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Article

# Impact and Mechanism of High Standard Farmland Construction on Farmland Abandonment: A Moderated Mediating Analysis

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**Abstract:** At present, farmland abandonment (FA) is a severe phenomenon in China, imposing a serious restriction on agricultural production. In this context, it is of great significance to explore the logical relationship between high-standard farmland construction (HSFC) and FA to optimize land resource allocation and guarantee national food security. Based on 838 samples of farmers in the main rice production area of the Yangtze River Basin in China, this paper employs the Tobit model, the mediating effect model, and the moderated mediating effect model to analyze the impact of HSFC on FA at the micro level. The results show that (1) HSFC inhibits FA, and FA proportion decreases by 1.14% for every 1% increase in HSFC proportion, and the robustness test and endogeneity treatment also yield consistent conclusions. (2) Agricultural socialization services (ASS) play a positive mediating role in the influence path. HSFC promotes farmers' purchase of ASS, which in turn inhibits FA. (3) The agricultural labor transfer distance (ALTD) plays a positive moderating role in the relationship between HSFC and FA. The farther the distance, the more likely HSFC can promote farmers' purchase of ASS and inhibit FA. The results provide enlightenment on how to precisely implement HSFC policy, that is, to inhibit FA by improving the construction of high-standard farmland and the post-construction management as well as protection system. Moreover, this study helps guiding the development of ASS and optimizing the institutional environment for agricultural labor transfer, creating conditions for agricultural scale management.

**Keywords:** high-standard farmland construction; farmland abandonment; agricultural socialization services; agricultural labor transfer distance; moderated mediating effect

## 1. Introduction

Farmland abandonment (FA) is a transformation result of land use patterns with changes in economic and social development stages. Since the 20th century, the acceleration of industrialization and urbanization worldwide has led to FA in most countries, evolving into a global socioeconomic phenomenon [1,2]. In China, the transition in land use began in the 1990s [3]. Economic development has created more non-agricultural employment opportunities, accelerating labor transfer to secondary and tertiary industries. Coupled with low comparative efficiency and poor production conditions in agriculture, farmland has gradually been edged out of agricultural production, leading to widespread FA. Research indicates that the proportion of FA in China has reached 20% [4], while the domestic labor transfer out has already surpassed the Lewis turning point [5], showing a trend of rural labor depletion. Furthermore, the persistent small-scale, fragmented farming model of "one mu and three fields per capita" complicates improving production efficiency and achieving economies of scale [6], indicating an intensification of FA. Long-term FA causes a serious waste of land resources,

threatening the adequate supply of agricultural products and national food security [7]. Therefore, ensuring the sustainable use of farmland resources is a critical challenge in achieving comprehensive and sustainable social, economic, and ecological development.

FA has attracted widespread attention from policymakers worldwide. For example, the Japanese government established the Direct Payment Scheme for Farmers in Hilly Mountainous Areas to counter FA by increasing direct payments to unfavorable regions [8]. Similarly, the European Union (EU) introduced the Areas of Natural Constraints (ANC) program to stimulate farmers in designated areas facing major problems due to factors such as remoteness, complex topography, climate, and soil conditions to continue farming by providing financial support. However, the support level and policy effectiveness have varied significantly across the EU. In contrast, the Chinese government focuses on the coordinated utilization of land and tries to inhibit FA by HSFC. HSFC mainly refers to a series of comprehensive measures, mainly funded by the government, aiming at making up for the shortcomings of agricultural production through a series of measures such as land leveling, soil improvement, water-saving irrigation, and field road repair [9]. The Ministry of Agriculture and Rural Affairs (MARA) 's "Guiding Opinions on the Coordinated Utilization of Abandoned Land to Promote the Development of Agricultural Production" in 2021 highlighted the need to improve the conditions of sloping land in hilly and mountainous areas or the cultivation of fragmented plots, increase investment, improve the infrastructure, and enhance the suitable machine operation level. The conditioned abandoned land can be included in the scope of HSFC. Therefore, it is of great practical significance to explore the impact of HSFC policy on FA.

Driven by natural endowment limitations [10], climate change [11], population out-migration [12], regime change[13,14] and other natural or social factors, FA has become a common challenge that adversely affects agricultural production. Existing studies have proposed governance solutions such as promoting agricultural mechanization [15], land transfer [16], and population migration [17]. Land fragmentation, which restricts agricultural development and inhibits the market competitiveness of agricultural producers, is a significant factor contributing to FA. As a result, land consolidation is frequently cited as a solution [18]. Most existing studies believe that land consolidation can overcome the comparative disadvantage of agricultural production by enhancing the essential elements for agricultural production and consolidating infrastructure, thereby stimulating farmers' enthusiasm for agriculture and reducing FA [19–21]. However, some scholars believe that although land consolidation barely maintains the area of usable farmland, it cannot avoid a slight reduction in farmland [22]. The research concerning the impact of land consolidation on FA has not reached a consensus. The New Economics of Migration (NELM) suggests that the transfer out of agricultural labor is also a key driver of FA [23], suggesting that ASS can alleviate the constraints of farmers' human resources [24], serving as an alternative to the loss of rural young and adult labor. For small-scale farmers lacking comparative advantages in production, outsourcing specific underperforming production activities to professional service organizations significantly enhances the efficiency of labor resource allocation, effectively inhibiting FA [25,26]. Some studies have shown that the impact of ASS on FA is related to the service link number purchased by farmers and non-agricultural employment proportion, and the inhibition effect of multi-link ASS on FA is more obvious than that of single link [27]. However, there exists different research findings. For instance, Zhang X et al. found that, for the areas with low non-agricultural employment proportion, ASS could not inhibit FA [28].

The existing literature serves as a valuable foundation for this study, yet several gaps remain. First, existing studies mainly explore the relationship between land consolidation and FA. At the same time, HSFC, an important policy of the Chinese government to improve agricultural productivity [29], is rarely involved in the relevant literature. It remains unclear whether there is a practical effect of FA inhibition after the completion of HSFC. Second, although the influence of ASS on FA has been examined, the role of HSFC in facilitating the development of ASS has not been thoroughly explored within a unified analytical framework that encompasses all the three elements. Third, existing studies on the relationship between ASS and FA lacks a detailed examination of the extent of agricultural labor departure. Therefore, this research, adopting 838 micro-research data

from the main rice-producing areas in China's Yangtze River Basin, explores the relationship between HSFC, ASS, and FA with a Tobit model, a mediating effect model, and a moderated mediating effect model. Furthermore, it probes the new path of sustainable development of agriculture under the trend of non-agriculture labor transfer, providing references for the improvement of relevant policies.

## 2. Theoretical Framework

### 2.1. High Standard Farmland Construction and Farmland Abandonment

Rising operation costs have led to a decline in agricultural incomes and weakened the economic productive capacity of farmland. According to the rational peasant theory, farmers, as rational economic agents, aim to maximize their interests by recombining production factors. When non-agriculture employment opportunities increase, and the income disparity between the agricultural and non-agriculture sectors gradually widens [30], it becomes economically sensible for the able-bodied labor force within families to transit out of agriculture. This shift results in a shortage of agricultural labor, an aging workforce, and underutilized farmland. Additionally, the slow development of the farmland transfer market, institutional rigidity, land fragmentation, and other real-world factors increase the transaction costs associated with farmland transfers, making farmland abandonment (FA) an inevitable outcome. HSFC can improve farmland's comprehensive production capacity, ease agricultural labor constraints, and facilitate farmland transfer, thus inhibiting FA.

Firstly, HSFC has improved the comprehensive production capacity of farmland, mitigating FA that arises from low comparative returns and high uncertainty risks of agricultural production. On one hand, HSFC has improved the quality and basic soil productivity conditions through soil improvement and fertilization, laying the groundwork for stable and increased yields. Furthermore, HSFC is mainly funded by the government's public investment, which, under the same conditions, offsets a portion of the farmers' capital investment, thereby improving the input-output ratio for farmers. On the other hand, HSFC improves the field water irrigation and drainage infrastructure, enhancing farmland's ability to prevent disasters and thus ensure crop output.

Secondly, HSFC has mitigated the FA caused by the agricultural labor shortage and the rising labor cost amidst continuous labor migration. Initially, by constructing field roads and adapting land for machinery use, high-standard farmland facilitates the use of advanced agricultural technology and equipment. This development makes it feasible for machinery to replace manual labor and enhances agricultural production efficiency, narrowing the income gap between agriculture and the secondary and tertiary industries. According to Migration Theory [31], laborers tend to return to rural areas when agriculture offers higher earnings, which helps alleviate the issues of labor loss and aging. Furthermore, HSFC improves land concentration and contiguity through measures like field amalgamation, supporting the transition towards larger-scale, specialized agricultural operations. This shift encourages new agricultural management entities to invest in rural areas, providing alternatives for part-time farmers.

Finally, HSFC encourages farmland transfer, thereby inhibiting FA. For farmers considering transferring their land, the decision follows the cost-benefit principle is that they are inclined to transfer their land when the benefits outweigh the costs, and conversely, they may abandon it. HSFC improves farming conditions, potentially increasing transfer prices to raise farmers' income in land transfer and stimulating transferring activities. For farmers considering transferring their land, high-standard farmland addresses the limitations of traditional agricultural production by reducing the need for labor and other input, enhancing the output of agricultural products, and increasing productive income. Therefore, HSFC makes farmland more appealing for farmers with comparative production advantages, encouraging them to acquire and cultivate additional land. Thus:

H1: HSFC inhibits FA.

## 2.2. High Standard Farmland Construction, Agricultural Socialization Services, and Farmland Abandonment

Transforming traditional agriculture hinges on the introduction of modern production factors, with agricultural machinery being a pivotal new factor that can alter the input structure and operational mode of traditional farming. However, the high technological threshold asset specificity and small farmers' limited direct purchasing capability present challenges. ASS organizations can serve as conduits for capital and technology, reducing the constraints on agricultural production at minimal cost, thereby facilitating their seamless integration with modern agricultural practices and subsequently mitigating FA. Specifically, ASS curtails FA through the following three mechanisms.

First, the labor substitution effect, stemming directly from the transfer of labor to non-agriculture sectors, intensifies the constraints on agricultural labor supply. To maintain the agricultural operation, farmers may resort to hiring labor or engaging ASS to compensate for labor shortages. Given the high costs associated with hiring labor, ASS emerges as a more cost-effective alternative. Second, the technology substitution effect sees ASS organization stepping in to replace farmers as the main body of investment, technology, and management. They act as both carriers and facilitators of new technology, integrating high-value-added production technology into the agricultural process at lower costs, thus enhancing the efficiency of farming operations. Third, the technology spillover effect amplifies the role of ASS organizations in empowering adjacent traditional agricultural producers and farmers. By facilitating the adoption of advanced production technologies, management experiences, and organizational systems, ASS helps optimize the mix of input factors and bolster business returns. However, for ASS to fully leverage these advantages, certain conditions must be met, including the availability of smooth agricultural roads, flat land plots, and areas conducive to mechanized operations. HSFC addresses these needs by developing inter-field roads, consolidating land plots, and adapting the land for machinery, thus providing ASS organizations with large-scale, mechanically compatible land equipped with comprehensive infrastructure. This enables the effective use of ASS in preventing FA. Thus:

H2: The HSFC promotes farmers' purchase of ASS, thereby inhibiting FA.

## 2.3. Moderating Role of Agricultural Labor Transfer Distance

The transfer of agricultural labor to non-agricultural sectors is not a uniform process without differences; instead, the transfer distance reflects the degree to which laborers have departed from agriculture. The varying degrees of departure influence the family's allocation of production factors and agricultural land disposal. This paper posits that the mitigating effect of HSFC and ASS on FA is affected by ALTD through the following three primary pathways.

First, the moderating effect of ALTD on the relationship between HSFC and FA is significant. Farmers who transfer locally may not fully detach from agricultural production due to HSFC's effectiveness in improving farming conditions and reducing the intensity of agricultural labor. This enables part-time farmers to manage basic agricultural production activities without reducing the operation scale. However, this also leads to a situation where, despite operating on high-standard farmland, these farmers are unable to shift away from traditional extensive farming practices, failing to achieve agricultural transformation and upgrading. The comparative income disadvantage of agricultural operations cannot be mitigated, and there is still the potential risk of FA. The opportunity cost of farming is higher for long-distance transfer farmers, who are more inclined to leave agricultural production. HSFC enhances the quality of farmland and increases the transfer price, encouraging some farmers to lease out their farmland for high rent, thereby inhibiting FA.

Second, the moderating effect of ALTD on the relationship between HSFC and ASS is noteworthy. After the off-farm transfer of labor, the family income structure changes, reducing the reliance on farmland for livelihood. However, for many farmers, farmland remains an irreplaceable asset of personal significance, often attributed to a higher value and even serving a social security role. For farmers engaging in long-distance transfers, the opportunity cost of farming is elevated, making it challenging to balance non-agricultural employment with agricultural production. Consequently, those with lucrative non-agricultural jobs at a distance are more inclined to maintain

the value of their farmland by purchasing ASS to compensate for the lost labor elements, thereby reducing the opportunity cost associated with agricultural production. In contrast, close-distance transfer farmers leave the land but not the native country, and their non-agriculture employment time is more flexible, so they can adapt to the seasonal and geographical characteristics of agricultural production activities and therefore have a smaller demand for ASS than those long-distance transfer farmers.

Third, the moderating effect of ALTD on the relationship between ASS and FA is crucial. The involvement of ASS organizations has significantly altered traditional agricultural production methods. However, the key factor in boosting agricultural output and mitigating FA through adopting new and modernized production techniques hinges on the extent to which advanced technologies are applied and adopted. Farmers who have transferred over long distances have engaged heavily with ASS, turning these providers into key decision-makers in the production process. By introducing efficient management methods and modern organizational systems, ASS has enhanced the efficiency of agricultural operations, thereby inhibiting FA. Conversely, the total demand for ASS among farmers who transfer over short distances is limited, making it challenging for the intervention of a single ASS to effectuate a transformation in agricultural production methods. As a result, the inhibiting effect of ASS on FA is less pronounced among these farmers. Thus:

H3a: ALTD positively moderates the relationship between HSFC and FA. Specifically, the greater the distance, the stronger the inhibiting effect of HSFC on FA.

H3b: ALTD positively moderates the relationship between HSFC and ASS. Specifically, the greater the distances, the more HSFC encourages farmers to purchase ASS, which, in turn, inhibits FA.

H3c: ALTD positively moderates the relationship between ASS and FA. Specifically, the greater the distance, the more pronounced the inhibitory effect of ASS on FA.

In summary, ASS may serve as a mediating role between HSFC and FA, with this mediating role being moderated by ALTD. Thus, we have constructed a hypothesis model for testing, as depicted in Figure 1. The impact of HSFC on FA through ASS is termed as the mediating effect, while the impact of HSFC on FA without any intermediaries is referred to as the direct effect. The total effect of HSFC on FA is the sum of both the mediating and direct effects. ALTD may moderate the mediating model via three pathways: path *d* represents the moderating effect of the ALTD on the direct effect, corresponding to hypothesis H3a; path *e* represents the moderating effect of the ALTD on the relationship between HSFC and ASS, corresponding to hypothesis H3b; and path *f* represents the moderating effect of ALTD on the relationship between ASS and FA, corresponding to hypothesis H3c.

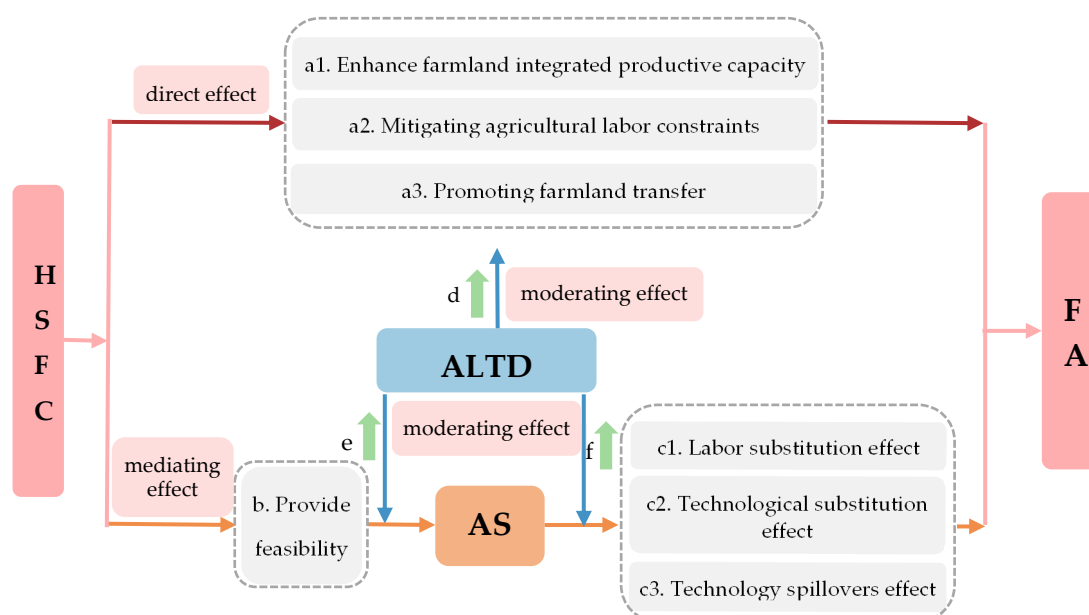
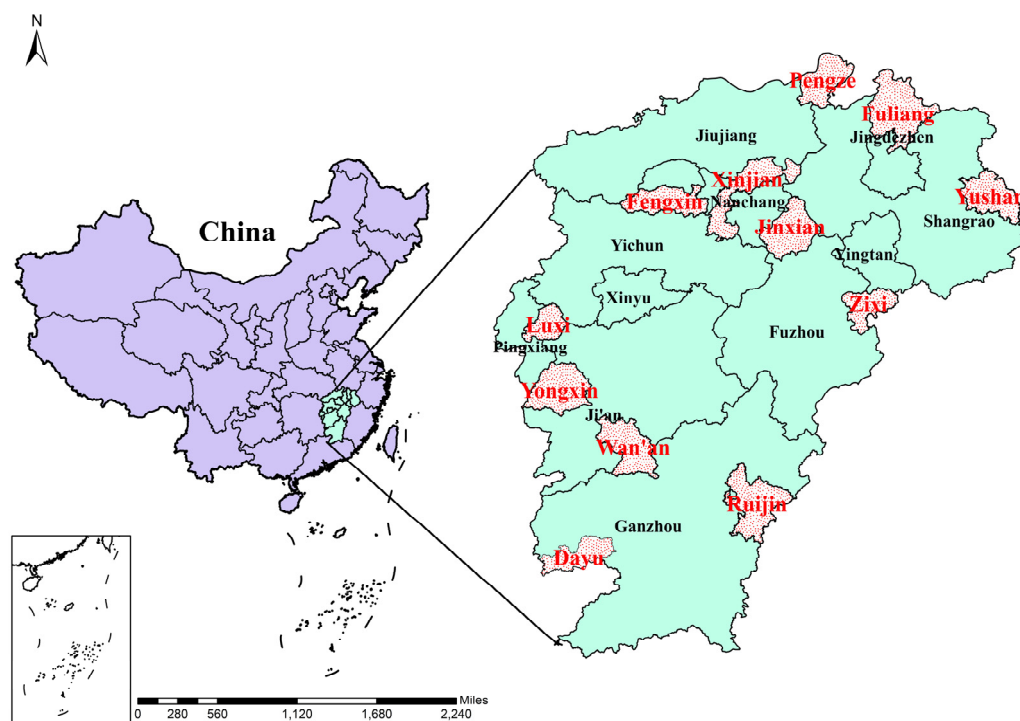


Figure 1. Research Model.

### 3. Data and Experimental Methods

#### 3.1. Data Collection

The microdata used in this paper come from the "One Hundred Villages, One Thousand Households" field research conducted in January-February 2022 by Peking University and Jiangxi Agricultural University. The reasons for choosing Jiangxi Province in China as the sample area are: first, Jiangxi Province is the main rice-producing province in China's Yangtze River Basin, with the third highest rice production in the country, and shoulders the important responsibility of guaranteeing national food security; second, the province is one of the regions in China where FA is serious [32], and third, the province has completed HSFC for 64.5 percent of the total farmland, and the policy implementation has been effective. The research group used a combination of stratified and random sampling methods; firstly, based on the per capita GDP, the 100 counties (cities and districts) in Jiangxi Province were divided into three levels, and four sample counties were randomly selected at each level, namely, Xinjian District, Jinxian County, Pengze County, Fuliang County, Yushan County, Zixi County, Fenghsin County, Luxi County, Wan'an County, Yongxin County, Dayu County, and Ruijin City, and ArcGIS drew the sample counties. The county distribution map is shown in Figure 2. Subsequently, based on the level of economic development and geographic location, three sample townships (towns) were selected in each sample county, three administrative villages were selected in each sample township (town), and ten farmers were randomly selected in each administrative village; a total of 1,080 questionnaires were distributed to the farmers, and 1,071 valid questionnaires were retrieved, with a validity rate of 99.17%. Agricultural management is usually based on collective decision-making by families, so this paper starts the study from the family level and limits the sample condition as obtaining the contracted management right of farmland, eliminating the samples with untrue information and missing data of the core variables, and finally obtaining 838 valid samples.



**Figure 2.** Distribution of Sample Counties. The map data in Figure 2 are from DataV. GeoAtlas. [https://datav.aliyun.com/portal/school/atlas/area\\_selector](https://datav.aliyun.com/portal/school/atlas/area_selector).

### 3.2. Description of Variables

Explained variable: FA proportion. Most of the existing literature measures the FA by "whether abandonment or not". However, only using a dummy binary variable cannot reflect the degree of abandonment, which easily causes information omission. Therefore, this paper refers to the study of Xu D et al. to measure the FA proportion by the proportion of the area of abandoned farmland to the total area of family-contracted farmland as an indicator of FA [30], and at the same time, set a dummy variable of "whether abandonment or not" in the robustness test to form a contrast with the benchmark regression.

Core Explanatory Variables: HSFC. HSFC is a systematic project with long time-consuming, and large capital demand, which ordinary farmers cannot afford alone. It is usually planned and constructed unified by the jurisdictional government or the village collectives through public financial expenditures. Therefore, with reference to existing studies [33,34], the level of HSFC is measured by the proportion of the area of high-standard farmland to the area of farmland in the village in which the farmer is located.

Mediating variable: ASS. Referring to the studies of Cheng C et al. and Zhang M et al. [32,35], six production segments, namely, land leveling, seedling cultivation, transplanting, fertilizing, pesticide, and harvesting, were selected to measure the total purchased number of ASS.

Moderating variable: agricultural ALTD. Referring to the study by Liao W et al [36], the destination of the householder's non-agriculture work is used as a measure of the agricultural ALTD.

Control variables. Referring to the current literature [3,37], household, land, and village characteristics are introduced to reduce estimation bias. Household characteristics include education level, household size, agricultural income proportion, and non-agriculture employment proportion; land characteristics include area of operated farmland, land transfer, farmland fragmentation degree, and farmland rights; and village characteristics include area of farmland in the village, unirrigated farmland proportion, and aging proportion in the village. The variables and descriptive statistics involved in the model are shown in Table 1.

**Table 1.** Main Explanatory Variables and Descriptive Statistics.

Variable Name	Meaning and Assignment	Average Value	Standard Deviation
Explained Variables			
FA proportion	The proportion of abandoned farmland area to the total area of family-contracted farmland	0.088	0.253
Whether abandonment or not	Is the family's farmland abandoned? 0=No; 1=Yes	0.136	0.343
Core Explanatory Variables			
HSFC proportion	The proportion of HSFC area to the total farmland area of the village.	0.192	0.270
Availability of HSFC	Has the village implemented HSFC? 0=No; 1=Yes	0.499	0.500
Mediating Variable			
ASS	Total number of agricultural socialization services purchased for land leveling, seedling cultivation, transplanting, fertilizing, pesticide, and harvesting (number)	0.9 43	1.201
Moderating Variable			
ALTD	Destination of non-agriculture work of the householder, 0 = no non-agriculture employment, 1 = within the village; 2 = within the commune outside the village; 3 = within the county outside the commune; 4 = within the province outside the county; 5 = outside the province	1.060	1.738
Farmer Characteristics			
Educational level	Educational level of householder, 1=no schooling, 2=elementary/private schooling, 3=junior high school, 4=high school/secondary school, 5=college and above	2.271	1.057

Family size	Number of family members (persons)	4.412	2.014
Agriculture income proportion	Proportion of income from agricultural operations	0.213	0.334
Non-agricultural employment proportion	The proportion of Non-agricultural employment to the total family size	0.342	0.266
Land Characteristics			
Area of operating farmland	Area of farmland cultivated by farmers (hectares)	0.439	1.683
Land transfer	Are you involved in land transfer? 0=No, 1=Yes	0.566	0.496
Farmland fragmentation degree	Number of plots of family-contracted farmland (plots)	5.974	6.684
Confirmation of farmland rights	Yes or no certificate of entitlement? 0=No, 1=Yes	0.273	0.446
Village Characteristics			
Farmland areas of villages	According to actual survey data (hectares)	133.517	85.906
Unirrigated farmland proportion	Farmland proportion in villages without access to surface and groundwater irrigation	0.050	0.128
Village aging proportion	The proportion of number of people aged 65 and over in villages to that of registered population	0.155	0.075
Observation		838	

### 3.3. Sample Description

From the statistical results in Table 2, the average FA proportion is 8.8%, of which 13.6% of farmers have FA behavior, indicating that FA in the sample area is more serious. The mean value of HSFC is 0.499, and the mean value of HSFC ratio is 19.2%, indicating that nearly half of the villages have implemented HSFC, but the construction efficiency is still low, which is in line with the findings of existing studies [38]. In Figure 3, we further illustrate the relationship between the core variables. In general, HSFC can inhibit FA, and when the HSFC proportion is high (greater than 0.6), the inhibition effect of FA is more obvious, and the results are consistent with the hypothesis proposed in the framework. The mean value of ASS is 0.943, which indicates that in the six production segments, only 0.943 segments of ASS were purchased by each farmer on average, reflecting that the demand for ASS in the sample area is not strong, possibly constrained by farmers' lack of understanding about ASS and the fact that the market for ASS is not yet mature [39]. The mean value of ALTD is 1.060, indicating that most of the farmers are predominantly engaged in local part-time work, mainly due to the development of rural industries in China, which provides more opportunities for farmers to engage in non-agricultural economic activities in close proximity.

**Table 2.** Benchmark Regression Results of HSFC on FA.

Model (1)	Explained Variable: FA Proportion	
	Coefficient	Marginal Effect
HSFC proportion	-0.621** (0.267)	-0.114** (0.049)
Farmer Characteristics		
Educational level	-0.101*(0.056)	-0.018*(0.010)
Family size	-0.077** (0.031)	-0.014** (0.006)
Agriculture income proportion	-0.476** (0.235)	-0.088** (0.043)
Non-agricultural employment proportion	0.433* (0.223)	0.079* (0.041)
Land Characteristics		
Area of operating farmland	-0.259 (0.215)	-0.047 (0.039)
Land transfer	-0.306** (0.121)	-0.056** (0.022)
Farmland fragmentation degree	0.021*** (0.008)	0.004*** (0.001)
Confirmation of farmland rights	-0.322** (0.150)	-0.059** (0.027)
Village Characteristics		
Farmland areas of villages	-0.002** (0.001)	-0.0003** (0.0002)
Unirrigated farmland proportion	1.584*** (0.377)	0.290*** (0.069)

Village aging proportion	1.123 (0.773)	0.206 (0.141)
Prob > chi2	0.001	
Observation	838	838

Note: \*, \*\*, and \*\*\* indicate significant at the 10%, 5%, and 1% levels, respectively, with robust standard errors in parentheses.

Regarding farmer characteristics, the average education level of the sample farmers is 2.271, reflecting the actual situation of low human capital level in rural China; the average family size is 4.412 persons, and the average agriculture income proportion is only 21.3%, indicating that most of the income comes from non-agricultural work, but the average non-agricultural employment proportion is 34.2%, which is in line with the fact that the young laborers in rural areas go out to work, and the older adults farm at home and take care of grandchildren [40]. In terms of land characteristics, the average area of farmland operated by farmers is 0.439 hectares, and the average number of contracted land plots is 5.974, indicating that decentralized management of farmland on a household basis is the main operation mode of agricultural production in the research area, which confirms China's basic national situation of "big country, small farmers" and the agricultural situation. Among them, 56.6% of the farmers have participated in land transfer, but only 27.3% of the farmland has the right certification. In terms of village characteristics, the average farmland area of villages is 133.517 hectares, 95% of which are under good irrigation conditions; the average aging proportion of villages is 15.5%, higher than the national average of 14.9% in the same year, showing that the aging problem of the rural population in the research area is serious, mainly since the increase in the wages of the non-agricultural sector aggravates the transfer of the young labor from the countryside, which will pose a challenge to agricultural production.

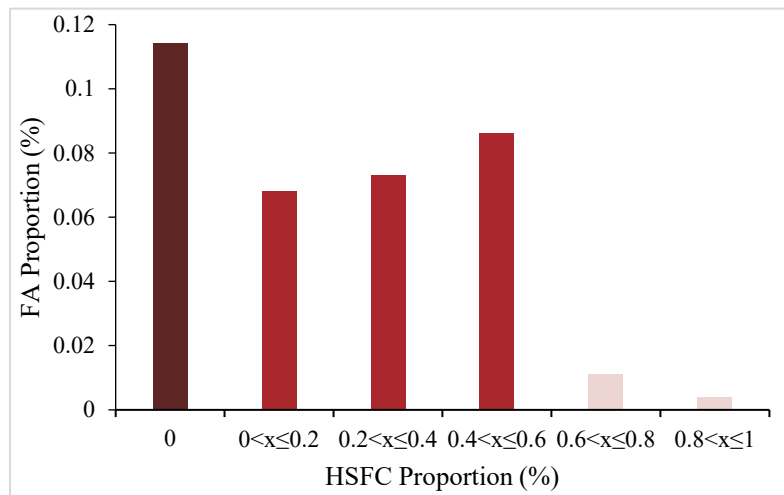


Figure 3. Impact of HSFC on the FA proportion.

### 3.4. Empirical Methodology

#### 3.4.1. Benchmark Regression

First, the relationship between HSFC and FA is analyzed. It should be noted that considering that 86.4% of the farmers did not have FA behavior, the FA proportion belongs to the restricted dependent variable with obvious left-end subsumption characteristics, and the use of the traditional linear regression model will lead to obvious bias of the results. Therefore, this paper refers to the study of Xu D et al. and Ji D et al. to construct the Tobit model based on the maximum likelihood method [30,41]. The specific settings are as follows:

$$AR_i = \beta_0 + \beta_1 HSFC_i + \sum \beta_2 controls_i + \varepsilon_i, AR_i = \begin{cases} AR_i^*, AR_i^* > 0 \\ 0, AR_i^* \leq 0 \end{cases} \quad (1)$$

In equation (1), the  $AR_i$  is the explained variable, denoting the FA proportion of the  $i$  farmer and  $HSF_i$  is the core explanatory variable, denoting the HSFC proportion in the village of the  $i$  farmer.  $controls_i$  are a series of control variables reflecting the characteristics of the householder, family, land, and village.  $\beta_k$  are the coefficients of each variable, where  $k=0,1,2$ , and  $\varepsilon_i$  is a randomized disturbance term.

### 3.4.2. Mediating Effect Test

Secondly, the mediating effect of ASS is tested. In this paper, we refer to the research of Baron R M and Kenny D A and Zhou C et al. to construct the mediating effect model [42,43], which has the advantage of reducing the probability of error in the product coefficient model, and is set as follows:

$$AR_i = a_0 + a_1 HSF_i + \sum a_2 controls_i + \varepsilon_i \quad (2)$$

$$ASS_i = b_0 + b_1 HSF_i + \sum b_2 controls_i + \varepsilon_i \quad (3)$$

$$AR_i = c_0 + c_1 ASS_i + c_2 HSF_i + \sum c_3 controls_i + \varepsilon_i \quad (4)$$

In equations (2)-(4), the  $ASS_i$  is the mediating variable, denoting the number of ASS purchased by farmer  $i$ , the  $a_i$ ,  $b_i$ , and  $c_i$  are the coefficients of each variable. The remaining variables are consistent with equation (1) and will not be repeated here.

### 3.4.3. Moderated Mediating Effect Test: Moderating Effect of Agricultural Labor Transfer Distance

The mediating effect of ASS was tested in the previous section, so when testing the moderating effect of the ALTD, a moderated mediating effect model should be constructed. Drawing on the method of BarNir A et al. [44], the regression equation is constructed as follows, corresponding to the direct path ( $d$ ), the first half of the path ( $e$ ), and the second half of the path ( $f$ ) are shown in Figure 1.

$$AR_i = d_0 + d_1 HSF_i + d_2 NF_i + d_3 HSF_i \times NF_i + \sum d_4 controls_i + \varepsilon_i \quad (5)$$

$$ASS_i = e_0 + e_1 HSF_i + e_2 NF_i + e_3 HSF_i \times NF_i + \sum e_4 controls_i + \varepsilon_i \quad (6)$$

$$AR_i = f_0 + f_1 HSF_i + f_2 ASS_i + f_3 NF_i + f_4 HSF_i \times NF_i + f_5 ASS_i \times NF_i + \sum f_6 controls_i + \varepsilon_i \quad (7)$$

In equations (5)-(7).  $NF_i$  are the moderating variables to be tested. The coefficients of the interaction terms  $HSF_i \times NF_i$ , the  $ASS_i \times NF_i$  are the moderating effects of the moderating variables in each path, and the rest are consistent with those in equations (2)-(4).

## 4. Results

### 4.1. Impact of High Standard Farmland Construction on Farmland Abandonment

#### 4.1.1. Benchmark Regression

Using stata16 software, the Tobit model was used to analyze the impact of HSFC on FA, and the estimated coefficients and marginal effects are shown in Table 2. The P value of model (1) is significant at 1% level, indicating that the overall fitting effect is good. The estimated coefficient of the HSFC proportion is negatively significant at the 5% level, indicating that the HSFC can significantly inhibit FA, and Hypothesis (1) is verified; the result matches the findings of Zhang Y et al. [45]. The results of the marginal effect show that, with other influencing factors remaining unchanged, for every 1% increase in the HSFC proportion, the FA proportion decreases by 1.14%.

The results of control variables show that the education level, family size, agricultural income proportion, land transfer, farmland rights, and village farmland area have a significantly negative effect on FA; the non-agricultural employment proportion, the farmland fragmentation degree, and the unirrigated area proportion significantly and positively affect FA. Specifically, farmers with

higher education level have stronger information acquisition ability and management ability, and are more willing to understand and respond to national policies and invest in agricultural production, which is not prone to FA. In addition, the larger the family size, the more adequate laborer force, the less likely that farmland will be abandoned; farmers with a high proportion of agricultural income rely on agricultural operation, and will prioritize laborers to be invested in agricultural production, which reduces the possibility of FA, and this also verifies the findings of Yan J et al. that increased non-agricultural income will promote labor transfer out of agricultural production [46], thus increasing the likelihood of FA. Land transfer promotes part-time farmers to transfer idle farmland for income, thus reducing the likelihood of FA, which matches the findings of Shao J et al. [47]. The confirmation of farmland right strengthens farmers' knowledge of the residual claim right of farmland; thus FA will cause the decline of land power and the depreciation of the farmland property rights value, hindering the realization of the residual claims. Therefore, farmers are more willing to revitalize the FA and make the decision to maximize the expected benefits [48], which is also verified in Zheng L and Qian W's study [49]. Meanwhile, villages with large farmland area pay more attention to the agricultural infrastructure construction, making farmland more attractive in the transfer market. On the contrary, as the non-agricultural employment proportion increases, the more obvious the lack of effective labor input in agricultural production is, the higher the likelihood of FA. Furthermore, the fragmentation of farmland raises the cost of production per unit area, further reduces the comparative efficiency of agriculture, and thus induces FA, which is consistent with the study of Liu G et al. [50]. The higher un-irrigated area proportion represents poorer irrigation conditions of the farmland, and the risk of agricultural operation increases subsequently, leading to farmers' planting decisions in reducing the agricultural operation area for risk avoidance. Finally, the effects of operating farmland area and village aging proportion on FA are not statistically significant and need to be further demonstrated in future research.

#### 4.1.2. Robustness Test

In robustness test, the independent variable "HSFC proportion" is replaced by "whether there is HSFC" for the robustness test, and the results are shown in model (2) of Table 3. Whether HSFC has a significant negative effect on the FA proportion and the results of the marginal effect show that the results of the control variables have not changed significantly, indicating that the research conclusions are robust.

Then, the dependent variable is replaced with the binary variable "whether abandonment or not," and the Probit model is used for estimation. The results are shown in model (3) of Table 3. The coefficient of the impact of HSFC on FA is negatively significant at the 5% level, and the direction and significance of the other variables are the same as those of the baseline regression, which once again verifies the robustness of the research findings.

**Table 3.** Robustness Test Results.

	Model (2)		Model (3)
	Explained Variable: FA Proportion		Explanatory Variable: Whether FA or not
	Coefficient	Marginal Effect	Coefficient
Availability of HSFC	-0.243*(0.127)	-0.045 *(0.023)	
HSFC Proportion			-0.564** (0.247)
Farmer Characteristics			
Educational level	-0.095*(0.056)	-0.017*(0.010)	-0.111*(0.059)
Family size	-0.079**(0.032)	-0.015** (0.006)	-0.070** (0.032)
Agriculture income proportion	-0.483**(0.235)	-0.089** (0.043)	-0.372 (0.229)
Non-agricultural employment proportion	0.432*(0.223)	0.079* (0.041)	0.524** (0.233)
Land Characteristics			
Area of operating farmland	-0.267 (0.219)	-0.049 (0.040)	-0.223 (0.166)
Land transfer	-0.296**(0.122)	-0.054** (0.022)	-0.336*** (0.119)

Farmland fragmentation degree	0.021*** (0.008)	0.004*** (0.001)	0.032*** (0.008)
Confirmation of farmland rights	-0.310** (0.150)	-0.057** (0.027)	-0.336** (0.150)
Village Characteristics			
Farmland areas of villages	-0.002** (0.001)	-0.0004** (0.0002)	-0.002*** (0.001)
Unirrigated farmland proportion	1.578*** (0.377)	0.289*** (0.069)	1.780*** (0.368)
Village aging proportion	1.026 (0.781)	0.188 (0.143)	1.241* (0.682)
Prob > chi2	0.000		0.000
Observation	838		838

Note: \*, \*\*, and \*\*\* indicate significant at the 10%, 5%, and 1% levels, respectively, with robust standard errors in parentheses.

#### 4.1.3. Endogenous Discussions

The endogeneity of this paper comes from two aspects, namely, two-way causality and omitted variable bias. First, two-way causality is adopted when the village's FA proportion is too high or when agriculture is no longer the main industry, the village collective will reduce the investment in HSFC. Second, the omitted variable bias refers to the inevitable bias that the set of control variables for the characteristics of farmers, land, and village cannot be completely excluded from the possibility of omitted variables. Therefore, referring to the method of Li B and Shen Y [51], "whether there is a large-scale agricultural industry in the village" is selected as an instrumental variable for HSFC. The reasons for considering the instrumental variable as appropriate are as follows: first, the existence of large-scale agricultural industries in villages has a strong exogenous relationship with FA; second, the existence of large-scale agricultural industries in villages has a strong correlation with HSFC, which is conducive to the realization of the large-scale operation of agriculture.

The IV-Tobit method is used to test the possible endogeneity of the model, and the results are shown in Table 4. The results of the weak instrumental variable test show that the value of the F-statistic is 145.380, which is much larger than the critical value of 10, indicating that the original hypothesis of the existence of weak instrumental variables is rejected. The results of the Wald test of exogeneity are significant at the 1% level, indicating that HSFC can be considered an endogenous variable at the 1% level, which verifies the necessity of the instrumental variable method. The first stage of the IV-Tobit model is an ordinary least squares regression, and the results indicate that HSFC promotes the formation of large-scale agricultural industries in villages; the coefficients of the second stage indicate that HSFC has a significant negative effect on FA, and the absolute value is larger than the corresponding estimated coefficients of the model (1), which suggests that the inhibitory effect on FA may be underestimated if the endogeneity of HSFC is not taken into account. In addition, the coefficients of the variables are significant, and the direction does not change, further verifying hypothesis H1.

**Table 4.** Estimation Results of the Instrumental Variables Approach to Endogeneity Treatment.

Models (4)	Explained Variable: FA Proportion	
	Phase I (OLS)	Phase II (IV-Tobit)
IV: Availability of large-scale agroindustries	0.525*** (0.013)	
HSFC		-1.788*** (0.445)
control variable	controlled	controlled
F	145.380	
Wald test of exogeneity		16.62
Prob>chi2		0.000
Observation		838

Note: \*\*\* indicates significant at the 1% level and robust standard errors are in parentheses.

#### 4.2. Mediating Effects Test of Agricultural Socialization Services

The mediating effect test was carried out with ASS as the mediating variable to reveal the role path of HSFC inhibiting FA, and the results of the Sobel method are shown in Table 5. Model (5) verifies the effect of HSFC on the FA proportion, and the regression coefficient of HSFC is -0.086, which is significant at 1% level, indicating that HSFC inhibits FA; model (6) examines the effect of HSFC on ASS, and the coefficient of HSFC is 0.795, which is significant at 1% level, indicating that HSFC promotes farmers to purchase ASS; model (7) tests the effects of HSFC, ASS and FA proportion, the coefficient of ASS is negatively significant at the 1% level, and the coefficient of HSFC is negatively significant at the 5% level. The absolute value is smaller than that of model (5), indicating that the mediating effect holds. ASS has a partial mediating effect in the influence path of HSFC on FA. The results of the mediating effect proportion show that about 18.68% of the inhibition effect of HSFC on FA is achieved through ASS. In addition, three significance tests, Sobel, Goodman1, and Goodman2, were provided in the Sgmediation command test, and the results met the requirements. The bootstrap method was utilized to test the robustness of the mediating effect to reduce the possible bias of the coefficient product, and the results are shown in Table 6. The mediating effect is -0.070, the confidence interval is [-0.116, -0.023], and the interval does not contain 0, indicating that the mediating effect is significant. In summary, HSFC promotes farmers to purchase ASS, which in turn inhibits FA, verifying hypothesis H2.

**Table 5.** Results of Sobel's Mediating Effect Test for ASS.

	<b>Models (5) FA Proportion</b>	<b>Models (6) ASS</b>	<b>Models (7) FA Proportion</b>
HSFC	-0.086*** (0.033)	0.795*** (0.150)	-0.070** (0.033)
ASS			-0.021*** (0.008)
Control variable	controlled	controlled	controlled
Sobel		-0.017** (Z=-2.454)	
Goodman-1		-0.017** (Z=-2.420)	
Goodman-2		-0.017** (Z=-2.489)	
Proportion of mediating effects		19.26%	

Note: \*\* and \*\*\* indicate significant at the 5% and 1% level, respectively, and robust standard errors are in parentheses.

**Table 6.** Results of the Bootstrap Mediating Effect Test for ASS.

<b>Models (8)</b>	<b>Effect</b>	<b>SE</b>	<b>Z</b>	<b>P</b>	<b>Bias Corrected (95%)</b>	
					<b>LLCI</b>	<b>ULCI</b>
Direct effect	-0.017	0.006	-2.62	0.009	-0.029	-0.004
Indirect effect	-0.070	0.024	-2.82	0.005	-0.116	-0.023

Note: 1000 replicate sampling times using the bias-corrected nonparametric percentile Bootstrap method.

#### 4.3. Further Analysis: Moderated Mediating Effects Test

The test results of the moderating effect of ALTD are shown in Table 7. In model (9), the interaction term between the HSFC proportion and the agricultural labor force transfer distance is not significant, indicating that there is no moderating effect of the ALTD on the direct effect and hypothesis H3a is rejected. The possible reason is that after the HSFC, some regions, in order to pursue the principle of absolute fairness of the contracted land distribution, divide a huge field into small fields belonging to different contracted farmers, and there is again fragmentation phenomenon, the near-employed farmers cannot improve the production efficiency to complete the agricultural production activities, and cannot incentivize the farmland transfer behavior of the far-employed farmers, and the farmland is similarly underutilized. In model (10), the main effect coefficients are positive and significant, and the interaction term coefficients are positive and significant, indicating

that the ALTD increases the explanatory role of the main effect. The farther the ALTD, the more the HSFC promotes the purchase of ASS by farmers, which inhibits FA, and verifies hypothesis H3b.

The coefficients of both ASS and the interaction term in model (11) are not significant, indicating that there is no moderating effect of the ALTD on the second half of the mediating process, and hypothesis H3c is rejected. The possible reason is that the development of China's ASS market is in the early stage, and there are still a lot of individual or private service subjects, mainly villagers in their villages or in the neighboring villages, whose operation and management styles have a long way to catch up with the professional organizations, or even are no different from those of ordinary farmers. When farmers purchase many such "non-professional" ASS, the promotion of changes in agricultural production methods may be relatively limited.

**Table 7.** Moderated Mediating Effect Test Results.

Variable	Moderating Variable: ALTD		
	(9) FA Proportion	(10) ASS	(11) FA Proportion
ASS			-0.012(0.013)
HSFC proportion	-0.107*(0.056)	0.271**(0.129)	-0.110**(0.056)
ALTD	0.021***(0.008)	-0.054**(0.025)	0.024***(0.008)
HSFC proportion * ALTD	-0.001(0.024)	0.110*(0.060)	0.010(0.025)
ASS* ALTD			-0.005(0.006)
Control variable	Controlled	Controlled	Controlled
Observation	838	838	838

Note: The table reports the marginal effects of the Tobit model; \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively, with robust standard errors in parentheses.

## 5. Conclusions

Based on 838 research samples of farmers in Jiangxi Province, a principal rice-producing region within the Yangtze River Basin of China, this paper employs the Tobit model, the mediating effect model, and the moderated mediating effect model to assess the impact of HSFC on FA. Additionally, it investigates the intermediary role of ASS and the moderating role of ALTD within this context. The findings show that: First, HSFC significantly reduces FA, with a 1.14% decrease in FA for every 1% increase in HSFC, a result that remains robust following robustness checks and endogeneity treatment using the IV-Tobit method. Second, ASS has a partial mediating effect on the influence path of HSFC on FA. HSFC enhances farmers' engagement with ASS, which in turn inhibits FA. Third, the influence path of HSFC on FA via ASS is positively moderated by ALTD; that is, the greater the ALTD, the more HSFC promotes farmers' purchase of ASS, thus inhibiting FA.

Based on the above research conclusions, this paper puts forward the following policy recommendations. First, HSFC should continue to be promoted. While HSFC has been effective in mitigating FA, the current construction standards are not yet optimal. The government should increase financial and social capital investment in HSFC to ensure the quality of the construction project. Additionally, establishing a diverse set of stakeholders to participate in the post-construction management system will guarantee long-term benefits from these projects. Second, the development of the ASS system should be supported to enhance farmers' adoption of ASS and thereby FA is inhibited. This involves not only continuing to refine policies related to subsidies for agricultural equipment purchases and service order financing but also considering the service capacity of ASS organizations. Improving service levels by promoting the construction of the talent team, fostering the development of new service entities, and other measures are crucial. Third, the non-agricultural transfer of rural labor is essential for the modern transformation of the traditional rural economy. Therefore, the government should optimize the institutional environment for the transfer of agricultural labor and promote the integration of urban and rural social security systems. This will facilitate the effective transfer of agricultural labor and support the transition towards more specialized and large-scale agricultural operations.

Compared with existing studies, this paper mainly has the following theoretical and practical implications. First, this paper integrates HSFC policy with new economics of labor migration theory and agricultural labor division theory and reveals the internal mechanism of HSFC policy affecting FA. Secondly, this paper uses the research data from the main rice producing areas for econometric analysis to identify the impact of HSFC policy on FA, which provides realistic data support for the theoretical logic as well as scientific and reasonable policy references to inhibit the increasingly serious FA in the future by relying on the construction of high standard farmland.

## 6. Limitations and Future Studies

This paper also has the following limitations. First, the research area is only a representative province of the main rice producing area in the Yangtze River Basin, and the conclusions of the study may not be universal due to the differences in the degree of FA and the progress of the construction of high-standard farmland among different regions. Future research can expand the scope of the sample area to make the research conclusions more scientific and objective. Second, as there is often a delayed effect in the actual effectiveness of policies and regulations, this paper lacks an analysis of the temporal effect of HSFC policy in inhibiting FA. HSFC being a continuous policy, we will conduct a follow-up survey of the sample farmers in the subsequent study, so as to use panel data to understand the trend of the inhibition of FA as HSFC continues to advance. Third, with the Chinese government's vigorous promotion of comprehensive land management in the whole region, numerous policies for farmland management are put forward. However, this study lacks comparative analyses as to which policy is more targeted at inhibiting FA. Therefore, the effectiveness of other land consolidation policies in China could be explored to further clarify new paths to inhibit FA.

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