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# Effects of Land Transfer on Farmer Households' Straw Resource Utilization in Rural Western China

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**Abstract:** With the continuous emphasis of the country on the construction of ecological civilization, promoting the utilization of straw resources has become an important measure to achieve green agricultural development. Based on the survey data of 540 households in Sichuan Province and under the guidance of the theory of planned behavior, this paper constructed the IV-Probit model to explore the impact of land transfer on the straw resource utilization of households. The results show that: (1) land transfer in and land transfer out can significantly promote the utilization of straw resources by farmers. (2) Heterogeneity analysis showed that land transfer in had a positive effect on crop straw utilization of the new generation and large-scale farmers. (3) Land transfer in can promote the utilization of straw resources by improving farmers' economic cognition and efficacy cognition; land transfer out can promote the utilization of straw resources by improving farmers' efficacy cognition. Accordingly, the government should improve the land transfer market, increase technology propaganda, and create an excellent policy environment to promote farmers' participation in straw resource utilization.

**Keywords:** land transfer; utilization of straw resources; rural

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## 1. Introduction

The United Nations Sustainable Development Goals propose to curb climate change and protect the environment. China's 2030 Carbon Peak Action Plan clearly calls for high-value and resource-based use of straw, improved storage and transportation systems, strict control of burning, and an accelerated process of straw industrialization. In recent years, with the continuous increase in the production of rice and other crops in the world, the accompanying agricultural wastes such as straw have caused tremendous pressure on the environment [1,2]. According to statistics, China's annual output of crop residues are about 5 billion tons, nearly 900 million tons of which is straw [3]. Crop straw, as one of the primary wastes in agricultural production, has the characteristics of large quantity, variety, and wide distribution, and is a biomass resource of "use for profit, discard for waste" [4]. In recent years, with the change in agricultural production, lifestyle, and energy consumption structure, there has been a regional and structural surplus of straw [5]. Since 2016, China's Central No. 1 document has continuously emphasized the promotion of straw resource utilization. With the improvement of straw resource utilization technology, the comprehensive utilization of straw as fertilizer, feed, and new energy has gradually attracted attention from areas of society [6]. Compared with extensive treatment methods such as "burning and discarding," the utilization of straw resources has apparent ecological and environmental effects [7], which is of great significance to improving the agricultural ecological environment and building a resource-saving society [8].

In the existing microscopic research, the academic community has conducted many investigations on the influencing factors of farmers' straw resource utilization behavior, mainly involving the characteristics of individuals, families, and villages. Factors such as the education level, age of household owners, whether they are engaged in non-agricultural industries, the degree of part-time employment, household income, cultivated land area, the degree of local public infrastructure perfection, and the distance between the village and market will all have an impact on farmers' straw treatment methods [9–11]. The second set of factors is motivation and cognition. Zhang et al. [12] proposed that improving motivation, opportunity, and ability can promote the transformation of farmers' straw resource utilization intention into behavior. At the same time, farmers' opinions also play a significant role in the sustainability of their agricultural practice [13]. Farmers' different cognition, such as environmental cognition, value perception, social trust, and sense of responsibility, will also impact straw resource utilization [14–18]. The third is the external environment, which mainly refers to government policies, including financial subsidies and constraints. Studies have found that the burning ban restricts farmers' straw-burning behavior, and straw subsidies affect farmers' decision making on straw resource utilization to varying degrees [19,20].

With the gradual advancement of agricultural marketization, large-scale land management has become a trend, and the heterogeneity of management scale has begun to affect farmers' behavioral decisions [21,22]. However, the change in straw use behavior caused by land transfer behind the large-scale land operation has received little attention. According to the Ministry of Agriculture and Rural Affairs statistics, as of 2019, the transfer area of household contracted farmland has increased to more than 555 million mu, and the transfer ratio has increased to 35.9%. The development of the land transfer market provides conditions for the optimal allocation of land resources, which dramatically impacts agricultural production [23]. Previous studies have shown that land transfer significantly impacts farmers' straw disposal behavior, but the conclusions are inconsistent. Cao et al. [24] found that the land transfer policy can reduce the burning of biomass such as straw. Cao et al. [25] found that land transfer in Ningxia positively impacted farmers' pro-environmental agricultural practices, while land transfer out had a negative impact. However, Gao et al. [26], based on the survey data of farmers in Henan Province, found that the possibility of farmers using the straw to return to the field on the transferred land is reduced by half compared with that on their land. Yang et al. [27] also found that farmers invest less in the conservation tillage of straw returning on the transferred land than on their land based on the survey data of farmers in Heilongjiang, Henan, Zhejiang, and Sichuan provinces.

Based on this, and based on the field survey data of 540 farmers in Sichuan Province, China, this paper empirically analyzed the influence and action path of land transfer on straw resource utilization in order to provide some reference for relevant policies to optimize straw resource utilization. The marginal contribution of this paper mainly includes the following aspects. First, in the existing research on straw utilization, most scholars only focus on the single straw utilization method of straw returning to the field and fail to pay attention to the utilization of straw resources. This paper can enrich the related research in this field to a certain extent. Second, only a limited number of studies consider the impact of land transfer and straw utilization technology adoption, but the impact process between the two needs to be clarified. This paper conducts a deeper analysis of the intermediary mechanism and reveals the heterogeneity of farmers' land transfer with different characteristics of straw utilization. Third, the existing studies mostly use simple empirical methods, ignoring the endogeneity problem in farmers' decision making and behavior. This study uses the IV-Probit model to deal effectively with the endogeneity problem.

## 2. Theoretical Analysis

Agricultural technology adoption behavior is an endogenous response to changes in key economic variables and is inevitably affected by the scale of cultivated land, a vital material resource [28]. Land transfer, an inevitable way for farmers to adjust the scale of cultivated land management, can effectively promote farmers' medium- and long-term investment behaviors, such as returning straw to the field, which is conducive to improving the soil environment and realizing sustainable development, while alleviating land fragmentation and realizing large-scale agricultural development [25]. In turn, it leads to the differentiation of farmers' production and operation actions and management methods [29]. According to the theory of economies of scale, the agricultural production of farmers who have transferred in land is long term and more dependent on land. A more extraordinary ability to eliminate technological risks or bear the costs of new technologies makes it easier to gain economies of scale [30,31]. Farmers will give more consideration to the protection and sustainable use of land [32], so they are more willing to use straw as a resource to protect the land. However, farmers who move out of the land and engage in non-agricultural work have low comparative advantages in agriculture and are less dependent on farmland [33]. Therefore, they tend to ignore medium- and long-term investment [34] and are unlikely to utilize straw resources. Based on this, the following hypotheses are proposed in this paper, and the research framework is shown in Figure 1.

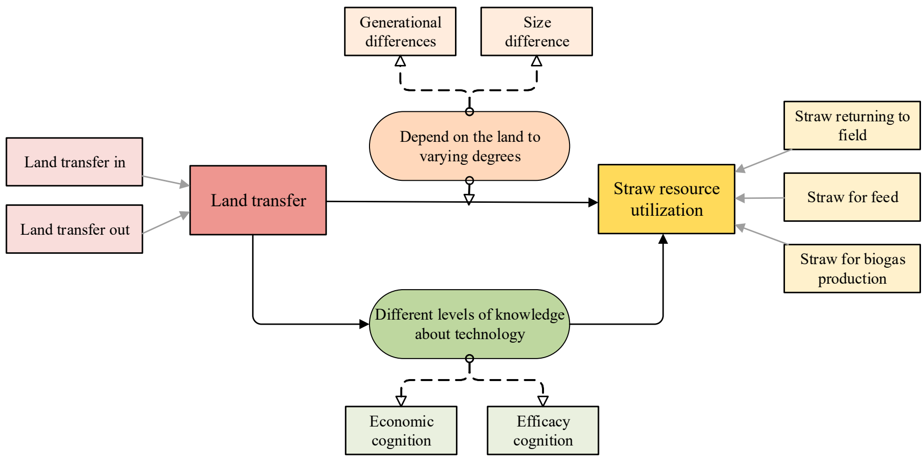


**Figure 1.** Theoretic analysis framework.

**H1:** Land transfer in will promote farmers' straw resource utilization.

**H2:** Land transfer out will inhibit farmers' straw resource utilization.

The theory of planned behavior believes that individual behavior is not only affected by behavior intentions, but is also limited by the individual's internal cognition. It incorporates non-rational factors, such as farmers' behavioral attitudes, subjective norms and other concepts, and psychological factors into the behavioral response analysis framework, which can reflect the bounded rationality hypothesis of individual behavior [35]. First, according to rational smallholder theory, as "rational economic people," whether farmers adopt technology is a result of comparing the technology's economic benefits and opportunity costs [36]. Farmers who believe that straw recycling has economic benefits will consider adopting it to maximize long-term profits. Generally speaking, large-scale farmers who carry out the land transfer in have more positive market thinking and green concepts, so they will have higher economic cognition and are more inclined to adopt straw resource utilization technology. However, most farmers whose land is transferred out are engaged in part-time production or are not even engaged in an agricultural operation. In this case, adopting straw resource utilization technology will increase the cost, negatively affecting their economic cognition and further inhibiting their straw resource utilization. Moreover, self-efficacy refers to the belief in the ability of individuals to perform specific actions [37]. This paper expresses the degree to which farmers subjectively consider their efforts to adopt the technology of straw resource utilization. Farmers judge whether the technology can be realized according to their experience and ability. If so, they are more inclined to carry out straw resource utilization.

The appropriate scale operation suitable for rural households brought by land transfer can promote the optimal allocation of production factors such as capital, land, and labor [38], which is helpful to improve the efficacy cognition of technology adoption on both sides of land transfer, to realize the resource utilization of straw. Therefore, this paper believes land transfer can affect farmers' efficacy cognition and promote straw resource utilization. The specific assumptions are as follows:

**H3:** Land transfer in affects economic cognition and promotes the straw resource utilization of farmers.

**H4:** Land transfer out affects economic cognition and further inhibits the straw resource utilization of farmers.

**H5:** Land transfer in affects efficacy cognition and promotes the straw resource utilization of farmers.

**H6:** Land transfer out affects efficacy cognition and promotes the straw resource utilization of farmers.

## 3. Data and Methods

### 3.1. Data Sources

As a central agricultural province, Sichuan is one of the main areas where straw is distributed [39]. Since 2008, the Sichuan provincial government has vigorously promoted the return of straw to the field, and in 2017, the pilot construction of the comprehensive utilization of straw began. Therefore, selecting samples in this area has a strong representativeness. The data for this study were collected from questionnaires conducted in October 2021 in the Luxian, Qionglai, and Nanjiang counties of Sichuan Province. This survey covers the basic situation of families and the perception and adoption of low-carbon agricultural technologies. A combination of general random and stratified probabilistic random sampling is adopted to determine the survey samples. The process is as follows: according to the economic development level and landform difference, Sichuan Province's 183 districts and counties were divided into three groups. Each group randomly selected one district and county to obtain three sample districts and counties. Each sample district and county randomly selected three towns as sample towns. Then, three villages in each sample township were investigated. Finally, 20 households were randomly surveyed in each village, and 540 valid questionnaires from farmers from 27 villages, 9 towns and 3 districts were obtained through one-to-one, face-to-face interviews. The distribution map of the sample villages is shown in Figure 2.

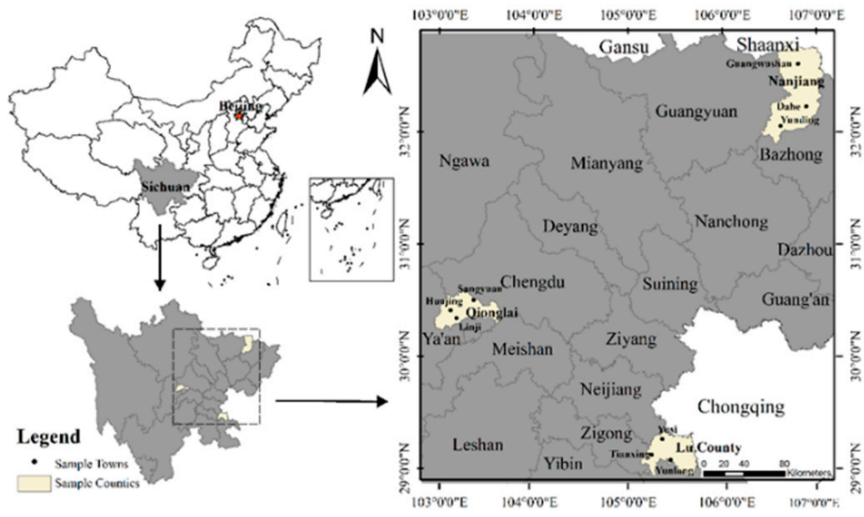


**Figure 2.** Distribution map of sample villages.

### *3.2. Index Selection*

#### 3.2.1. Dependent Variable

The utilization modes of straw resources include five modes: energy, feed, fertilizer, base material, and industrial raw material [40]. Since the main body of this study is small farmers, three utilization methods of straw returning to fields, straw to feed, and straw to biogas are selected for characterization (Table 1). In the model construction, straw resource utilization is the dependent variable of this paper. If farmers adopt one or more straw utilization methods, the value is 1; otherwise, the value is 0.

**Table 1.** Classification of straw resource utilization.

| Variable | Classification | Mean | Sd | N |
|---|---|---|---|---|
| Straw resource utilization | Straw returning to field (used = 1, unused = 0) | 0.843 | 0.365 | 540 |
| | Straw for feed (used = 1, unused = 0) | 0.157 | 0.365 | 540 |
| | Straw for biogas production (used = 1, unused = 0) | 0.013 | 0.113 | 540 |

Figure 3 shows the investigation of the straw resource utilization of farmers. Among the three straw resource utilization technologies, the straw returning to the field has the highest utilization rate (84.3%), followed by the straw to feed (15.7%), and the straw to biogas has the lowest utilization rate (only 1.3%).

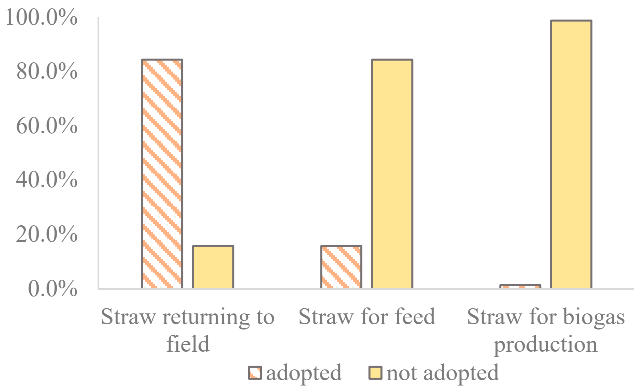


**Figure 3.** Utilization of farmers' straw resources.

#### 3.2.2. Independent Variable

The independent variable of this paper is land transfer, divided into land transfer in and land transfer out. The questionnaires are characterized by "in 2020, will your family transfer in the land?", "in 2020, will your family transfer out of the land?". If the farmer answers "yes," the value is 1; if not, the value is 0.

#### 3.2.3. Control Variable

Referring to the relevant studies of Yang et al. [21] and Zhang and Liu [29], this paper selects control variables from three aspects: household head characteristics, family characteristics, and land resource endowment, including household head gender, household head age, household head education level, household per capita income, the number of household labor force, per capita arable land under operation, and the topographic characteristics.

#### 3.2.4. Mediation Variable

The mediating variables in this paper include economic cognition and efficacy cognition. The questionnaires were characterized by "Do you think that green production technologies such as straw returning to the field are economical?" and "Do you think you can achieve green agricultural production?". The questions were put forward using a Likert scale, with "1" representing disagree, and "5" strongly agree. The definition, assignment, and descriptive statistics of each variable are shown in Table 2.

**Table 2.** Variable settings and descriptive statistics.

| Variable | Definition | Mean | SD |
|---|---|---|---|
| Straw resource utilization | Whether to utilize straw resources (1 = yes, 0 = no) | 0.765 | 0.425 |
| Land transfer in | Whether to transfer in the land (1 = yes, 0 = no) | 0.272 | 0.446 |
| Land transfer out | Whether to transfer out the land (1 = yes, 0 = no) | 0.259 | 0.439 |
| Gender of the head of household | 1 = male, 0 = female | 0.919 | 0.274 |
| Age of head of household | Unit: year | 56.487 | 9.920 |
| Education level of the head of household | Unit: year | 7.352 | 3.106 |
| Per capita household income | Unit: CNY | 33,639.985 | 99,254.933 |
| Per capita arable land under the operation | Unit: mu | 3.990 | 26.682 |
| Labor force | The number of people aged 16–64 in the labor force | 3.085 | 1.552 |
| Plain | Plain = 1; non-plain = 0 | 0.333 | 0.472 |
| Hills | Hills = 1; non-hills = 0 | 0.333 | 0.472 |
| Mountains | Mountains = 1; non- mountains = 0 | 0.333 | 0.472 |
| Efficacy cognition | Do you think you can achieve green agricultural production? (1−5, strongly disagree−strongly agree) | 3.531 | 1.199 |
| Economic cognition | Do you think straw returning and other green production technologies have economic benefits? (1−5, strongly disagree−strongly agree) | 3.637 | 1.135 |

### *3.3. Research Methods*

#### 3.3.1. Basic Regression Model

The explained variables are dichotomous. Therefore, the binary Probit model based on the micro level is selected for regression. The model is set as follows:

$$P(Recycling_i = 1) = \Phi(\beta_0 + \beta_1 Transfer_i + \beta_2 Control_i + \varepsilon_i) \quad (1)$$

In the formula, $\beta_1$, $\beta_2$ are the parameters to be estimated. $i$ represents different peasant households. $Recycling_i$ indicates whether farmer $i$ uses straw for resource utilization. $Transfer_i$ represents the land transfer behavior of farmers $i$, which can be divided into land transfer in and land transfer out. $Control_i$ represents the relevant control variables of farmer $i$, $\varepsilon_i$ is the random perturbation term.

Since land transfer and straw resource utilization may cause endogeneity problems due to bidirectional causality, this paper uses the instrumental variable method (IV-Probit) to solve this problem. Referring to the processing ideas of Xu et al. [41], this paper selects "the percentage of the number of farmers who transfer-in land in the village to the total number of farmers in the village" as the instrumental variable for land transfer in, and "the percentage of the number of farmers who transfer out of the land in the village to the total number of farmers in the village" as an instrumental variable for land transfer out. The variable was adopted based on the following considerations. First, the proportion of land transfer in villages reflects the development of the land transfer market in the region to a certain extent, which will affect the land transfer behavior of households. Second, the land transfer ratio of the village exists objectively and will not directly affect the household's straw resource utilization. This variable is an exogenous variable relative to straw resource utilization. Therefore, the instrumental variable meets the requirements of the correlation and homogeneity of instrumental variables theoretically and logically.

3.3.2. Mediating Effect Model

Referring to the mediation effect test procedure of Wen and Ye [42], this paper intends to use the stepwise regression method to test and explain how farmers' land transfer plays a role in straw resource utilization. The specific estimation equation is as follows:

$$P(Recycling_i = 1) = \Phi(\beta_0 + \beta_1 Transfer_i + \beta_2 Control_i + \varepsilon_i) \quad (2)$$

$$Mediator_i = \gamma_0 + \gamma_1 Transfer_i + \gamma_2 Control_i + \mu_i \quad (3)$$

$$P(Recycling_i = 1) = \Phi(\rho_0 + \rho_1 Transfer_i + \rho_2 Mediator_i + \rho_3 Control_i + \tau_i) \quad (4)$$

In the above formula, $\beta_1$, $\gamma_1$, $\rho_1$, $\rho_2$ are the parameters to be estimated. $Mediator_i$ was the mediator variable, representing the economic cognition or efficacy cognition of farmer $i$. Other variables had the same meanings as Formula (1).

## 4. Results

### *4.1. Descriptive Results Analysis*

As seen from Table 2, 76.5% of farmers have used straw resources, indicating that farmers have adopted a high degree of resource utilization. Regarding land transfer behavior, 27.2% of farmers moved in the land, and 25.9% moved out of the land. In addition, in terms of control variables, the majority of the household heads are male, accounting for 91.9%. The average age of the household heads is 56 years old, and the average number of years of education is 7.35 years. The average number of laborers aged 16 to 64 in a family is three, the average per capita area of arable land under management is 4 mu, and the average per capita income of the family is CNY 33,640. Regarding mediating variables, the mean value of efficacy cognition is 3.531, and the mean value of economic cognition is 3.637.

### *4.2. Analysis of Regression Results*

As shown in Table 3, Model 1 and Model 3, respectively, represent the Probit model to investigate the impact of land transfer in and land transfer out on farmers' straw resource utilization. The results showed that land transfer in could significantly promote farmers' straw resource utilization, but there was no correlation between land transfer out and straw resource utilization.

At the same time, the instrumental variable method (IV) was adopted to alleviate endogenous bias. The results are shown in Model 2 and Model 4. Land transfer in (land transfer out) is an endogenous variable. The test result of weak instrumental variable rejects the null hypothesis of a weak instrumental variable, confirming that it is appropriate to select "Percentage of the number of farmer households transferring in (transferring out) land in the village to the total number of farmer households in the village" as the instrumental variable of land transfer in (land transfer out). Second, the Wald test rejects the null hypothesis of homogeneity at the 1% level. As can be seen from the estimation results obtained by the instrumental variable method, land transfer in is still positively correlated with straw resource utilization. H1 is verified, indicating that farmers with land transfer in are more inclined to increase long-term investment in farmland quality protection and carry out straw resource utilization. Meanwhile, contrary to H2, land transfer out is positively correlated with straw resource utilization, which is different from the research results of Cao et al. [25]. The possible explanation is that although the farmers who transfer out of land may leave their straw idle for cost, they may also use straw for efficient resource allocation [21]. In addition, the development of a land transfer market guides the flow of a large amount of capital, talent, and information. It further helps reduce the cost of farmers' information search, helps farmers learn to more helpful information about straw resource utilization, and promotes straw resource utilization.

**Table 3.** Regression results of land transfer on straw resource utilization.

| | Straw Resource Utilization | | | |
|---|---|---|---|---|
| | **Model 1** | **Model 2** | **Model 3** | **Model 4** |
| Land transfer in | 0.377 ** | 1.438 ** | | |
| | (0.167) | (0.560) | | |
| Land transfer out | | | 0.149 | 0.847 *** |
| | | | (0.151) | (0.261) |
| Gender of the head of household | 0.441 ** | 0.431 ** | 0.458 ** | 0.563 *** |
| | (0.210) | (0.204) | (0.211) | (0.201) |
| Age of head of household | 0.012 | 0.012 * | 0.011 | 0.006 |
| | (0.007) | (0.007) | (0.007) | (0.007) |
| Education level of the head of household | −0.019 | −0.017 | −0.021 | −0.029 |
| | (0.022) | (0.022) | (0.022) | (0.022) |
| Per capita household income (logarithm) | 0.037 | 0.059 | 0.023 | −0.003 |
| | (0.050) | (0.050) | (0.051) | (0.052) |
| Per capita arable land under operation (logarithm) | −0.074 | −0.405 ** | 0.067 | 0.214 ** |
| | (0.099) | (0.187) | (0.097) | (0.109) |
| Labor force | 0.020 | −0.025 | 0.036 | 0.045 |
| | (0.041) | (0.045) | (0.041) | (0.039) |
| Plain | −0.154 | 0.085 | −0.250 | −0.339 ** |
| | (0.154) | (0.196) | (0.153) | (0.149) |
| Hills | −0.090 | −0.050 | −0.129 | −0.194 |
| | (0.160) | (0.158) | (0.159) | (0.157) |
| N | 540 | 540 | 540 | 540 |
| Pseudo R2 | 0.0338 | – | 0.0270 | – |
| Wald test | – | 2.85 (0.0914) | – | 9.01 (0.0027) |
| Weak IV AR Test | – | 5.74 (0.0166) | – | 10.22 (0.0014) |

Note: ***, **, and * indicate that the estimation results are significant at 0.01, 0.05, and 0.1, respectively.

### 4.3. Robustness Check

In order to test the robustness of the estimation results, the conditional mixed process (CMP) was used to re-estimate the impact of land transfer in and land transfer out on farmers' straw resource utilization. This method was proposed by Roodman [43]. The estimation process first estimates the correlation between instrumental and endogenous variables, and then puts the results into the benchmark model for regression. When atanhrho_12 is significantly different from 0, it indicates an endogeneity problem. In this case, the CMP estimation results prevail. As shown in Table 4, the atanhrho_12 parameters are all significant, indicating that the CMP estimation results are more accurate. The results show that land transfer in and land transfer out are positively correlated with straw resource utilization, indicating that the results of this paper are robust.

**Table 4.** Robustness test.

| | Straw Resource Utilization | |
|---|---|---|
| | **Model 5** | **Model 6** |
| Land transfer in | 1.438 *** | |
| | (0.551) | |
| Land transfer out | | 0.847 *** |
| | | (0.252) |
| atanhrho_12 | −0.448 * | −0.347 *** |
| | (0.262) | (0.110) |
| Control variables | controlled | controlled |
| N | 540 | 540 |

Note: *** and * indicate that the estimation results are significant at 0.01 and 0.1, respectively.

### *4.4. Heterogeneity Analysis*

Studies have found that intergenerational differences and land size are important factors affecting straw resource utilization [21]. First, referring to the classification method of He and Zhang [44], this paper defines those born in 1980 and later as the new generation of farmers and those born before 1980 as the old generation. The age of the head of household, a control variable, was removed from the heterogeneity analysis of different generations, and the results are shown in Table 5. There are intergenerational differences in the impact of land transfer in on straw resource utilization. At the same time, there is no intergenerational difference in the impact of land transfer out on straw resource utilization. Specifically, land transfer in had a significant positive impact on the new generation of farmers' straw resource utilization behavior, but had no significant effect on the old generation's straw resource utilization. A reasonable explanation for this result is that, compared with the older generation, the new generation generally has more human capital advantages [45–48] and is more likely to accept and adopt the new technology of straw resource utilization. Therefore, there are intergenerational differences in the impact of land transfer in on straw resource utilization.

**Table 5.** Heterogeneity analysis.

| | Land Transfer in and Straw Resource Utilization | | Land Transfer out and Straw Resource Utilization | | Land Transfer in and Straw Resource Utilization | | Land Transfer out and Straw Resource Utilization | |
|---|---|---|---|---|---|---|---|---|
| | New Generation | Old Generation | New Generation | Old Generation | Small-Scale | Large-Scale | Small-Scale | Large-Scale |
| Land transfer in | 0.874 ** | 0.212 | | | 0.432 | 0.462 ** | | |
| | (0.362) | (0.190) | | | (0.392) | (0.220) | | |
| Land transfer out | | | 0.186 | 0.138 | | | 0.274 | 0.031 |
| | | | (0.270) | (0.183) | | | (0.201) | (0.294) |
| Control variables | controlled | | controlled | | controlled | | controlled | |
| Pseudo R2 | 0.0926 | 0.0183 | 0.0605 | 0.0169 | 0.0391 | 0.0571 | 0.0415 | 0.0385 |
| N | 143 | 397 | 143 | 397 | 265 | 220 | 265 | 220 |

Note: ** indicate that the estimation results are significant at 0.05.

In addition, according to whether the scale of land being operated by households in the sample is larger than the sample mean, the sample is divided into two levels: large scale and small scale. In order to make the results more accurate, the samples with a family business scale more outstanding than 10 mu are excluded here. There is no scale heterogeneity between land transfer out and straw resource utilization, while there is scale heterogeneity between land transfer in and straw resource utilization. Land transfer in has a significant positive effect on the straw resource utilization of large-scale farmers. However, it has no significant effect on the straw resource utilization of small-scale farmers. The reasonable explanation for this result is that large-scale farmers have a higher production capacity and risk resistance, and are more willing to make a long-term investment in land [18]. Therefore, as an environmentally friendly technology, straw resource utilization is easier to adopt by large-scale farmers.

### *4.5. Mechanism Analysis*

First, the mediating effect of economic cognition on land transfer in and land transfer out on farmers' straw resource utilization was tested, and the results are shown in Table 6. In the case of land transfer in, first, land transfer in can positively affect straw resource utilization and economic cognition, respectively. Second, after incorporating land transfer in and economic cognition into the regression equation of straw resource utilization, both are positively correlated with straw resource utilization, indicating that economic cognition has a mediating effect on land transfer in and straw resource utilization. Furthermore, it is a partial intermediary (Mechanism 1), which verifies H3. In terms of land transfer out, land transfer out can positively affect straw resource utilization, but there is no correlation with economic cognition. Therefore, economic cognition does not mediate between farmers' land transfer out and straw resource utilization, and thus, H4 was not verified. In this regard, a reasonable explanation is that for small-scale farmers who transfer land out, their straw yield is low, which is likely due to the consideration of resource allocation and government policy constraints for straw resource utilization. At the same time, although the farmers who have transferred the land out have less time and energy for farming, and the opportunity cost is higher when adopting resource utilization technologies such as straw returning to the field, they are also less sensitive to the economic benefits of straw resource-based utilization due to a series of government subsidies and incentive policies.

**Table 6.** Analysis of the intermediary mechanism of economic cognition.

| | **Mechanism 1: Land Transfer in →Economic Cognition →Straw Resource Utilization** | | | **Mechanism 2: Land Transfer out →Economic Cognition →Straw Resource Utilization** | | |
|---|---|---|---|---|---|---|
| | **Straw Resource Utilization** | **Economic Cognition** | **Straw Resource Utilization** | **Straw Resource Utilization** | **Economic Cognition** | **Straw Resource Utilization** |
| Land transfer in | 1.438 ** (0.560) | 0.239 * (0.133) | 1.415 ** (0.568) | | | |
| Land transfer out | | | | 0.847 *** (0.261) | 0.111 (0.114) | 0.785 *** (0.271) |
| Economic cognition | | | 0.176 ** (0.070) | | | 0.205 *** (0.056) |
| Control variables | | controlled | | | controlled | |
| N | | 540 | | | 540 | |
| Pseudo R2 | – | 0.0657 | – | – | 0.0639 | – |
| Wald test | 2.85 (0.0914) | – | 2.72 (0.0993) | 9.01 (0.0027) | – | 7.62 (0.0058) |

Note: ***, **, and * indicate that the estimation results are significant at 0.01, 0.05, and 0.1, respectively.

Moreover, the mediating effect of efficacy cognition on the impact of land transfer in and land transfer out on farmers' straw resource utilization was tested. The results are shown in Table 7. Land transfer in can positively affect straw resource utilization and efficacy cognition, respectively. Secondly, when land transfer in and efficacy cognition were included in the regression equation of straw resource utilization, both were positively correlated with straw resource utilization. This indicates that efficacy cognition had a mediating effect on land transfer in and straw resource utilization and belonged to a partial mediating effect (Mechanism 3). H5 is therefore verified. Similarly, land transfer out can also promote straw resource utilization through a positive influence on efficacy cognition (Mechanism 4), and efficacy cognition has a partial mediating effect; thus, H6 is verified.

**Table 7.** Analysis of mediating mechanism of efficacy cognition.

| | **Mechanism 3: Land Transfer in →Efficacy Cognition →Straw Resource Utilization** | | | **Mechanism 4: Land Transfer out →Efficacy Cognition →Straw Resource Utilization** | | |
|---|---|---|---|---|---|---|
| | **Straw Resource Utilization** | **Efficacy Cognition** | **Straw Resource Utilization** | **Straw Resource Utilization** | **Efficacy Cognition** | **Straw Resource Utilization** |
| Land transfer in | 1.438 ** (0.560) | 0.232 * (0.127) | 1.508 *** (0.531) | | | |
| Land transfer out | | | | 0.847 *** (0.261) | 0.355 *** (0.110) | 0.669 ** (0.277) |
| Efficacy cognition | | | 0.205 *** (0.066) | | | 0.222 *** (0.055) |
| Control variables | | controlled | | | controlled | |
| N | | 540 | | | 540 | |
| Pseudo R2 | – | 0.0470 | – | – | 0.0507 | – |
| Wald test | 2.85 (0.0914) | – | 3.53 (0.0601) | 9.01 (0.0027) | – | 6.04 (0.0139) |

Note: ***, **, and * indicate that the estimation results are significant at 0.01, 0.05, and 0.1, respectively.

## 5. Conclusions and Policy Recommendations

Promoting the recycling and effective management of crop straw and other agricultural waste resources is the inevitable demand for sustainable agricultural development and ecological civilization construction in the new era. Based on the micro-survey data of 540 farmers in Sichuan Province, China, this paper empirically analyzed the impact of land transfer in and land transfer out on farmers' straw resource utilization and its action path by using the instrumental variable method (IV-Probit). It drew the following conclusions.

(1) Both land transfer in and land transfer out can significantly promote the utilization of straw resources by farmers. (2) There are intergenerational and scale differences between land transfer in and farmers' straw resource utilization. There are no intergenerational differences or scale differences in land transfer out. Specifically, land transfer in has a positive and significant impact on crop straw utilization of the new generation and large-scale farmers. (3) Land transfer in can further promote the utilization of straw resources by improving farmers' economic cognition and efficacy cognition; land transfer out can promote the utilization of straw resources by improving farmers' efficacy cognition.

The results of this study have policy implications for sustainable agriculture development. First, land transfer's positive impact on straw resource utilization indicates that the government should encourage farmers to carry out the land transfer and improve the land transfer market. For example, farmers can be guided to sign written contracts with legal benefits when transferring land to standardize the transfer market to ensure the transfer's security and stability. Second, the differences in straw resource utilization among farmers of different scales indicate that the government should accelerate the cultivation of new agricultural management entities such as large professional households and agricultural co-operatives. Promoting the moderate-scale operation of agriculture will provide the resource basis for popularizing farmers' straw resource utilization technology. Third, land transfer impacts straw resource utilization by affecting farmers' subjective cognition, indicating that farmers' understanding and cognition of straw treatment technology is conducive to promoting their subjective norms. Therefore, the government should strengthen the publicity of straw recycling technology and optimize the promotion system. For example, regular agricultural production training on straw disposal and display of straw resource utilization technology and related achievements can make farmers fully understand the expected benefits brought by technology and promote them to establish positive value and efficacy cognition, to realize the maximum utilization of resources. In addition, various communication methods can be adopted to reach farmers of different age groups. For example, propaganda methods based on the Internet, radio, and television can be adopted by the new generation of farmers. In contrast, propaganda methods based on publicity manuals, bulletin boards, and publicity training can be adopted for the old generation of farmers. Fourth, the government should create a favorable policy environment and improve supporting policies. On the one hand, it is necessary to focus on the straw resource utilization policy. While exploring the differentiated subsidy policy for the straw resource utilization of farmers at different levels in different regions, we should continue to investigate and punish straw burning for achieving a combination of rewards and punishments. On the other hand, it is necessary to focus on other policies, strengthen the construction of rural infrastructure, and improve the support system for straw processing and recycling enterprises, technology research, and development subjects.

Of course, there is room for further research in this field. This paper focuses on the influence of land transfer (land transfer in and land transfer out) on straw resource utilization. However, the scale, duration, and rent of land transfer may affect farmers' straw resource utilization decisions, and further research on this aspect is needed in the future.

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