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The Effect of Labor Migration on Farmers' Cultivated Land Quality Protection

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Abstract: Since the reform and opening up, a large proportion of the Chinese rural labor force has transferred to urban and non-agricultural industries. Rural labor transfer not only changes the allocation of household labor in agricultural and non-agricultural sectors but also affects the utilization of other agricultural production factors. Based on data from 818 households in three counties in northern Jiangsu province, this paper analyzed the impact of labor migration on farmers' adoption of cultivated land quality protection (CLQP) behaviors. The survey results showed that farmers' awareness of CLQP was still very weak, and the proportion of farmers adopting measures such as subsoiling, straw application, cover crops and green manures and the complementary use of organic fertilizers was still relatively low. The empirical results showed that perennial out-migration for work can constrain households' protective inputs into soil conservation, but part-time farming locally can promote households' inputs. The results also showed that farmer characteristics, farming conditions and external environment also significantly affected the farmers' adoption of soil conservation practices. According to these conclusions, this paper puts forward the corresponding policy implications.

1. Introduction

The quantity and quality of cultivated land is closely related to national food security [1]. As a very large country with a population of 1.4 billion people, stabilizing grain production and ensuring food security are of paramount importance to the Chinese national economy and people's livelihood. In Chinese agricultural production, there are long-term problems such as excessive application of fertilizers, insufficient circulation of organic matter and unreasonable farming methods, which have caused a degradation of cultivated land quality. The traditional agricultural production mode also has a negative impact on the environment and ecosystem functions, and the contradiction with the ecological environment is increasingly prominent. The key to solving the contradiction is to promote the coordinated development of intensive agriculture and sustainable agriculture technically [2]. Moreover, since opening up in 1978, the rapid progress of urbanization and industrialization and urban expansion, which have re-purposed what were formerly high-quality farmlands, have prominently contravened cultivated land quality protection (CLQP) [3].

Farmers, as the basic decision-making units, are the main subjects in the countryside economy and are even the organizers of cultivated land use and protection [4,5], especially with regard to raising quality [6]. At present, farmers' awareness of CLQP is still very weak in China, and the proportion of farmers adopting CLQP measures is still far behind that in developed countries [7–9].

Beyond China's late start in farmland quality protection, does the exodus of the rural labor force also restrict CLQP? Previous studies provide different views. Some scholars believe that labor migration prevents farmers from adopting cultivated land quality protection measures [10,11]. The argument is that labor migration reduces the share of agricultural income in households, making farmers less concerned about productivity and the sustainable use of cultivated land [12]. Some scholars also believe that off-farm employment promotes farmers' adoption of conservation agriculture techniques [13,14]. Because conservation agriculture techniques usually have the characteristics of saving labor input, the existence of off-farm employment opportunities means that the opportunity cost of agricultural labor is higher, thus helping to induce farmers to adopt labor-saving technology. In addition, some scholars believe that the negative impact of labor out-migration for work is mainly on farmers with non-agricultural income. For farmers with mainly agricultural income, labor out-migration for work promotes the adoption of sustainable agricultural technology [15]. In fact, China's rural labor force is characterized by "selective transfer" [16]. For example, in 2017, among the rural migrant labor force (excluding relocation of the whole family), 54% chose to work in other places instead of family agricultural production, while the remaining 46% chose to work in local non-agricultural industry and consider family agricultural production [17].

Measures of CLQP refer to all the methods that can maintain or improve the quality of cultivated land, including straw application, the complementary use of organic fertilizers, cover crop and green manure utilization, soil testing and formulated fertilization, crop rotation and other measures to improve the poor cultivated land. It also includes the measures to improve the capacity of moisture and fertility conservation of soil, such as ditch renovation and subsoiling [18]. These techniques for CLQP are resource conserving, environmentally non-degrading, technically appropriate and economically and socially acceptable. These characteristics are consistent with the characteristics of sustainable agriculture proposed by Food and Agriculture Organization of the United Nations (FAO) [18]. Scholars have analyzed farmers' CLQP behaviors based on a variety of econometric models. Some have used logistical modeling [19] and probit modeling [20] to analyze the decision-making mechanism of farmers' behavioral choice of whether to adopt farmland quality protection measures. Others have used ordered probit modeling [21], the Poisson model [8] and Heckman sample selection modeling [22] to analyze the influence factors for farmers' adoption of CLQP measures. However, these studies have several main deficiencies, which are as follows: First, the description of CLQP behavior is relatively simple, either taking one of the measures as an example or lumping all measures together; second is the assumption that the probability of different measures being taken by farmers is the same; third, they have ignored the potential correlation between different measures, which not only leads to biased estimation results but also leads to the extension of promotional policies for sub-optimal agricultural technology. In view of this, the Mvprobit model was selected in this paper to analyze the influence of labor migration on farmers' CLQP behaviors to avoid the above deficiencies of previous studies.

Whether the out-migrating labor force can consider agricultural production will inevitably lead to differences in the decision of whether farmers will adopt farmland quality protection measures. Based on questionnaire survey data from farmers in northern Jiangsu region, multivariate probit modeling was used to analyze the effect of labor migration on cultivated land quality protection, and the two-stage instrumental variable method was used to test the robustness of the analysis results. The results will provide new empirical evidence for the impact of migrant labor on the adoption of conservation tillage technology and provide an effective decision-making basis for the promotion and popularization of CLQP measures.

2. Material and Methods

2.1. Sample and Data

The data used in this paper are from a questionnaire survey of rural households conducted by our research group in northern Jiangsu province from January to February 2016. The survey sample

was distributed in three counties, namely, Lianshui, Shuyang and Xiangshui. The survey collected information on farmers' production management behavior, labor migration, cultivated land utilization and costs and benefits in 2015. The questionnaire survey used a two-round sampling method. The first round used improbability sampling to identify the survey site. Huaian, Suqian and Yancheng were selected from five cities in north Jiangsu, with each city selecting a county. Among thirty villages that were surveyed, twelve belonged to Lianshui county, ten to Shuyang county and eight to Xiangshui county. Random sampling was followed for the second sampling to determine the specific respondents in each village. Thirty farmers (excluding large grain growers, family farms and other new agricultural management subjects) were selected randomly as the survey objects.

The survey adopted the household survey method of face-to-face conversation between the investigator and the farmer in order to fill out the questionnaire. As a result, 887 questionnaires were completed. Among these, the invalid samples were removed, leaving 818 samples included in this paper, with an effective rate of 92.2%.

2.2. Model Specification

Assuming that farmers decide whether to adopt CLQP measures based on the principle of utility maximization, if the utility of adopting CLQP measures is greater than the utility generated by not adopting them, farmers will choose to adopt them, and vice versa. The impact of labor migration on farmers' adoption of CLQP can be defined as:

$$S_{ij}^* = \alpha_{0j} + O_{ij}\alpha_{1j} + Z_{ij}\alpha_{2j} + \mu_{ij}, S_{ij} = \begin{cases} 1, & S_{ij}^* > 0 \\ 0, & S_{ij}^* \leq 0 \end{cases} \tag{1}$$

Let S_{ij}^*, a latent variable, capture the ith farmer adopting the jth $(j = 1, 2, \cdots, J)$ CLQP measure. O_{ij} is a vector of observable variables that depict household labor migration. Z_{ij} is a vector of control variables that might influence the farmer's adoption of CLQP measures. $\alpha_{0j}, \alpha_{1j}, \alpha_{2j}$ are the parameters to be estimated, μ_{ij} is an error term and S_{ij} is a dichotomous variable that is observed as a 1 if the farmer adopts the CLQP measures and 0 otherwise.

A given farmer adopting multiple CLQP measures is allowed in Mvprobit. $\mu_{ij}(j = 1, 2, \cdots, J)$ is subject to a multivariate normal distribution with a conditional mean of zero. Its covariance Ω can be represented as:

$$\Omega = \begin{bmatrix} 1 & \rho_{12} & \cdots & \rho_{1J} \\ \rho_{21} & 1 & \cdots & \rho_{2J} \\ . & . & \cdots & . \\ \rho_{J1} & \rho_{J2} & \cdots & 1 \end{bmatrix} \tag{2}$$

In Equation (2), $\rho_{kj} = \rho_{jk}(k = 1, 2, \cdots J)$, $\rho_{kj}(k \neq j)$ is the correlation coefficient of the error terms μ_{ik} and μ_{ij} in Equation (1). If $\rho_{kj} > 0$, remarkably, it means that there are complementarities in adopting measures k and j of CLQP. If $\rho_{kj} < 0$, remarkably, it means that there are substitutions in adopting measures k and j of CLQP [23,24].

2.3. Variable and Data Description

Based on the policy document from the original ministry of agriculture and related findings [9,25], this paper mainly focuses on famers' adoption of CLQP measures, which consist of subsoiling, straw application, cover crops and green manures and the complementary use of organic fertilizers. In order to reveal the differential impact of different modes of out-migration for work, this paper sets two variables: Perennial out-migration for work and local out-migration for both work and agriculture. The former means that the transferred labor force works in other places all year round and that the labor force is no longer engaged in family agricultural production; the latter means that the transferred labor force is employed in local non-agricultural industry and that the labor force also gives consideration to family agricultural production.

According to available research results, we considered the following control variables: farmer characteristics, farming conditions and external environment. Farmer characteristics include householder's age, education, family size and agricultural income. Many participation and adoption studies have confirmed the role of household head or decision-maker characteristics, such as age and education, in the participation decision [26,27]. By general consensus, the acceptance of CLQP measures by farmers with younger heads of household is higher than that of older farmers, but the role of age is ambiguous because age as a proxy for experience may be offset by a greater reluctance to try new things, including new technologies or government-sponsored programs [19]. Higher age also means a deeper understanding of the negative effects of cultivated land quality degradation, so the possibility of adopting CLQP measures is higher [11]. Education is not only related to the ability to obtain and process information but also often conducive to implementing knowledge-intensive conservation and sustainable agricultural technologies [28]. We expect education to increase farmers' ability to process information [27] and to implement new farming techniques and apply them to production practices [29,30]. At the same time, farmers with higher education levels are more likely than those with lower education levels to obtain off-farm employment opportunities, reducing the incentive to adopt measures to protect the quality of cultivated land [9]. The adoption of CLQP measures also depends to a certain extent on whether farmers have enough labor force. Farmers with more labor are more likely to adopt CLQP measures [11]. The proportion of agricultural income may also affect the CLQP of farmers. The higher ratio of agricultural income to household income is, the more dependent farmers are on agricultural operation and the more likely they are to adopt CLQP measures [31]. Farming conditions include the scale of cultivated land, the quality of cultivated land and the convenience of irrigation. With large-scale cultivated land, it is not only easy to form economies of scale, enabling farmers to maintain or improve the fertility of cultivated land to increase crop yields, but also conducive to the use of machinery by farmers, reducing the difficulty of adopting measures to protect the quality of cultivated land [20,27]. The higher the evaluation of cultivated land quality is, the more likely the protection of cultivated land fertility will be neglected. Previous studies have found a lack of awareness of the fact that cultivated land quality degradation has a significant negative impact on the adoption of CLQP measures by farmers [9]. The convenience of irrigation can also affect farmers' CLQP behavior. Wollni et al. found that timely and effective irrigation is conducive to improving cultivated land value and promoting farmers' adoption of CLQP measures [21]. The external environment includes the availability of agricultural machinery services, agricultural technical guidance and participation in cooperatives. The employment of tillage machinery affects farmers' CLQP behavior because farmers mainly adopt some CLQP measures by purchasing agricultural machinery services. If they cannot employ protective tillage machinery, they may abandon the adoption of these measures [22]. Agricultural technical guidance can enhance farmers' awareness of cultivated land quality protection and is conducive to the popularization of CLQP measures [32]. Participating in cooperatives is beneficial for saving farmers the purchasing cost of agricultural materials (such as organic fertilizer, green manures seeds) and agricultural machinery services (subsoiling and straw application all rely on machinery). It can also accelerate the diffusion and promotion of cultivated land quality protection experience, thus affecting farmers' CLQP behavior [9] The definitions of variables in this study are shown in Table 1:

Table 1. Definition of variables.

Variables Name	Definition of Variable
Outcome Variables	
Subsoiling	Whether mechanized subsoiling has been carried out in the last three years: Yes = 1; no = 0
Straw application	Whether crop stalks are mechanized or stubble covered: Yes = 1; no = 0
Complementary use of organic fertilizers	Whether to purchase and apply commercial organic fertilizer: Yes = 1; no = 0
Cover crops and green manures	Whether to plant green manure crops: Yes = 1; no = 0
Explanatory Variables	
Perennial out-migration	The family has labor force outside work, and labor force is not engaged in family agricultural production: Yes = 1; no = 0
Part-time farming locally	The family has the labor force to work concurrently in the local, and the labor force still gives attention to the family agricultural production: Yes = 1; no = 0
Age	Measured in years
Education	Measured in years
Family size	Measured in number
Agricultural income	The ratio of agricultural income to household income: ≤20% = 1; 20–40% = 2; 40–60% = 3; 60–80% = 4; >80% = 5
Cultivated land scale	The scale of cultivated land actually managed at present: Measured in mu
Cultivated land quality	Subjective evaluation of the quality of cultivated land: not so good = 1, medium = 2, good = 3
Irrigation convenience	Subjective evaluation of the irrigation convenience of cultivated land: convenient = 1, inconvenient = 0
Agricultural machinery services	When agricultural machinery services are needed, whether they are available in time: Yes = 1; no = 0
Agricultural technical guidance	Have received agricultural technical guidance: Yes = 1; no = 0
Participate in a cooperative	Have participate in a cooperative: Yes = 1; no = 0

Farmers in the surveyed areas mainly adopted three kinds of measures to protect the quality of cultivated land: Subsoiling, straw application and the complementary use of organic fertilizers. In view of this, the samples that planted green manures were incorporated into the complementary use of organic fertilizers to facilitate the model analysis. The statistical results showed that the farmers who adopted subsoiling, straw application and increased application of organic fertilizer accounted for 38.9%, 35.6% and 16.4% of the total sample, respectively. The overall level was not high, indicating that encouraging farmers to participate in farmland quality protection is still very difficult. Table 2 shows the unconditional probability and conditional probability of farmers adopting different CLQP measures. It shows that the adoption of any of the CLQP measures, such as subsoiling, straw application and the complementary use of organic fertilizers, promotes the adoption of the other two kinds of CLQP measures. Thus, they are likely to be interdependent. Therefore, it is reasonable to use the Mvprobit model for empirical analysis.

Among the samples, 605 households had a labor force that left for work, accounting for approximately 74.0% of households. Three hundred nineteen rural households had migrant workers, and 397 had part-time workers. It is worth noting that 95 rural households were led by workers who chose to work either in other areas or in local areas. The cross-relationship between the different patterns of labor force out-migrating for work and CLQP behavior is shown in Table 3. These results show that out-migration for work had an inhibitory effect on farmers' CLQP behavior, but the local

part-time employment had a promoting effect on farmers' CLQP behavior. However, whether this is the case still needs to be tested by rigorous econometric models.

Table 2. The unconditional and conditional probability of adopting cultivated land quality protection (CLQP) measures.

	Subsoiling (*D*)	Straw Application (*M*)	Complementary Use of Organic Fertilizers (*O*)
$P(S_j = 1)$	38.9	35.6	16.4
$P(S_j = 1 \mid S_D = 1)$	100	83.6 ***	38.3 ***
$P(S_j = 1 \mid S_M = 1)$	91.4 ***	100	36.4 ***
$P(S_j = 1 \mid S_O = 1)$	91.0 ***	79.1 ***	100
$P(S_j = 1 \mid S_D = 1, S_M = 1)$	91.4 ***	83.6 ***	36.4 ***
$P(S_j = 1 \mid S_D = 1, S_O = 1)$	91.0 ***	79.5 ***	38.3 ***
$P(S_j = 1 \mid S_M = 1, S_O = 1)$	91.5 ***	79.1 ***	36.4 ***

Notes: S_j represents the adoption of different CLQP measures by farmers; *j* = subsoiling (*D*), straw application (*M*), complementary use of organic fertilizers (*O*); *** represents that the difference between conditional probability and unconditional probability is significant at the level of 1%.

Table 3. The cross relationship between labor migration and CLQP behavior.

		Subsoiling (*D*)		Straw Application (*M*)		Complementary USE of Organic Fertilizers (*O*)	
		Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
Perennial out-migration	Yes (*N* = 319)	0.34	2.36 ***	0.29	2.78 ***	0.14	1.40 *
	No (*N* = 499)	0.42		0.39		0.17	
Part-time farming locally	Yes (*N* = 397)	0.46	−4.30 ***	0.43	−4.54 ***	0.23	−5.17 ***
	No (*N* = 421)	0.32		0.28		0.09	

Notes: *** significant at 1% level; * significant at 10% level. Standard errors are in parentheses.

Results of the descriptive analysis of the model control variables are shown in Table 4. As seen from Table 4, the average age of the heads of households interviewed was approximately 56 years old, and the average years of schooling was approximately 9 years, which is equivalent to a middle school education level. The average household size was approximately 5, and the ratio of agricultural income to household income was mainly concentrated in the range of 40–60%. The average scale of cultivated land was approximately 7.5 mu, and the subjective evaluation of cultivated land quality was mainly medium. Approximately 65% of the surveyed farmers said that their cultivated land could not be irrigated in a timely and adequate manner, which had a negative impact on crop growth. Among the farmers interviewed, only 20% said that their demands for agricultural machinery services could be met in time, approximately 15% said that they had received technical guidance related to CLQP, and approximately 23% had joined cooperatives. In addition, compared with farmers who did not adopt CLQP measures, farmers who adopted CLQP measures had more years of schooling, more sources of income, larger scale farms, poorer quality of cultivated land and higher availability of agricultural machinery services. Experience in agricultural technical guidance and participation in cooperatives were relatively high.

<div align="center">**Table 4.** Description of control variables.</div>

Variables	Samples	Subsoiling		Straw Application		Complementary Use of Organic Fertilizers	
		$D = 1$	$D = 0$	$M = 1$	$M = 0$	$O = 1$	$O = 0$
Age	55.74	55.82	55.70	55.88	55.67	54.79	55.93
	(9.14)	(9.29)	(9.06)	(9.09)	(9.17)	(9.02)	(9.15)
Education	8.66	8.87 **	8.53	8.78 *	8.59	8.85 *	8.62
	(2.16)	(2.27)	(2.07)	(2.12)	(2.17)	(2.25)	(2.14)
Family size	4.90	4.99 *	4.84	5.04 *	4.82	4.92	4.89
	(1.17)	(1.16)	(1.18)	(1.16)	(1.17)	(1.16)	(1.17)
Agricultural income	2.85	3.06 ***	2.74	3.06 ***	2.73	3.00 **	2.82
	(1.17)	(1.17)	(1.15)	(1.15)	(1.16)	(1.21)	(1.16)
Cultivated land scale	7.48	8.33 ***	6.95	8.42 ***	6.97	8.27 ***	7.33
	(4.84)	(5.07)	(4.62)	(5.12)	(4.61)	(5.56)	(4.68)
Cultivated land quality	2.14	2.06 **	2.20	2.06 **	2.19	2.07 *	2.16
	(0.67)	(0.71)	(0.64)	(0.73)	(0.64)	(0.70)	(0.67)
Irrigation convenience	0.65	0.65	0.64	0.66	0.62	0.66 **	0.57
	(0.47)	(0.47)	(0.48)	(0.47)	(0.48)	(0.47)	(0.50)
Agricultural machinery services	0.20	0.27 ***	0.15	0.25 ***	0.17	0.23 **	0.19
	(0.40)	(0.44)	(0.35)	(0.43)	(0.38)	(0.42)	(0.39)
Agricultural technical guidance	0.15	0.22 ***	0.10	0.23 ***	0.10	0.27 ***	0.13
	(0.36)	(0.42)	(0.30)	(0.42)	(0.31)	(0.44)	(0.33)
Participate in a cooperative	0.23	0.33 ***	0.18	0.34 ***	0.18	0.36 ***	0.21
	(0.42)	(0.47)	(0.38)	(0.47)	(0.38)	(0.48)	(0.40)

Notes: The value in brackets is the standard deviation; *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

3. Theory

China underwent rapid urbanization following the reform and opening-up policies that were initiated in 1978. The urbanization rate, measured by urban population, increased from 17.92% in 1978 to 57.35% in 2016 [33]. While making up for a shortage of labor force in the urban and industrial development, the environment of agricultural development has undergone profound changes, which are mainly reflected in the decreasing labor input in agricultural production, the continuous rise in agricultural labor costs and decreasing liquidity constraint.

Labor migration has fundamentally shaped economic development in destination areas. It is also one of the strongest forces affecting rural household change within the sending communities [34]. Relevant research shows that labor migration may influence whether farmers adopt cultivated land quality protection measures through five channels [35,36]. First, labor migration reduces the quantity and quality of the household agricultural labor force, which is likely to cause a shortage in the agricultural labor force, thus hindering the adoption of labor-biased measures to protect the quality of cultivated land (such as the application of organic fertilizer) by farmers. In the rural labor market, which has incomplete environment constraints, the effect is more pronounced [37]. Second, labor migration contributes to raising the income level of rural households and relaxing the liquidity of remaining members of the budget constraint boundary [34]. This enables rural households to invest in the protection of cultivated land quality, such as purchasing commodity organic fertilizer and agricultural machinery operation services (deep loosening soil preparation, straw returned without agricultural machinery service, green manure crops that also need the use of agricultural machinery to incorporate into the soil) [38]. Third, labor migration changes the household income structure. Farmers are becoming less dependent on agriculture, and the importance of farm income for households is declining. As a result, farmers no longer expect to increase their income through agriculture, and extensive operation gradually becomes a rational choice [12]. Fourth, labor migration can alleviate the negative impact of risk shocks such as nature and disease on agricultural production, and it can have certain agricultural insurance functions that enhance the ability of farmers to resist risk shocks and promote the adoption of measures to protect the quality of cultivated land [39]. Fifth,

labor migration can ease the credit constraints of farm households. The increase in income level and the diversification of income sources brought about by labor migration increases the probability of peasant households obtaining formal credit [40]. Labor migration plays a promoting role in building a weak relationship network that is dominated by business margins, interest margins and friendship margins to obtain more informal credit sources [41]. Previous studies have confirmed that easing credit constraints has a promoting effect on cultivated land quality protection [9]. The effect of labor migration on protecting cultivated land quality depends on the competition between positive and negative effects. When migrant workers are no longer engaged in agricultural production, farmers' focus of employment begins to deviate from agricultural production. The negative effect of labor migration may take over, which is reflected in the reduced probability of adopting measures to protect the quality of cultivated land [15]. In contrast, when migrant workers can still give consideration to agricultural production, the focus of farmers' employment is not fundamentally changed. Thus, the positive effect of an out-migrating labor force is likely to take the lead, resulting in increased likelihood of farmers' adoption of farmland quality protection measures.

4. Empirical Results

4.1. Results from the Mvprobit Model

The Mvprobit model was used for estimation, and the random sampling times were set as 30, which was slightly larger than the arithmetic square root of the number of household samples needed to obtain robust regression results [42]. According to a likelihood ratio test, the null hypothesis that the correlation coefficients between the error terms would equal zero was rejected at the 1% level, indicating that farmers' varying decision-making regarding CLQP measures was not independent of each other. Specifically, the error terms' correlation coefficients ($\rho_{DM}, \rho_{DO}, \rho_{MO}$) were all greater than zero and significant at a 1% level, indicating that the unobserved factors in Equation (1) had a homogenous effect on farmers' adoption of subsoiling, straw application and complementary use of organic fertilizers, which means that they were complementary to each other. The model fit was good. Table 5 reports the estimated coefficients of the variables and their marginal effects.

Consistent with previous expectations, the results showed that perennial out-migration for work has a significant negative impact on farmers' CLQP behavior, while local part-time farming has a significant positive impact on farmers' CLQP behavior. In terms of the marginal effect, perennial out-migration for work decreased the probability of farmers adopting subsoiling, straw application and the complementary use of organic fertilizers by 6.5%, 9.0% and 5.0%, respectively. Local part-time farming increased the probability of farmers adopting subsoiling, straw application and the complementary use of organic fertilizers increased by 12.9%, 12.7% and 11.5%, respectively. According to the survey, transferred labor belongs to rural household heads that go out for work. The quality of the labor force left behind for farming is generally not high. These individuals lack knowledge of new agricultural technologies and pay little attention to the sustainable use of cultivated land. Instead, they focus on the current output of cultivated land, blindly pursuing high input and high output, and have little enthusiasm for the protection of cultivated land quality. This is related to the reconfiguration of the household labor force between agricultural and non-agricultural sectors. The lack of an agricultural labor force also causes farmers to neglect or abandon the management of cultivated land [11]. The survey also found that the agricultural and non-agricultural income of local part-time farmers occupy an important position in the family income structure compared with those of rural households for which the head goes out for work all year long. Such rural households still attach higher importance to agricultural production activities. In a context in which a large amount of labor input is replaced by machinery in current agricultural production, the local part-time industry enables farmers to improve the substitution of capital for labor through capital accumulation, thus promoting the adoption of capital-biased CLQP measures (such as subsoiling and straw application) [15]. Moreover,

under the complementary effect of different types of CLQP measures, this will further promote the adoption of labor-based CLQP measures (such as complementary use of organic fertilizers).

Table 5. Results from Mvprobit model.

Variables	Subsoiling		Straw Application		Complementary Use of Organic Fertilizers	
	Coefficients	Marginal Effects	Coefficients	Marginal Effects	Coefficients	Marginal Effects
Perennial out-migration	−0.194 *	−0.065 *	−0.290 ***	−0.090 ***	−0.223 *	−0.050 *
	(0.109)	(0.034)	(0.111)	(0.033)	(0.126)	(0.027)
Part−time farming locally	0.387 ***	0.129 ***	0.390 ***	0.127 ***	0.515 ***	0.115 ***
	(0.110)	(0.034)	(0.112)	(0.032)	(0.125)	(0.026)
Age	−0.001	−0.000	0.003	0.001	−0.008	−0.001
	(0.005)	(0.001)	(0.005)	(0.002)	(0.006)	(0.001)
Education	0.190 ***	0.060 ***	0.153**	0.049 **	0.121	0.027
	(0.068)	(0.021)	(0.069)	(0.021)	(0.078)	(0.016)
Family size	0.090 **	0.028 **	0.122 ***	0.042 ***	0.045	0.012
	(0.041)	(0.012)	(0.041)	(0.012)	(0.047)	(0.010)
Agricultural income	0.182 ***	0.057 ***	0.194 ***	0.059 ***	0.114 **	0.023 **
	(0.041)	(0.013)	(0.042)	(0.012)	(0.048)	(0.010)
Cultivated land scale	0.046 ***	0.014 ***	0.051 ***	0.014 ***	0.033 ***	0.007 ***
	(0.009)	(0.003)	(0.010)	(0.003)	(0.011)	(0.002)
Cultivated land quality	−0.200 ***	−0.061 ***	−0.217 ***	−0.061 ***	−0.123	−0.025
	(0.071)	(0.022)	(0.071)	(0.021)	(0.079)	(0.017)
Irrigation convenience	0.436 ***	0.147 ***	0.580 ***	0.185 ***	0.582 ***	0.132 ***
	(0.114)	(0.035)	(0.117)	(0.033)	(0.130)	(0.027)
Agricultural machinery services	0.496 ***	0.160 ***	0.334 ***	0.104 ***	0.147	0.033
	(0.116)	(0.036)	(0.120)	(0.035)	(0.135)	(0.028)
Agricultural technical guidance	0.527 ***	0.190 ***	0.593 ***	0.207 ***	0.602 ***	0.144 ***
	(0.130)	(0.040)	(0.132)	(0.038)	(0.141)	(0.029)
Join a cooperative	0.450 ***	0.161 ***	0.510 ***	0.177 ***	0.322 **	0.078 ***
	(0.112)	(0.034)	(0.113)	(0.034)	(0.126)	(0.027)
Regional fixation effect	Controlled		Controlled		Controlled	
ρ_{DM}			0.929 ***			
ρ_{DO}			0.612 ***			
ρ_{MO}			0.706 ***			
Logarithmic likelihood			−943.02			

Notes: The value in brackets is the standard deviation; *** Significant at 1% level; ** significant at 5% level; * significant at 10% level.

Among the control variables, education, family size, agricultural income, cultivated land scale, cultivated land quality, irrigation convenience, agricultural machinery services, agricultural technical guidance and joining a cooperative had significant influence on farmers' cultivated land quality protection behavior and the direction of this influence was consistent with expectations.

4.2. Robustness Examination

In the above model setting, there may be endogenous problems in the variable of out-migrating for work: Some unobservable characteristics of farmers may not only affect the decision to out-migrate for work by family members but also affect the adoption of CLQP measures, resulting in the problem of missing variables [15]. To eliminate the endogenous problem caused by missing variables, on the basis of the above Mvprobit model, this paper uses the two-stage instrumental variable method [43]. In the first stage of the model, considering the values of perennial migrant and local part-time farming are 0 or 1 and that there may be a substitute relationship between them, the Biprobit model was selected to conduct a regression analysis on the factors influencing the decision of household labor forces'

migrant work behavior. The purpose was to estimate the generalized error terms of the perennial out-migration equation and the local part-time farming equation. In the second stage of estimation, the generalized error term obtained by Biprobit model estimation was added to the Mvprobit model as a new explanatory variable for parameter estimation, to solve or alleviate the endogeneity.

It should be noted that the explanatory variables for the Biprobit model included the characteristics of farmers, farming conditions, external environment, regional fixation effect and instrumental variables of labor migration mentioned above. The instrumental variable selected in this paper was the proportion of the transferred labor force out of the total number of workers in the village. Through the function of social relation networks, this variable has a strong correlation with the decision underlying household labor migration [44]. The estimated results of the Biprobit model also confirmed that the influence of this variable on farmers' decision-making regarding migration was significant at the 1% level, meeting the correlation requirements of instrumental variables. There is no other possible way for this variable to affect the CLQP behavior of farmers except through the influence of the rural labor force going out for work, which can meet the exogenous requirements. In addition, the correlation coefficient of the error term of the Biprobit model was significant and negative, which means that there is indeed an inverse relationship between perennial out-migration and local part-time farming, which also indicates that it is reasonable to use Biprobit modeling in the first stage of model estimation.

Table 6 shows the main results of the second step of estimation. Perennial out-migration had a significant negative impact on the adoption of CLQP measures, such as subsoiling, straw application and the complementary use of organic fertilizers, while the impact of part-time farming locally was significant and positive, confirming the robustness of the previous research conclusions. The results of the model also show that after considering the endogeneity of the key variable, the marginal effect of both perennial out-migration and local part-time farming on the adoption of CLQP measures by farmers increased significantly, indicating that labor migration is an important factor affecting farmers' CLQP behavior.

Table 6. Results from robustness test.

Variables	Subsoiling		Straw Application		Complementary Use of Organic Fertilizers	
	Coefficients	Marginal Effects	Coefficients	Marginal Effects	Coefficients	Marginal Effects
Perennial out-migration	−1.584 *** (0.378)	0.512 *** (0.119)	−1.617 *** (0.380)	−0.502 *** (0.114)	−1.375 *** (0.439)	−0.293 *** (0.093)
Part-time farming locally	1.125 *** (0.395)	0.364 *** (0.126)	1.016 ** (0.398)	0.315 ** (0.122)	1.072 ** (0.468)	0.229 ** (0.099)
Control varibles	controlled		controlled		controlled	
Regional fixation effect	controlled		controlled		controlled	

Notes: The value in brackets is the standard deviation; *** Significant at 1% level; ** significant at 5% level.

5. Discussion

5.1. Interpreting the Results within the Context of the Literature

In accordance with results from the extant literature, farmer characteristics, farming conditions and external environment all had an impact on CLQP. Farmers with more years of education were more inclined to adopt subsoiling and straw application. Li and Yang found that education promoted farmers' adoption of sustainable agricultural technologies related to the protection of cultivated land quality [9,22]. The higher the household population was, the higher the probability of straw returning and organic fertilizer application.

Previous studies have pointed out that farmers' decisions regarding CLQP depends on families' labor endowment or the labor consumption of CLQP [25]. Increasing the application of organic

fertilizer requires more labor. Similarly, returning straw to the field can increase damage caused by grass and pests in the field, which also ultimately requires more labor. A higher proportion of agricultural income is conducive to the adoption of CLQP measures by farmers, which is consistent with the conclusion drawn by other researchers [20]. This is because measures to protect the quality of cultivated land can increase crop yields, thus encouraging farmers to adopt them [45]. Large scales of cultivated land and convenient irrigation can promote farmers to adopt CLQP measures. From the perspective of a marginal effect, the positive effect of convenient irrigation on the probability of the adoption of measures to improve farmers' CLQP is at least equivalent to the expansion of farmers' cultivated land by 10 mu, indicating the importance of cultivated land irrigation infrastructure for sustainable agricultural development. The higher the subjective evaluation of cultivated land quality is, the lower the probability that farmers will adopt CLQP measures. Previous studies have found that the lack of a correct and comprehensive understanding of cultivated land quality degradation is an important factor keeping farmers from carrying out CLQP investment [11].

Availability of agricultural machinery services has a positive impact on farmers' CLQP behavior, especially on subsoiling and straw application. Availability of agricultural machinery services increases the adoption probability of both by 16% and 10.4%, respectively, and this effect is significant at the 1% level. The experience of agricultural technical guidance had a positive and significant influence on the farmers' CLQP measures. Farmers who participate in agricultural technical guidance are more aware of the benefits of CLQP, so they are more likely to adopt CLQP measures than farmers who have not received agricultural technical guidance. Joining cooperatives had a significant positive effect on adopting CLQP measures, which is consistent with the conclusion of Yang and Xie [8,9]. However, the enthusiasm of farmers in the surveyed areas for participating in cooperatives was generally low. One of the most important reasons was that agricultural income has been replaced by non-agricultural income as the main part of household income, and the motivation to participate in cooperatives has declined.

5.2. Implications for CLQP

Based on the above results, there are a number of implications: (1) In the process of popularizing CLQP technology, the relevant departments should focus on the subject of agricultural production. (2) For rural households whose main labor force works in other areas, it is necessary to comply with their non-agricultural intention and help rural households with the intention to stay in cities and towns to settle down. (3) In terms of promoting CLQP, efforts should also be made to improve cultivated land irrigation infrastructure, actively promote the development of a socialized agricultural machinery service market, continue to strengthen the technical guidance of CLQP, and give full consideration to the demonstration and publicity functions of cooperatives.

5.3. Limitations and Future Research Directions

Chinese society is a relational society, and farmers naturally form their own social networks and culture in the long-term relationship. Cultural and social aspects influence farmers' decisions through interaction, reciprocity, learning and trust. The paper considers the influence of farmers' characteristics, farming conditions and external environment, but very few considerations are given to the cultural and social aspects. In this paper, the definition of CLQP behavior did not include the measures of trench repair, crop rotation, soil testing and formulated fertilization. While some enlightening conclusions have been drawn from the empirical analysis of subsoiling, straw application and the complementary use of organic fertilizers, it is not clear whether these conclusions are still valid for other types of CLQP measures. Besides the mentioned CLQP measures, sustainable agriculture concepts such as water-saving irrigation and processing and utilization of crop straw are also important measures worth thinking about in future research. Moreover, the impacts of different types of CLQP measures on farmers' production costs, output benefits and ecological environment also need to be investigated and evaluated in depth. These are important questions worth thinking about in follow-up research.

6. Conclusions

Labor migration not only changes the resource allocation of rural household labor forces in agricultural and non-agricultural employment sectors but also affects the utilization of other agricultural production factors. Based on survey data from rural households in north Jiangsu Province, this paper analyzed the influence of different labor migration on farmers' CLQP behavior. The results showed that in the surveyed areas, the proportion of CLQP measures such as subsoiling, straw application, cover crop and green manure utilization and the complementary use of organic fertilizers was still relatively low. Empirical results showed that perennial out-migration inhibits the input of CLQP by farmers, while local part-time farming promotes the input of CLQP by farmers.

In view of this, this paper holds that the transferred labor force belongs to perennial out-migration, and typically agricultural income loses its dominant position in the family income structure. Moreover, the labor force left behind for farming is of low quality and does not care much about the sustainable use of cultivated land. Transfer labor belongs to local part-time farming, whose agricultural income still occupies an important position in the family income structure. Through capital accumulation, migrant workers can help to promote the adoption of capital-biased CLQP measures. At the same time, under the complementary effect of different measures of CLQP, the adoption of labor-biased CLQP measures is promoted. The empirical results also show that education, family size, agricultural income, cultivated land scale, cultivated land quality, irrigation convenience, agricultural machinery services, agricultural technical guidance, participation in a cooperative and other factors affect farmers' CLQP behavior.

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