainly produced in the east and south shores of Poyang Lake and the Jitai Basin. Oilseed crops mainly include rapeseed, peanut, sesame, and woody oilseed oil tea. In addition, cotton, ramie, sugar cane, roasted tobacco, tea plantations, and citrus are grown. Jiangxi Province has a large agricultural population, a largely rural area, and a relatively high proportion of agriculture. It is a typical agricultural province and one of the 13 major grain-producing regions in China, and the output of major agricultural products such as grain, oilseeds, vegetables, and aquatic products has a pivotal position in China [47]. Jiangxi Province is the epitome of Chinese agricultural characteristics. The sample of Jiangxi farmers basically reflects China's agricultural development, and the policy insights are applicable to the whole country.

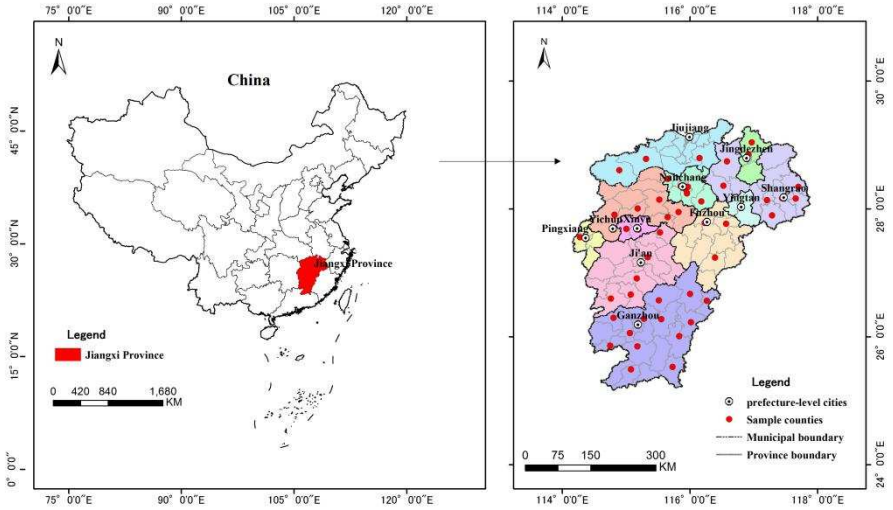

Figure 2. Location of the study area.

3.2. Survey Design and Data Collection

Based on a literature review of farmers' decision-making and ecological farming [48,49], a preliminary questionnaire was designed. After consulting with experts and a preliminary

study, a final questionnaire was determined. The main structure of the survey is shown in Appendix A. The questionnaire mainly includes three primary parts. The first part primarily collected information on the respondents' gender, age, educational attainment, the degree of part-time employment, the total household population, the labor force, the cultivated land area, the number of cultivated plots, and household income. The second part primarily asked about farmers' knowledge and adoption of ecological farming, such as soil testing and fertilization, planting green manure, reducing chemical fertilizer application, using low-toxicity and low-residue pesticides, straw return to the field, and agricultural film recycling. The last part focused on farmers' knowledge of the ecological environment and ecological farming.

The field survey was conducted in Jiangxi Province from January to March 2018. A multistage stratified random sampling method was used to determine the specific survey points. The sample farmers were selected by adopting a combination of stratified sampling and random sampling. First, 4 to 5 counties (districts) from 11 cities in Jiangxi province were selected based on the level of economic development, grain production, and population. During the second stage, 2–3 villages and towns were randomly selected in every county (district), and in each town, 1–2 villages were randomly selected. For the third stage, according to the population and size of the villages, 10–15 rice households were randomly selected. With the combination of interviews and questionnaires, this survey was conducted with household heads or major family members involved in agricultural management decisions. A total of 1600 questionnaires were issued, and 1488 effective questionnaires were obtained after eliminating some questionnaires with missing or inconsistent core data. Thus, the effective rate was 93.00%.

3.3. Research Method

In this survey, there were many individual farmers who had no intention of adopting. To solve such problems, the Tobit model was mostly adopted. However, this paper analyzes the decision-making of farmers with regard to the adoption of ecological farming in two stages, i.e., farmers' willingness and the degree of adoption, and the Tobit model cannot deal with a two-stage problem. For a two-stage study and analysis of influencing factors, the Heckman model is generally used for fitting, but the equation of adoption intention and the equation of adoption degree in this model are not independent of each other, and the error of the equation of adoption intention is brought into the equation of adoption degree, which will cause a deviation from model estimation. Therefore, a double-hurdle model that can well separate adoption intention and adoption degree into two stages was used so that endogenous problems did not arise.

The double-hurdle model is an econometric model proposed by the economist Cragg in 1971. It divides the process of individual decision-making into two stages: whether to participate and how much to participate [50]. Only two stages can form a complete decision in the double-hurdle model. Moreover, the equation of adoption intention and the equation of adoption degree are two independent equations, which can well avoid the error caused by the influence of either equation. The double-hurdle model has been successfully applied in empirical research on household energy expenditure [51], consumers' willingness to pay [52], and decision-making in farming technology [53].

The double-hurdle model consists of two parts: adoption willingness and adoption degree, and its equations are set as follows:

(1) Adoption willingness (participation in decision-making)

$$\mathrm{D}^*{}_i = Z_i\alpha + \mu_i, \mu_i \sim N(0,1), \begin{cases} D_i = 1, \quad if \quad \mathrm{D}^*{}_i > 0 \\ D_i = 1 \quad if \quad \mathrm{D}^*{}_i \leq 0 \end{cases} \tag{1}$$

In the formula, D^*_i is the latent variable. When the observed value variable D_i is 1, it indicates a willingness to adopt ecological farming. When its value is 0, the farmer has no willingness to adopt ecological farming. Z is a variable that influences participation in decision-making.

(2) Adoption degree (adoption decision)

$$Y^*_i = X_i\beta + \nu_i, \nu_i \sim N(0,1), \begin{cases} Y_i = Y^*_i, & if \quad D_i = 1 \quad and \quad Y^*_i > 0 \\ Y_i = 0, & else \end{cases} \tag{2}$$

In the formula, Y^*_i is the potential adoption intention variable, X_i is the variable affecting the degree of adoption; μ and ν are random disturbance terms, assumed to obey a binary joint normal distribution, and $corr(u_i, \varepsilon_i) = \rho$.

If $D^* > 0$, farmers are willing to adopt ecological farming, at which point, D = 1. Conversely, D = 0 ($D^* \leq 0$) if farmers are not willing to adopt ecological farming. If $D^* > 0$ and $Y^* > 0$, the farmer has adopted ecological farming, and their degree of adoption is $Y = Y^*$; otherwise Y = 0.

It can be seen in Formula (2) that farmers who adopt 0 items are likely to choose not to participate in the decision-making stage or be willing but not actually engage in any adoption. The log-likelihood function of the double-hurdle model is:

$$\log(L) = \sum_{y_i=0}\left\{\log\left[1 - \varphi\left(z_i\alpha, \frac{x_i\beta}{\sigma}, \rho\right)\right]\right\} + \sum_{y_i>0}\left\{\log\left[\varphi\left(\frac{z_i\alpha + \frac{\rho}{\sigma}(Y_i - x_i\beta)}{\sqrt{1-\rho^2}}\right)\right] - \log(\sigma) + \log\left[\varphi\left(\frac{Y_i - x_i\beta}{\sigma}\right)\right]\right\} \tag{3}$$

When ρ = 0, its log-likelihood function is

$$Log(L) = \sum_0 \ln\left[1 - \Phi(z'_i\alpha)\Phi\left(\frac{x'_i\beta}{\sigma}\right)\right] + \sum_+ \ln\left[\Phi(z'_i\alpha)\frac{1}{\sigma}\varphi\left(\frac{Y_i - x'_i\beta}{\sigma}\right)\right] \tag{4}$$

In the formula, $\phi(\bullet)$ is the cumulative probability distribution function and the probability density function.

3.4. Variables and Measurements

Each variable included in the model is defined in Table 1. The dependent variable of this paper is the decision-making behavior of farmers in ecological farming, which is broken down into two stages, the willingness to adopt and the degree of adoption. The question set in the first stage is whether there is a willingness to adopt 10 specific behaviors of ecological farming. The options are divided into 5 categories, namely, very willing, relatively willing, willing, not very willing, and not willing. Since the first three options are all "willing" attitudes, one of the first three represents willingness to adopt and is assigned a value of 1, and a choice of one of the last two is assigned a value of 0. The second stage determines the degree of adoption of specific ecological farming behaviors by willing farmers. Based on the definition of ecological farming and combined with the limitation of the questionnaire survey, ecological farming in this paper mainly refers to 10 specific behaviors commonly used by farmers at present, such as soil formula fertilization, agricultural film recovery, a reduced application of chemical fertilizers, planting with green fertilizers, low-toxicity and low-residue pesticides, rational crop rotation, straw returning, ecological agriculture, less tillage, and not illage, and an application of organic fertilizers. One point is provided for adopting 1 item, two points for 2 items, and so on, and the final score interval is [0,10]. If there is a willingness to adopt in the first stage, the question of the specific action items for the adoption of ecological farming can be continued in the second stage.

Table 1. List of variables and descriptive statistics.

Category	Variable	Definition	Mean	Std. Dev.
Dependent variables	Willingness	Willing to adopt = 1; No willingness to adopt = 0	0.67	0.45
Decision-making of ecological farming	Degree	Number of specific ecological farming behaviors adopted by farmers	5.32	2.03
Independent variables	Hhsize	Actual number of household population (persons)	5.39	1.77
Labor endowment	Labor force	Actual number (persons)	3.45	1.31
	TP farm laborers	Actual number of permanent farm laborers (persons)	1.37	0.88
	part-time empl	Migrant workers = 4; Work primarily and have part-time jobs = 3; Agriculture primarily and have part-time jobs = 2; Agriculture = 1	2.35	1.08
	CLF	Area of cultivated land/number of cultivated land blocks	1.08	1.33
Control variables	Gender	Male = 1; female = 0	0.75	0.44
	Age	Age of respondents	48.38	10.77
	Health	Very good = 5; better = 4; Good = 3; worse = 2; very bad = 1	3.54	0.85
	Education	Junior College and above = 4; High school or technical secondary school = 3; Junior high school = 2; Primary schools and below = 1	1.84	0.83
	PCT of agr_income	Agricultural income/Annual household income	0.38	0.29
	Agri_subsidies	Availability of agricultural subsidies(yes = 1; no = 0)	0.78	0.42
	Cooperative	Whether to join a Cooperative (yes = 1; no = 0)	0.14	0.35

One of the greatest weaknesses of the concept of peasant labor endowment is the lack of consensus on how to measure it [54]. We used 4 potential items in the questionnaire to measure farmers' labor endowment, including the total family population, the number of labor force, the number of perennial agricultural laborers, and the degree of part-time employment. Fragmentation of cultivated land is represented by the ratio of cultivated land area to the number of cultivated land blocks [55].

A series of relevant control variables were added to the model to improve the scientific nature and credibility of the research results and to better analyze the decision-making of farmers with respect to ecological farming. Relevant studies have shown that other factors can also have an important impact on the decision-making of farmers in terms of ecological farming. Therefore, gender, age, education level, health status, the proportion of agricultural income, whether to join the cooperatives, and the availability of agricultural subsidies were selected as control variables [56].

In order to ensure the stability and accuracy of the model and make the results real and effective, the multicollinearity of each variable was tested before an empirical analysis of the double-hurdle model. According to the relevant evaluation criteria, if the two restrictions of Tolerance (Tolerance) > 0.1 and the variance inflation factor (VIF) <10 are both met, there is no serious multicollinearity problem between variables. The results showed that 0.54 < Tolerance < 0.97, and 1.03 < VIF < 1.86. Both are within a reasonable range, and there was no serious multicollinearity among variables.

4. Results

4.1. Socioeconomic Characteristics of the Respondents

The respondents' characteristics were examined and are presented in Table 2. The qualitative and quantitative information gathered was edited, coded, and analyzed using Excel® spreadsheets, Stata 13 statistical package software (StataCorp, 2015. Stata Statistical Software: Release 15. College Station, TX, USA), and IBM SPSS statistics 26 (SPSS Inc., Chicago, IL, USA). Through the analysis of 1488 valid questionnaires, the results show that 74.6% of the interviewed farmers are male and that men still comprise the majority of laborers in agricultural production. The average age of the interviewed farmers was 48.38 years old, and the proportion of farmers over 50 years old was 36.15%. The educational level of the respondents was generally low, and the average education level was between primary school or less and junior high school. The mean household size of the interviewees

was 5.39, medium size. The average contracted cultivated land area was 5.55 acres. Small peasant households with a smallcultivated land area are the most significant proportion of households in agricultural production. The average yearly household income was USD 12,797.25. To sum up, the sample farmers are mainly middle-aged with a low education level, a medium family size, a smallcultivated land area, and a low family income level. The survey data are basically consistent with the realities of farmers in Jiangxi province.

Table 2. Descriptive statistics of the survey sample.

Variable	Description	Mean	Std. Dev.
Gender	male = 1; female = 0	0.75	0.44
Age	Age of the respondent	48.38	10.77
Education	Primary school and below = 1; Junior high school = 2; High school = 3; Technical secondary school and above = 4	1.84	0.83
Hhsize	Number of household members	5.39	1.77
Cultivated	Contracted cultivated land area	5.55	14.96
Landowned Income	Respondent's yearly household income (US$)	12,797.25	10867.29

4.2. Respondents' Adoption of Ecological Farming

Among the 1488 valid questionnaires, 1000 interviewed farmers had a willingness to adopt ecological farming, accounting for 67.20% of the total sample. On the whole, farmers had a high willingness to adopt ecological farming. Among the farmers who were willing to adopt ecological farming, the average number of ecological farming practices was 5.32. In addition, there were great differences in the adoption degree of ecological farming among farmers (Figure 3). Among the farmers with the intention to adopt ecological farming, the number of adoption items was less than six, and the cumulative proportion of this finding was 53.50%. Considering the status quo of the Jiangxi province, a typical large agricultural province with a large agricultural population, a largely rural area, and a relatively high agricultural proportion, farmers had a high willingness to adopt ecological farming but not a high degree of adoption.

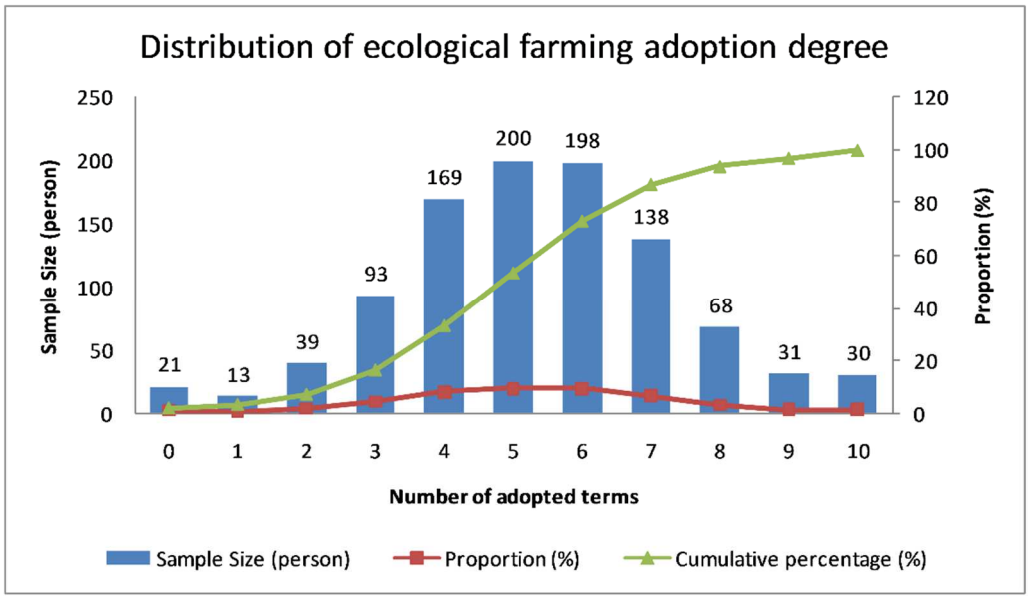

Figure 3. Distribution of ecological farming adoption degree.

4.3. Impact of Farmers' LEs and CLF on Ecological Farming Decision-Making

The impacts of LEs and CLF on ecological farming behavior are displayed in Table 3. The χ^2 values for the significance test of the two regression models are 73.59 ($p < 0.01$) and 59.56 ($p < 0.01$), indicating that some predictor variables can predict the ecological farming behavior of farmers. In addition, the Heckman model was used for a robustness test (Table 4), and it was found that the direction and degree of influence were basically the same, so the model was more stable, and the overall fit was superior.

Table 3. Estimation results of the double-hurdle model.

Variable	Willingness to Adopt		Degree of Adoption	
	Coef	Std.Err	Coef	Std.Err
Hhsize	−0.09 ***	0.03	−0.11 **	0.05
Labor force	0.10 ***	0.04	0.15 **	0.64
TP farm laborers	−0.01	0.04	−0.08	0.08
part-time empl	0.04	0.04	0.17 *	0.07
CLF	−0.07 ***	0.03	−0.03	0.06
Gender	0.01	0.09	−0.00	0.14
Age	0.01	0.01	−0.01	0.01
Health	0.04	0.04	0.04	0.08
Education	0.17 ***	0.05	0.00	0.08
PCT of agr_income	0.54 ***	0.14	0.44*	0.24
Agri_subsidies	0.40 ***	0.08	0.58 ***	0.16
Cooperative	0.25 **	0.10	0.70 ***	0.17
Cons	−0.670 *	0.35	4.77 ***	0.62
Log likelihood	−904.69		−1984.4225	
	LR chi2(12) = 73.59		wald chi2(12) = 59.56	
Prob>chi2	0.00		0.00	
Pseudo R2	0.039		_	

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4. Heckman model validation results.

Variable	Willingness to Adopt		Degree of Adoption	
	Coef	Std.Err	Coef	Std.Err
Hhsize	−0.09 ***	0.03	−0.11 **	0.05
Labor force	0.10 ***	0.04	0.14 **	0.06
TP farm laborers	−0.006	0.04	−0.08	0.079
Part-time empl	0.036	0.04	0.16 **	0.068
CLF	−0.07 ***	0.03	−0.03	0.058
Gender	0.01	0.08	−0.00	0.14
Age	0.01	0.00	−0.01	0.01
Health	0.04	0.04	0.04	0.07
Education	0.17 ***	0.05	−0.00	0.08
PCT of agr_income	0.56 ***	0.14	0.44*	0.23
Agri_subsidies	0.40 ***	0.082	0.57 ***	0.16
Cooperative	0.25 **	0.104	0.691 ***	0.17
Cons	−0.67 *	0.35	4.79 ***	0.61

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The estimation results of the regression analysis of factors influencing the willingness to adopt ecological farming and the degree of that adoption are presented in Table 3. Consistent with earlier findings, the results indicate that LEs and CLF are statistically significant factors. Respondents who reported a large household size and high CLF would not consider adopting ecological farming and preferred an original cultivation method. If respondents had a greater labor force, a high degree of part-time employment, and a low CLF, they would adopt ecological farming.

Our results show that the effects on ecological farming behavior differ in response to different LEs and CLF. The household size has a significant negative impact on the willingness to adopt, and the degree of, ecological farming. The larger the household population, the lower the willingness to adopt, and the degree of, ecological farming. Based on the current situation of traditional Chinese smallholder production patterns and the mountainous and hilly topography of Jiangxi Province, it is difficult to form economies of scale to increase family income. The larger the total population of a family, the greater the pressure in family life; furthermore, the lower the risk resistance, the lower the willingness to adopt, and the degree of, ecological farming when certain risks are present. The number of laborers has a significant positive effect on the willingness to adopt, and the degree of, ecological farming. This indicates that the larger the labor force is, the higher the willingness to adopt, and the degree of, ecological farming will be. Compared with traditional farming methods, more laborers and material resources are needed in the early stage of ecological farming. The larger the number of laborers, the more the demand for a labor force in the adoption of ecological farming can be guaranteed, which makes farmers more willing to adopt ecological farming. The degree of concurrent occupation has a positive effect on the degree of ecological farming adoption. The higher the degree of part-time farming, the higher the degree of adoption. Due to the development of urbanization, many rural laborers move to cities and towns for short-term part-time work or long-term work, and the proportion of pure farming households is small, so the impact on the adoption intention of ecological farming is less significant. However, among farmers with a willingness to adopt ecological farming, those with a higher degree of part-time farming have a higher non-agricultural income, a lower capital constraint, a stronger anti-risk ability, more access to external relevant information, and a higher degree of adoption of ecological farming and other new technologies. This result verifies Hypothesis H1, i.e., that labor endowment has a significant impact on ecological farming decision-making.

CLF has a significant negative impact on farmers' willingness to adopt ecological farming, which is consistent with Hypothesis H2. That is, the smaller the degree of cultivated farmland fragmentation, the higher the willingness to adopt ecological farming. The greater the degree of CLF, the more difficult it is for peasant households to scale and mechanize farming, which leads to a low utilization efficiency of cultivated land and a higher production cost for peasant households, and seriously hinders peasant households' willingness to adopt more advanced and more effective farming techniques and modes. However, there is still a gap between peasant households' intentions and behaviors. There may not be corresponding behaviors if there is anintention, and even behaviors that are contrary to thatintention can appear [57]. Therefore, CLF affects the willingness of farmers to adopt ecological farming but has no significant impact on the degree of their adoption behavior.

Education level has a significant, positive impact on farmers' willingness to adopt ecological farming. Through education, farmers' ability to respond to, understand, and accept ecological farming information can be greatly improved, and their willingness to adopt ecological farming will be higher. The proportion of agricultural income, the availability of agricultural subsidies, and whether farmers had joined cooperatives had a significant positive impact on the willingness to adopt, and the degree of, ecological farming. The proportion of agricultural income represents the proportion of agricultural income in total household income. The higher the proportion, the greater the degree of input and dependence on agriculture. In order to obtain a higher income, the adoption of ecological farming conforms to the behavior theory of farmers of rationalsmallholder schools. Agricultural subsidies add a layer of insurance for farmers, enhancing the risk resistance of farmers to adopt new technologies, and the enjoyment of agricultural subsidies can enhance the enthusiasm of farmers to adopt ecological farming. The cooperative model has stronger vitality and advantages than traditional farmers, and farmers who join cooperatives have a stronger tendency to adopt ecological farming. Therefore, farmers with a higher proportion of agricultural income, who receive agricultural subsidies, and who

have joined joining cooperatives have a stronger willingness to adopt ecological farming and a higher degree of adoption.

5. Discussion

Ecological farming is important for conserving and protecting farmland resources. In essence, it is an environmentally friendly use of farmland that respects the ecosystem laws of farmland resources and aims to achieve the sustainable use of farmland. It is based on ensuring the health of the farmland itself and maintaining its productive and ecological qualities. By adopting ecological farming, farmers can protect their farmland resources from being destroyed. Not only can they obtain greater returns in agricultural production, but they can also improve the rural living environment. The development of green agriculture and sustainable agriculture in Jiangxi Province can also be improved.

Our findings suggest that LEs have significant effects on ecological farming decision-making. The labor force has a negative effect on farmers' willingness to adopt ecological farming and the degree of adoption. This finding was expected because agricultural production requires a large amount of labor, and an adequate labor force can increase the opportunities for farmers to adopt ecological farming [58,59]. Marenya and Barrett [60] indicated that families that have an adequate labor force are likely to adopt ecological farming, especially straw returning and the application of organic fertilizer. In terms of overall impacts, the degree of part-time employment has a positive impact on the degree of adoption. This finding is consistent with other studies [61]. Specifically, farmers with a higher degree of part-time employment are more likely to adopt ecological farming, such as straw returning to the field, shrimp-fish culture, notill or lesstillage on the farmland, pesticide control techniques, and deep tillage. Of course, the results of this study also differ from other studies. A study of the factors influencing the adoption behavior of different types of rice farmers found that household size positively influenced the adoption of conservation tillage technology [62]. However, this study did not classify farmers into traditional retail farmers and large grain growers, and there may be large differences in the economic, agricultural, and social development levels in the study area.

Our results also show that CLF has a negative effect on willingness to adopt ecological farming. The fragmentation of cultivated land is not conducive to agricultural production and equipment use and reduces the likelihood that farmers will practice ecological farming. This finding is consistent with other studies [63,64].

Many factors were found to have important effects on ecological farming behavior. First, education level had a significant, positive effect on willingness. Farmers with a high education level usually have a high willingness to adopt ecological farming. In previous studies [65,66], education level was found to be positively associated with farmers' willingness to farm ecologically. Thus, it seems that more investment in rural education is required to increase farmers' willingness and the degree of ecological farming. Second, the proportion of agricultural income to total household income is another important factor influencing the behavior of farmers. Some studies found that the higher the share of agricultural income in the total household income, the higher the willingness to adopt, and the degree of, ecological farming, as found in [67]. Finally, regression results show that agricultural subsidies also play a significant role in ecological farming behavior.

Although there are important discoveries revealed by these studies, there are also limitations. This study did not compare and analyze the differences among farmers in three different terrain areas, i.e., plains, hills, and mountains. Topography is one of the most important factors affecting agricultural farming. A plain terrain is suitable for large-scale agriculture and the use of machinery, but mountainous and hilly terrains can make agricultural production more difficult. Distinguishing the ecological farming behavior of farmers in different topographic areas can provide a deeper understanding of the reasons for changes in farmers' behavior. Recent studies have shown that there is a discrepancy between willingness and behavior, so behavior should be considered as well, in additionto willingness and degree [68,69]. Moreover, we only examined the ecological

farming decision-making of farmers in Jiangxi Province, so there is a lack of generality in the sample selection. However, these problems could be solved if we add a classification study of farm households with different topographies and expand the number and scope of the sample. Despite the above limitations, the findings of our study contribute to an understanding of ecological farming decision-making through two major social contexts: labor force fragmentation and CLF.

6. Conclusions and Policy Recommendations

Against the background of farmer differentiation and CLF, based on the field survey data from 1488 farmers in Jiangxi Province, this paper considers farmers' participation in ecological farming as occurring in two stages: a willingness to adopt it and the degree of its adoption. The influence of LEs and CLF on ecological farming decision-making was analyzed using the double-hurdle model. The survey results indicate that farmers have a high willingness to adopt ecological farming, but the degree of adoption is low. LEs and CLF are strongly correlated with farmers' willingness to adopt, and the degree of, ecological farming. On the one hand, farmers with a small total household population, a large labor force, and relatively low cultivated farmland fragmentation are more willing to adopt ecological farming. On the other hand, farmers with a small total household population, a large labor force, and a high degree of part-time employment have a higher degree of ecological farming adoption. In addition, education level, the proportion of agricultural income, agricultural subsidies, and membership in cooperatives all have a positive impact on the willingness to adopt, and the degree of, ecological farming.

The results show that farmers' labor endowment and cultivated land fragmentation can significantly affect farmers' decision-making with respect to the adoption of ecological farming. More than half of the respondents were willing to adopt ecological farming, but the average number of activities adopted among the 10 ecological farming technologies we considered was only 5.32, which is not high for Jiangxi Province, which has a strong agricultural base. There is still much room for farmers to improve their degree of adoption. Based on the current study findings, there are important implications forcultivated land conservation and sustainable agriculture that should be emphasized by policy-makers. First, the results indicate that agricultural income and membership in cooperatives can increase farmers' adoption of ecological farming. Thus, it is necessary to increase the investment of funds and related technical services and to strengthen the promotion of ecological farming. Considering the reality of Jiangxi Province, it is necessary to protect the interests of farmers in ecological farming, to enhance their willingness to adopt, and the extent to which they adopt, ecological farming. Second, our research shows that part-time employment can help farmers increase income and extend information sources. This suggests that the government can build a platform for peasant households to work temporarily and encourage peasant households to find other work during the low season. When farmers have part-time jobs, they have access to more information about ecological farming from the outside world, broaden their horizons, and develop a deeper understanding of relevant policies and technologies, thereby increasing their willingness to adopt, and the degree to which they adopt, ecological farming. Third, as indicated by the results of this study, the less fragmented the cultivated land is, the more farmers are willing to adopt ecological farming. Therefore, the government should standardize and promote land circulation and land management and promote large-scale land management. On the one hand, rural land circulation and land consolidation can improve the utilization efficiency of cultivated land, reduce waste, effectively reduce the cost of ecological farming, and increase the income of farmers in agricultural production. On the other hand, it can reduce the breakage of cultivated land and promote the development of modern and mechanized agricultural production. Finally, the results indicate that education greatly influences the willingness of farmers to adopt ecological farming. Hence, the relevant actors should increase investment in rural education, improve the rural education system, and cultivate new types of agricultural subjects. The development of rural education, on the one hand,

can improve the education level of farmers and promote the adoption of ecological farming behavior. On the other hand, the cultivation of new agricultural subjects can not only increase the proportion of agricultural income among farmers but also guide farmers to join cooperatives and other new agricultural operating subjects so as to increase the willingness to adopt, and the degree of, ecological farming.

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Appendix A

Table A1. Main structure of the survey questionnaire.

Question Categories	Questionnaire
1. Farmers' Labor Endowment	How many members are there in your family? How many laborers are in your household (people aged 16–60 who are capable of working)? How many people are in the permanent farming workforce? What is your degree of part-time work? ☐Work ☐Work as a mainstay, farming as a supplement ☐Farming as a mainstay, and work as a supplement ☐Farming
2. Cultivated Land Fragmentation	Area of contracted cultivated land. Number of plots of contracted cultivated land.
3. Respondents' Background Information	
3.1 Gender	What's your gender?
3.2 Age	How old are you?
3.3 General health status	How is your physical condition? ☐Very good ☐Good ☐General ☐Poor ☐Very poor
3.4 Education	What is your highest level of education? ☐College degree or above ☐High school or post-secondary education ☐Lower secondary education ☐Primary school or below
3.5 Share of Agricultural Income	What is the share of agricultural income in total income?
3.6 Agricultural Subsidies	Are you entitled to agricultural subsidies?
3.7 Cooperative	Have you joined a farmers' cooperative?

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