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Analysis of Factors Influencing the Adoption Behavior of Agricultural Productive Services Based on Logistic—ISM Model: A Case Study of Rice Farmers in Jiangxi Province, China

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Abstract: Agricultural productive services can increase grain output and farmers' incomes, promote agricultural production efficiency and break the constraints of agricultural environmental resources. In practice, China's agricultural productive services are developing, and the use of agricultural machinery in rice planting is not sufficient. The employment rate of machinery in farming and harvesting is high, but the employment rate of machinery in seedling raising, planting, fertilization, and pesticide spraying is very low. This paper takes rice farmers in Jiangxi Province of China as the research object, uses 647 survey data of farmers in nine counties of Jiangxi Province, constructs a logistic-ISM model, first identifies the influencing factors of rice farmers' adoption of agricultural productive services, and then analyzes the hierarchical structure of each influencing factor. The results indicate that: (1) among the seven significant influencing factors of rice farmers' adoption of agricultural productive services, agricultural income rate and rice planting area are the deep-rooted factors; (2) the social identity of the household head, the risk preference of the household head and the understanding degree of the social service subsidy of agricultural machinery are intermediate level factors; and (3) the age of the household head and the number of agricultural laborers in the family are the direct factors. Based on the significance analysis of the influencing factors of rice farmers' adoption of agricultural productive services, this paper puts forward policy suggestions to strengthen policy publicity, enhance the level of farmer policy cognition; encourage the transfer of labor force and reasonable allocation of family agricultural labor force; encourage land transfer and expand the scale operation of rice; we should guide farmers reasonably and give full play to their professional advantages.

Keywords: agricultural productive services; farmers' behavior; Logistic-ISM model; China

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1. Introduction

The inevitable trend of agricultural development is sustainable agriculture and modern agriculture. Both sustainable agriculture and modern agriculture need to rely on scientific and technological progress, agricultural mechanization is the product of scientific and technological progress, agricultural machinery is an important symbol of agricultural modernization and an indicator of the deepening of agricultural capital [1]. It also has an important impact on sustainable agriculture development [2]. Agricultural machinery services and the adoption of mechanical technologies can save labor, enhance agricultural productivity and lower the unit cost of crop production [3,4], but mechanization inputs are usually expensive, so providing professional services will be the way forward [5]. Whether farmers buy machinery to operate by themselves or to buy machinery services is often determined by multiple factors. Lack of sufficient labor means that more machinery is needed, because agricultural machinery can save labor [6,7]. Farmers with below-average productivity tend to outsource [8]. Farmers outsource some labor-intensive stages of

production to specialized mechanization service providers in response to rising labor costs [9]. When the family's operating area exceeds the family's labor capacity, it is unable to afford the purchase of machinery, and it is difficult to pay the wages of the hired labor, it may choose to purchase agricultural productive services. There is a complementary relationship between household-owned farm machinery and outsourcing agricultural machinery services [10].

Schultz pointed out in "Transforming Traditional Agriculture" that the key to transforming traditional agriculture is to introduce modern production factors [11]. We believe that agricultural productive services are one of the modern production factors. The development of agricultural productive services can transform traditional agriculture, which is an inevitable requirement to promote the organic connection between small farmers and modern agriculture.

The adoption behavior of agricultural productive services in this paper mainly refers to whether mechanical services are purchased in the fields of rice planting such as farming, sowing, seedling raising, planting, spraying, fertilizing, and harvesting, it includes agricultural machinery socialization services and outsourcing of agricultural production links. Mechanization services can increase farm productivity by replacing labor [12,13], agricultural productive services can promote production efficiency, family economic welfare and the development of modern agriculture [14–16], and the service sector plays a great role in medium and high-scale development, increasing land productivity, thereby improving agricultural productivity [17,18]. Sustainable agricultural mechanization is the essential to the agricultural sector development [19]. Mechanized services, which include machinery leasing and technology services, have long been regarded as a supplement to self-owned machinery in agricultural production of OECD (Organization for Economic Co-operation and Development) countries. From 1973 to 2011, the proportion of plant and machinery rental expenditures in the total intermediate cost of the U.S. agricultural sector increased by 40% [12]. Agricultural production outsourcing is crucial to the rapid mechanization of agriculture [20]. Agricultural production outsourcing can improve the welfare of smallholder farmers by increasing household income, increasing consumer spending and improving labor convenience [21]. Outsourcing services can not only save labor and increase the speed and timeliness of operations, but also promote the adoption of agriculture green production methods, improving the ability to manage weather-related risks and reduce harvesting loss [22,23]. Outsourcing is measured by the proportion of outsourced labor and capital in farms' total use of these production factors [24]. The agricultural productive service industry is an important way to realize the development of green agriculture [25]. The government should consider the development of Agricultural Social Services as one of the main means for promoting the establishment of moderate and large-scale agriculture and rural revitalization [26].

With the development of reform and opening up, a large number of young and middle-aged laborers in rural China have gone out to work. Most of those who stay in rural areas are old people or women who are engaged in agricultural production. However, the grain in China has been increasing year by year, which may be related to agricultural productive services. The Chinese No. 1 Central Document has proposed to develop agricultural productive services for many years. The development of an agricultural productive service industry is an inevitable requirement to promote the organic connection between small farmers and modern agriculture. The fundamentals of Chinese national conditions are that of large countries and small farmers. The per capita arable land of farmers is small, the traditional agriculture is inefficient, and the characteristics of farmers' concurrent occupation and weak quality are obvious. The agricultural development trend must be modern agriculture. Jiangxi Province is the main producing area of double-cropping rice in the south of China, but Jiangxi Province has a per capita arable land of 0.95 mu, a large proportion of migrant workers, a high degree of part-time jobs, a shortage of disposable labor in rural areas, and rising labor costs. In order to stabilize grain production, Jiangxi urgently needs to rapidly develop agricultural productive services, find new momentum

for agricultural development, and solve the contradiction between "small production" and "big market". Therefore, this paper takes Jiangxi rice farmers as an example to study the influencing factors of agricultural productive service adoption behavior, which has an important theoretical value for further improving the country's agricultural productive service policy and has practical significance for Jiangxi's food security.

There are abundant studies on the adoption of agricultural productive services. Qiu and Luo think that an inverted U-shaped relationship between farm size and the adoption of agricultural mechanization services exists [27]. Bangladesh has been heralded as a successful example of mechanizing smallholder agriculture through appropriate small machinery and policies. Their research shows that farmers' economic status, market access and participation in off-farm work contribute to the likelihood of adoption to promote food security and farm incomes [17,28]. Zang et al. deeply understood the influencing factors of smallholder farmers using socialized agricultural services, and constructed a cooperative mechanism to solve the collective action dilemma in rural areas of China [29]. Outsourcing decisions are mainly influenced by farm size, age of the household head, and other household characteristics [30]. Government subsidies encourage farmers to outsource [31]. Paudel, G.P. et al. use the preliminary investigation data of 628 randomly chosen families and found that farm scale, the local wage rates, out-migration, access to credit service opportunities and networks of agricultural cooperatives have positive impacts on willing to pay (WTP) for mini-tillers [32]. Farmer education and land area are positively associated with the adoption of many agricultural technologies [33]. In China, aging population and rising wages will boost the demand for agricultural mechanization services in the future [34]. Farmers' decision to adopt agricultural technology depends on their socio-economic environment and institutional effectiveness [35]. In China, many other scholars have done a lot of empirical research on the influencing factors of agricultural productive service adoption behavior. Ying and Xu use the spatial Probit model, obtain the influencing factors of farmers' social service adoption behavior: age, physical condition, education level, experience, extent of pesticide poisoning of the head of household, whether the farmer is a part-timer, the income of the farmer's family going out to work, the planting area, the strength of the connection with the agricultural technician, etc. [36]. Song and Jiang use the Logit model to investigate the influencing factors of wheat farmers' choice of agricultural machinery socialization services, and the result shows, service price, planting area, plot area, landform features, the age and health of the household head, the number of family labor, the distance from the township government to planting land, and the purpose of engaging in agriculture all have a significant impact on the choice of agricultural machinery socialization services for wheat farmers [37]. Hu et al. use the logistic model to analyze the influencing factors of farmers' outsourcing behavior of production links. The results show that there is an inverted "U"-shaped relationship between planting scale and outsourcing of production links, the aging of the planting scale and labor force inhibits farmers from choosing "service outsourcing", while agricultural technical training and the value of agricultural machinery and equipment encourage farmers to choose "service outsourcing" [38]. Cai et al. use the survey data of farmers in the main rice producing areas of Anhui Province, an empirical study on the outsourcing behavior of agricultural production was carried out. the survey suggests, family farming labor resources have a significant inhibitory effect on outsourcing of production links; the age of the household head, the number of migrant workers, the size of the paddy field, the fragmentation of the paddy field and the agricultural cooperative organization also have a significant impact on the outsourcing of production links [39].

From the above analysis, it can be seen that the main factors that affect farmers' adoption behavior of agricultural productive services are farmers' personal factors, family characteristic factors, and land management characteristic factors. Their research conclusions provide theoretical guidance for this paper and are of great significance for us to better grasp the factors influencing the adoption of agricultural productive services. However, the existing research results also leave us the following space worth studying:

First, existing studies mainly focus on the exploration of the influencing factors of farmers' adoption of agricultural productive services and the direction and degree of the influencing factors, but lack further research on the relationship and hierarchy between the factors. Second, previous empirical studies focused mostly on other provinces in China, but less on the adoption of agricultural productive services by rice farmers in Jiangxi Province. Third, most of the current studies only use ordinary regression and logistic regression, and few will use other methods to further explore the relationship between the influencing factors of agricultural productive services. Consequently, in order to make up for the above deficiencies, this paper selects Jiangxi Province of China as the research area. First, we make a descriptive statistical analysis of the adoption of agricultural productive services; second, we use the binary logistic model to identify the influencing factors of farmers' adoption of agricultural productive services; and finally, we use interpretative structural modeling (ISM) to further analyze the correlation and hierarchy of the influencing factors.

The contributions of this research are primarily as follows: First, this study uses descriptive statistical analysis to understand the adoption behavior of agricultural productive services by rice farmers in Jiangxi Province, China. Second, this study uses ISM to deeply analyze rice farmers' adoption behavior of agricultural productive services, the influencing factors are divided into direct factors, middle level factors and deep level factors. We can reveal the internal laws of various influencing factors and provide policy recommendations. Third, we draw the following countermeasures and suggestions: enhance the level of farmer policy cognition; reasonably allocate the family agricultural labor force; and encourage land transfer and expand the scale operation of rice.

2. Theoretical Analysis

On the basis of full reference to the existing research results, the factors affecting the adoption of agricultural productive services of rice farmers in this study were divided into personal characteristics of the household head, family characteristics, production and management characteristics, and policy cognitive characteristics.

Personal characteristics of the household head include gender, age, education level, social identity, and risk preference. There are different views on the effect of gender on the adoption of productive services in agriculture. One view is that women are relatively conservative and less willing to accept new things, while men are more willing to try new things. Female farmers have limited access to key productive resources such as land, irrigation water, and extension services [25]. Some studies show no gender differences in technology adoption [40], while others claim that co-management has a positive impact on technology adoption [41,42]. In general, older householders have less energy and physical strength than younger householders, in order to reduce physical input and achieve the same labor productivity, they tend to adopt agricultural productive services, and age has a positive impact on the demand for agricultural machinery services [43]; the aging of the labor force significantly promotes the outsourcing of high labor intensity production represented by land preparation [44]. There are also two views on the influence of educational level on the adoption of agricultural productive services. One view is that the higher the educational level, the easier it is to accept new things, so we choose to adopt productive services, another view is that the higher the education level, the more agricultural production skills, the higher the production efficiency, and the lower the probability of adopting agricultural productive services [37]. Social identity in this article refers to village cadres. Village cadres need to know more about the lines, guidelines and policies of the Party and the country because of their work. They are excellent representatives of the village, who have outstanding receptivity, logical thinking, judgment, courage, and shoulder the responsibility of promoting the adoption of agricultural productive services [45]. Household head risk preference also affects the adoption behavior of agricultural productive services. In general, there is little risk in the adoption of agricultural productive services. The more risk-loving farmers are, the more likely they are to choose other industries with higher risk coefficients than agriculture. Therefore, this paper assumes that: the age of the household

head positively affects the adoption behavior of agricultural productive services of rice farmers, the social identity of household head positively affects the adoption behavior of agricultural productive services of rice farmers, the risk preference of household head negatively affects the adoption behavior of agricultural productive services of rice farmers.

Family characteristics include the number of agricultural labor, agricultural income rate. The larger the number of farmers in the family, the agricultural production is not constrained by labor, but under the influence of leisure preference, it is more likely to buy agricultural machinery operation services [46]. A higher agricultural income rate indicates that the household takes agriculture as its main occupation. In order to improve agricultural productivity, farmers are willing to adopt agricultural productive services in the process of rice planting; therefore, this paper hypothesizes that both the amount of agricultural labor and agricultural income rate positively affect the adoption behavior of agricultural productive services by rice farmers.

Production and management characteristics include rice planting area and rice planting years. Foster and Rosenzweig find that, consistent with this result, farmers with experienced neighbors are more profitable than those with less experienced neighbors, and the former are likely to devote more land to the new technology [47]. The larger the rice planting area and the longer the rice planting years, the richer the planting experience of rice farmers, and they may be more willing to rely on experience rather than adopt agricultural productive services in rice planting. Therefore, this paper hypothesizes that both rice planting area and rice planting years negatively affect the adoption behavior of agricultural productive services by rice farmers.

The cognitive characteristics of policy include the degree of understanding of the social service subsidy of agricultural machinery and who should be supplied with the subsidy. Zhang and Du believe that subsidies do not necessarily promote agricultural productive services, and inappropriate subsidies will misguide farmers to make decisions [48]. The subsidy instrument is suitable when the market for agricultural productive services is not well-developed. The policy cognition of this paper is measured by the cognition of the social service subsidy of agricultural machinery, which mainly includes the understanding of the subsidy and who should be subsidized. If the farmer has a good understanding of the subsidy, especially if the subsidy favors the agricultural productive service provider, the farmer is willing to buy agricultural machinery and tools to become the service provider, but is unwilling to buy agricultural productive services. If the farmer thinks that the subsidy policy is to supply rice farmers, the farmer may expand the planting scale, purchase agricultural machinery and tools, use their own machinery in most links, and consider purchasing agricultural productive services in a few links. Therefore, there is uncertainty about who the subsidy should go to and whether or not to adopt agricultural productive services. When farmers do not know the subsidy at all, they only compare the cost of labor and the cost of purchasing services. When the cost of labor is higher, farmers are more inclined to purchase agricultural machinery services. Therefore, this paper hypothesizes that farmers' understanding of agricultural machinery socialization service subsidies negatively affects the adoption behavior of agricultural productive services by rice farmers.

3. Materials and Methods

3.1. Data

3.1.1. Study Area and Data Source

Jiangxi Province is located in the south of China. Jiangxi Province has rich water resources, sufficient soil fertility, suitable climate, average temperature of 17–19 °C, all of which provide good conditions for rice planting and growth, and 3.25% of the grain is produced with 2.3% of the cultivated land. The perennial sown area of rice accounts for about 85–90% of the sown area of grain crops. There is 5 billion kg of grain transferred to the whole country every year, making outstanding contributions to China's food security. The reasons for choosing the areas were as follows: (1) Jiangxi Province has good conditions for

rice planting and growth. Climate, soil, sunlight, temperature and water are all suitable for rice planting and growth. (2) Jiangxi Province is one of the most important grain producing areas in China. The total output of rice accounts for about 95% of the total output of grain. In 2021, the rice output of Jiangxi Province was 20.739 million tons, ranking the third in China. (3) Agricultural productive services of Jiangxi Province are developing. Many farmers purchase agricultural productive services in rice planting, the employment rate of machinery in farming and harvesting is high, but the employment rate of machinery in seedling raising, planting, fertilization, and pesticide spraying is very low, this is similar to the situation in China, so Jiangxi Province is representative.

The data in this study was obtained from a field survey of rice farmers in Jiangxi Province from 12 November 2020 to 30 January 2021, on the basis of comprehensive consideration of Jiangxi county economic development level and geographical environment and other factors. First, we selected nine counties: Poyang County, Gao'an City, Yongxiu County, Nanchang County, Xinjian District, Yushui District, Fengcheng City, Yifeng County and Yudu County. These areas are the main rice producing areas (Figure 1). Second, we conducted a one-to-one questionnaire survey. A total of 656 questionnaires were collected, some questionnaires with missing information were removed, and a total of 647 valid questionnaires were collected, with an effective rate of 98.6%.

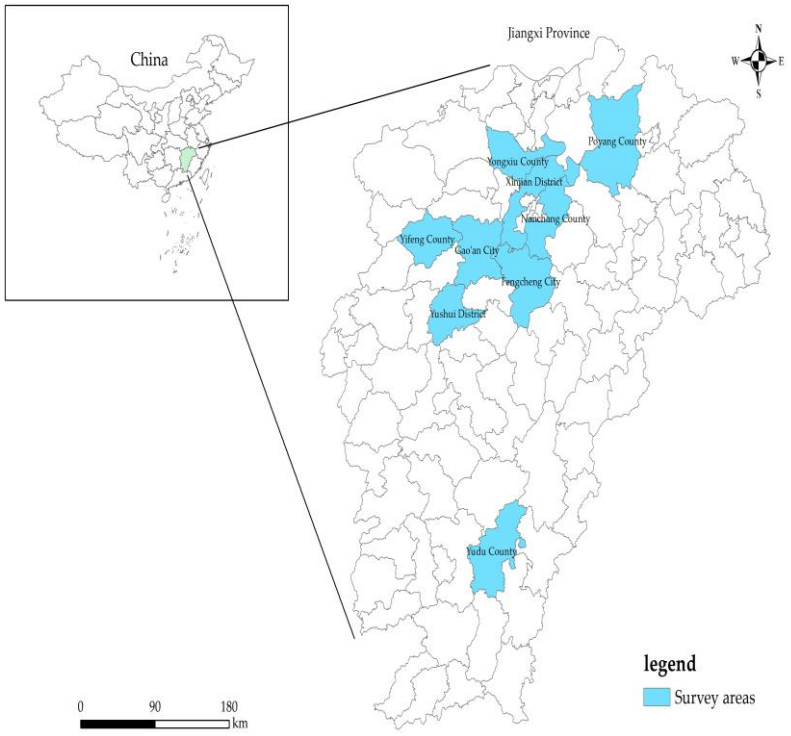

Figure 1. The location of the investigated area in this study.

3.1.2. Descriptive Statistical Analysis of Sample Data

Among the 647 valid samples, the majority of rice farmers were male, accounting for 97.25%. In terms of age structure, middle-aged and elderly people accounted for the majority, and 95.58% were over 40 years old. In terms of education level, 39.48 percent were in primary school or below, junior high school accounted for 45.58%, high school or technical secondary school accounted for 12.50%, junior college accounted for 2.14%, and bachelor's degree or above accounted for 0.30%. Education level is mainly in junior high school or below. In terms of social status, 20.58% of rice farmers are village officials. From the perspective of risk preference, 70.88% of household heads are risk averse, 12.96% are risk neutral, and 16.16% are risk loving. In terms of the number of family farmers, the maximum number of family farmers is 5, the minimum number is 1, and the average number is about 2. In terms of agricultural income rate, more than half of the farmers'

household agricultural income accounted for more than 50%. In terms of rice planting area, the largest is 10,500 mu, the smallest is 1 mu, and the average is 116 mu. From the perspective of rice planting years, the maximum is 68 years, the minimum is 1 year, and the average is 30 years. From the perspective of policy cognition, about the understanding degree of agricultural machinery socialization service subsidies, the farmers who do not know very much account for 24.62%, the farmers who do not know much account for 24.92%, the farmers who know generally account for 15.29%, the farmers who know more about 20.95%, and the farmers who know very much account for 14.22%. As for who should be subsidized for the social service of agricultural machinery, 30.49% of the respondents thought that the social service of agricultural machinery should be subsidized, and 69.51% of the respondents thought that the social service of agricultural machinery should be subsidized to rice farmers.

3.1.3. Variables and Measure

According to the above research hypotheses in the theoretical analysis, referring to previous research results [31–33,36–39,45,47,48], this paper selected four categories of 11 variables to construct the econometric model of the adoption behavior of agricultural productive services by rice farmers. The four category variables include personal characteristics of the household head, family characteristics, production and management characteristics and policy cognitive characteristics. Personal characteristics of the household head include gender, age, education level, social identity, and risk preference; family characteristics include the amount of agricultural labor and agricultural income rate; production and management characteristics include rice planting area and rice planting years; and the cognitive characteristics of policy include the degree of understanding of the social service subsidy of agricultural machinery and who should be supplied with the subsidy.

See Table 1 for the variable names, definitions and expected directions.

3.2. Methods

In this study, the adoption of agricultural productive services by rice farmers can be divided into two types: "adoption" or "non-adoption". It's a binary choice problem; therefore, this study intends to use a binary logistic model to analyze the adoption behavior of rice farmers' agricultural productive services. The basic form of binary Logistic model is as follows:

$$p = F(y = 1|X_i) = \frac{1}{1 + e^{-y}} \quad (1)$$

In Equation (1), y denotes the adoption behavior of agricultural productive services by rice farmers, y = 1 means that rice farmers adopt agricultural productive services, and y = 0 means that rice farmers do not adopt agricultural productive services; p represents the probability that rice farmers adopt agricultural productive services; $X_i(i = 1, 2, \cdots, n)$ is defined as the factors that may affect the adoption behavior of agricultural productive services by rice farmers; and y is a Linear combination of variable $X_i(i = 1, 2 \cdots, n)$, namely:

$$y = b_0 + b_1x_1 + b_2x_2 + \cdots + b_nx_n \quad (2)$$

In Equation (2), $b_i(i = 1, 2, \cdots, n)$ denotes variable regression coefficient. If b_i is a positive number, that means the first *i* factor positively affects the rice family agricultural productive service adoption behavior; otherwise, it represents the first factor's negative influence on rice agriculture productive service adoption behavior.

By transforming Equations (1) and (2), the logistic model expressed in the occurrence ratio can be obtained as follows:

$$\ln\left(\frac{p}{1-p}\right) = b_0 + b_1x_1 + b_2x_2 + \cdots + b_nx_n + \varepsilon \quad (3)$$

In Equation (3), b_0 is a constant term; and ε is the random error.

Table 1. Variable description and descriptive statistics.

Variables	Variable Name	Variable Definition	Mean	S.D.	Expected Direction
Dependent variable	Whether agricultural productive service is adopted by rice farmers	Yes = 1, No = 0	0.67	0.47	
Personal Characteristics of the household head	Gender	Male = 1; Female = 0	0.97	0.16	?
	Age	Actual age/age	56.52	9.65	+
	Education level	primary school or below = 1, junior high school = 2, senior high school/technical secondary school/vocational high school = 3, junior college = 4, Bachelor degree or above = 5	1.78	0.77	?
	Whether the household head is the village cadre	Yes = 1, No = 0	0.21	0.40	+
	Risk appetite	1 = like risk, 2 = risk neutral, 3 = risk aversion	1.45	0.75	−
Family characteristics	Agricultural labor	Actual number of farmers in the household (persons), Proportion of household agricultural income	1.88	0.63	+
	Agricultural income rate	To total income less than 10% = 1, 10–50% = 2, 51–90% = 3, more than 90% = 4	2.59	1.03	+
Production and operation characteristics	Rice planting area	Actual rice planting area of farmers/mu	116.05	464.05	−
	Rice planting years	Actual rice planting years of farmers/years	29.56	14.62	?
Policy cognitive characteristics	The understanding degree of agricultural machinery socialization service subsidy	1 = very little, 2 = less, 3 = average, 4 = better, 5 = very much	2.75	1.40	−
	Who should be subsidized for socialized agricultural machinery services	1 = Social service organization of agricultural machinery, 2 = rice farmers	1.70	0.46	?

Note: in the expected impact, "+" indicates that it may be a positive impact, "−" indicates that it may be a negative impact, and "?" indicates that the impact is unknown.

According to the estimation results of the binary logistic model, seven factors that have significant influence on the adoption behavior of agricultural productive services of rice farmers are extracted, which are the age of the household head, social identity of the household head, risk preference of the household head, number of agricultural labor, agricultural income rate, rice planting area, and understanding degree of social service subsidy of agricultural machinery. In order to further understand the hierarchical structure of factors that significantly affect the adoption behavior of agricultural productive services by rice farmers, we need to discover the surface direct factors, middle indirect factors and deep root factors that affect the adoption behavior. This paper intends to use ISM to analyze the relationship between the influencing factors. As a structured modeling technology, ISM was proposed by Professor J. N. Warfield of the United States in 1973 [49]. It is used to analyze the relationship between various elements of complex social and economic systems as the premise and influence of each other in many studies [50–55]. Specific analysis steps are as follows:

Assuming that there are k factors affecting rice farmers' adoption behavior of agricultural productive services, using S_0 indicates whether rice farmers adopt agricultural productive services, and $S_i(i = 1, 2, 3 \cdots \cdots k)$ represents the influencing factors of rice farmers' adoption behavior of agricultural productive services. The elements in the adjacency matrix R can be determined by Equation (4):

$$R_{ij} = \begin{cases} 1 \; S_i \text{ is related to } S_j \\ 0 \; S_i \text{ is not related to } S_j \end{cases} \tag{4}$$

The adjacency matrix of these factors can be obtained. The adjacency matrix reflects the direct relationship between elements, the reachability matrix reflects the indirect relationship between elements, and the reachability matrix between factors can be obtained from Equation (5):

$$M = (R + I)^{(\lambda+1)} = (R + I)^{\lambda} \neq (R + I)^{(\lambda-1)} \neq \cdots \neq (R + I)^2 \neq (R + I) \tag{5}$$

where, I is the identity matrix; $2 \leq \lambda \leq 7$. By calculation, M can be obtained.

The factors contained in the top layer can be determined according to Equations (6)–(8):

$$P(S_i) = \left\{ S_j \,|\, m_{ij} = 1 \right\} \tag{6}$$

$$Q(S_i) = \left\{ S_j \,|\, m_{ij} = 1 \right\} \tag{7}$$

$$L = \{ S_i \,|\, P(S_i) \cap Q(S_i) = P(S_i); i = 0, 1, 2, \cdots, k \} \tag{8}$$

Firstly, the reachable set $P(S_i)$ is determined according to the reachable matrix M, and the set of column elements corresponding to all matrix elements whose values are 1 in the row corresponding to element S_i in the matrix can be reached; secondly, the antecedent set $Q(S_i)$ is determined according to the reachability matrix M, i.e., a set of row elements corresponding to all matrix elements of 1 in the corresponding column of element S_i in reachable matrix M; then, according to the principle that the intersection of the reachable set and the antecedent set is equal to the reachable set, the top-level factor is determined, that is, according to the above equation; finally, the top-level element set $L_1 = \{S_0\}$ can be obtained according to Equation (8). Then, in turn, for the second set, the elements of the third and fourth layer are, respectively, $L_2 = \{S_1, S_4\}$, $L_3 = \{S_2, S_3, S_7\}$, $L_4 = \{S_5, S_6\}$. Rearrange the rows and columns of the reachable matrix according to the root data L_1, L_2, L_3, L_4 to obtain the skeleton matrix N.

4. Results

4.1. Logistic Regression

Stata 16 software was used for regression to obtain the estimation results of the influencing factors of the adoption behavior of agricultural productive services by rice farmers.

According to the model results, the value is 56.85, and the corresponding probability value is 0.0000, indicating that the null hypothesis that all the estimated coefficients are zero is rejected by the model at the significance level of 1%. The value of is 0.070, indicating that the independent variable has a strong ability to explain the change of the dependent variable. The age of the household head, social identity of the household head, risk preference of the household head, number of household agricultural laborers, agricultural income rate, rice planting area, and understanding of the social service subsidy of agricultural machinery were the factors that significantly affected the adoption of agricultural productive services of rice farmers. A specific analysis (Table 2)is as follows:

Table 2. Results of the regression model.

Independent Variable	Coef.	Std. Err.	Z	p > z
Gender	−0.429	0.558	−0.77	0.442
Age	0.035	0.014	2.60	0.009 ***
Education level	0.012	0.121	0.10	0.923
Whether the village cadres	0.836	0.241	3.47	0.001***
Risk appetite	−0.295	0.117	−2.52	0.012 **
Agricultural labor	0.275	0.151	1.82	0.068 *
Agricultural income rate	0.362	0.095	3.81	0.000 ***
Rice planting area	−0.001	0.001	−2.48	0.013 **
Rice planting years	−0.007	0.008	−0.87	0.385
The understanding degree of agricultural machinery socialization service subsidy	−0.111	0.067	−1.67	0.095 *
Who should be subsidized for socialized agricultural machinery services	0.020	0.195	0.10	0.918
Constant	−1.382	0.951	−1.45	0.146
Log Likelihood		−380.089		
Pseudo R^2		0.070		
Prob > chi^2		0.000		

Note: *, **, and *** are significant at the levels of 0.10, 0.05 and 0.01, respectively.

4.2. ISM Regression

In the first step, this paper uses S_1, S_2, S_3, S_4, S_5, S_6 and S_7 to represent the age of the household head, the social identity of the household head, the risk preference of the household head, the number of agricultural labor in the household, agricultural income rate, the rice planting area, and the understanding degree of agricultural machinery socialization service subsidy. At the same time, scholars in agricultural economics were hired to form an expert group, and the logical relationship among the influencing factors was analyzed by brainstorming method, and Table 3 was obtained. Among them, "V" means that row factors have a direct or indirect influence on the column factors, "A" means that column factors have a direct or indirect influence on the row factors, and "0" means that there is no direct or indirect relationship between the row and column factors.

Table 3. Logical relationship of influencing factors.

A	A	A	A	A	A	A	S_0
0	V	V	0	V	0	S_1	
V	V	V	0	V	S_2		
A	V	V	0	S_3			
0	V	V	S_4				
A	A	S_5					
A	S_6						
S_7							

In the second step, according to Table 3 and Equation (4), the adjacency matrix R of influencing factors (Equation (9)) can be obtained. The Equation is as follows:

$$R = \begin{array}{c} \\ S_0 \\ S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \\ S_6 \\ S_7 \end{array} \begin{array}{c} \begin{array}{cccccccc} S_0 & S_1 & S_2 & S_3 & S_4 & S_5 & S_6 & S_7 \end{array} \\ \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 & 1 & 1 & 0 \\ 1 & 0 & 1 & 1 & 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 & 0 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 & 1 & 1 & 1 & 0 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 & 0 & 1 & 1 & 1 \end{bmatrix} \end{array} \quad (9)$$

In the third step, the reachable matrix M of the influencing factors was calculated from the adjacency matrix R according to Equation (5) and combined with Mat-lab 7.0 software (Equation (10)).

$$N = \begin{array}{c} \\ S_0 \\ S_4 \\ S_1 \\ S_2 \\ S_3 \\ S_7 \\ S_5 \\ S_6 \end{array} \begin{array}{c} \begin{array}{cccccccc} S_0 & S_4 & S_1 & S_2 & S_3 & S_7 & S_5 & S_6 \end{array} \\ \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 & 0 & 1 & 1 \\ 1 & 0 & 1 & 0 & 1 & 0 & 1 & 1 \\ 1 & 0 & 0 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix} \end{array} \quad (10)$$

5. Discussion

5.1. Significance Analysis of Influencing Factors on Adoption Behavior of Agricultural Productive Services

5.1.1. Personal Characteristics of the Household Head

The age of household head is significant at the level of 1%, and the regression coefficient is positive, indicating that the age of household head positively affects the adoption behavior of agricultural productive services, that is, the older the household head is, the more willing to adopt agricultural productive services. The social identity of the household head is significant at the level of 1%, and the regression coefficient is positive, indicating that the social identity of the household head positively affects the adoption of agricultural productive services, that is, if the household head is the village cadre, who is willing to adopt agricultural productive services. The risk preference of household head is significant at the level of 5%, and the regression coefficient is negative, indicating that the risk preference of the household head negatively affects the adoption behavior of agricultural productive services, that is, the more risk averse the household head is, the more willing to adopt agricultural productive services, indicating that there is basically no risk in purchasing agricultural productive services.

5.1.2. Family Characteristics

The number of agricultural labor is significant at the level of 10%, and the regression coefficient is positive, indicating that the larger the number of family agricultural laborers, the more agricultural productive services will be adopted. The larger the family agricultural labor, the larger the scale of planting will be expanded. In order to improve the production efficiency, the more agricultural productive services will be adopted. Agricultural income rate is significant at the level of 1%, and the regression coefficient is positive, indicating that agricultural income positively affects the adoption of agricultural productive services, that is, the higher the household agricultural income, the more the adoption of agricultural productive services.

5.1.3. Production and Management Characteristics

The rice planting area is significant at the level of 5% and the regression coefficient is negative, indicating that the larger the rice planting area, the less willing rice farmers are to adopt agricultural productive services. It is possible that farmers with large planting areas generally purchase agricultural machinery and tools, and do not need to purchase agricultural productive services from outside, which is consistent with the opinions of Qiu and Luo and Hu et al., who think that an inverted U-shaped relationship between the farm size and the adoption of agricultural mechanization services exists [27,38].

5.1.4. The Cognitive Characteristics of Policy

Understanding of the farm machinery socialization service subsidies is at a 10% significance level, and the regression coefficient is negative, so that rice households of agricultural productive service are more understanding, more reluctant to adopt agricultural productive service, the more farmers know farm subsidies and farm machinery socialization service subsidies, the more likely it is to buy agricultural machinery, and do not need to purchase the productive service.

5.2. Analysis on the Mechanism of Factors Affecting the Adoption Behavior of Agricultural Productive Services

According to the hierarchical structure of the factors, the hierarchical factors of the same hierarchical structure are represented by boxes at the same level, and the factor boxes with influential relations are connected according to the logical relationship between the influencing factors, so as to obtain the explanatory structure model diagram of the adoption behavior of agricultural productive services of rice farmers (Figure 2).

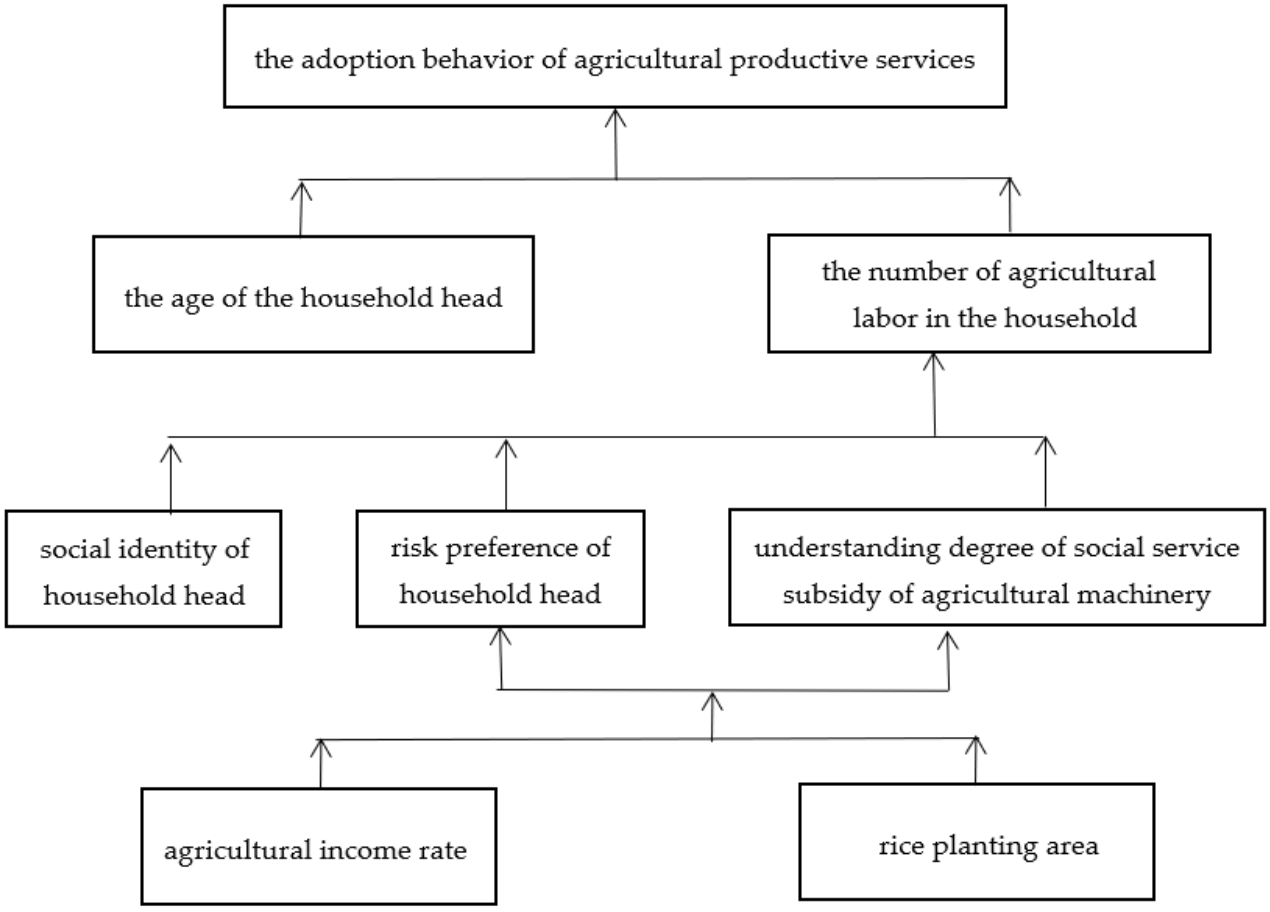

Figure 2. Interpretative structural model of the influencing factors.

Analysis of the results of the interpretation structure model. As can be seen from Figure 1, the seven influencing factors affecting the adoption behavior of agricultural productive services of rice farmers can be divided into three levels: The first layer is the direct factors of the surface layer, namely the age of the household head and the number of agricultural labor; and the second layer is the middle-level indirect factor, which is the social identity of the household head, the risk preference of the household head, and the understanding degree of the social service subsidy of agricultural machinery. All these factors affect the adoption of agricultural productive services by influencing the amount of agricultural labor. The third layer is the deep root factors, namely agricultural income rate and rice planting area. Among them, the agricultural income rate and rice planting area have an effect on the amount of agricultural labor force by influencing the risk preference of the household head, and finally affect the adoption behavior of agricultural productive services of rice farmers.

When the agricultural income rate is high, it shows that the family is mainly agricultural and may often adopt agricultural productive services, especially when there are cadres in the family, they are more willing to adopt agricultural productive services because cadres are busy with administrative affairs.

Farmers often hire machinery services because of their small rice planting area. This is the adoption of agricultural productive services. If the planting scale is large, farmers will buy machinery, especially when the policy awareness is good, they will strive for subsidies from the state, and even provide agricultural productive services to small farmers.

6. Conclusions and Policy Implications

6.1. Conclusions

Based on the data of nine counties in Jiangxi Province of China, this study uses a logistic-ISM model to analyze the influencing factors of the adoption behavior of agricultural productive services, then explores the logical relationships and the hierarchical structure of significant influencing factors. The main conclusions are as follows. First, the influencing factors of the adoption behavior of agricultural productive services include the following seven significant factors: the age of the household head, the social identity of the household head, the risk preference of the household head, the number of agricultural laborers in the household, agricultural income rate, the rice planting area, and the understanding degree of agricultural machinery socialization service subsidy. Second, agricultural income rate and rice planting area are the deep-rooted factors; the social identity of the household head, the risk preference of the household head and the understanding degree of the social service subsidy of agricultural machinery are intermediate level factors; and the age of the household head and the number of agricultural laborers in the family is the direct factors.

6.2. Policy Implications

Based on the above empirical findings, this paper puts forward the following policy implications to enhance the adoption behavior of agricultural productive services by rice farmers in Jiangxi Province:

First, strengthen policy publicity, and enhance the level of farmer policy cognition. We should vigorously publicize the document spirit of agricultural productive services and agricultural mechanization; accurately interpret policies on subsidies for purchasing agricultural machinery and tools and subsidies for agricultural productive services; and let every farmer know the relevant national, provincial, and county documents, professional farmers capable of good management may organize the establishment of specialized rice planting cooperatives, specialized agricultural machinery cooperatives, providing productive services in agriculture, and make productive agricultural services very accessible to farmers who need to buy them.

Second, encourage the transfer of labor and reasonable allocation of family agricultural labor. In general, family agriculture has a large labor force and a large operation scale, but

the family does not necessarily buy all the farm machinery that goes into production. Some production links will hire machinery, such as mechanical seedling breeding, mechanical transplanting, and UAV spraying. If the family farming labor is small and agricultural productive services are not adopted, the rice planting area is generally small and basically self-sufficient; but if family farming has a small labor force and uses agricultural productive services, it tends to be a decent operation. In order to increase farmers' income, it is necessary to rationally allocate family labor, which can give full play to the labor saving advantage of agricultural productive services, appropriately transfer part of the labor force, increase non-farm income, and thus increase the total income of family operation.

Third, encourage land transfer and expand the scale operation of rice. The planting area is one of the fundamental reasons for rice farmers to adopt agricultural productive services. In order to promote the healthy, orderly and prosperous development of agricultural productive services, it is necessary to strengthen the land transfer, increase farmers' rice planting area, and encourage farmers to purchase agricultural machines and tools, so as to meet their own needs and provide services for other farmers.

Fourth, reasonably guide farmers and give play to their professional advantages. For some skilled farmers, we can guide them to transfer more land and expand the planting area. For some farmers who like risks and have skills, we can encourage them to engage in non-agricultural occupations. For some farmers who are willing to take root in the countryside and have mastered the agricultural machinery operation technology, they can become suppliers of agricultural productive services to meet the needs of farmers for agricultural productive services.

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