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Does aging and off-farm employment hinder farmers' adoption behavior of soil and water conservation technology in the Loess Plateau?

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Abstract

Purpose – Based on the survey data of 1,152 households in three provinces of Shaanxi, Gansu and Ningxia on the Loess Plateau, this paper aims to empirically analyze the impact of aging and off-farm employment on farmers' adoption behavior of soil and water conservation technology. This paper analyzes the moderating effect of social network and the mediating effect of technological cognition in this impact relationship.

Design/methodology/approach – Based on the above analysis, the second part of this paper is based on relevant theories and constructs a theoretical model of the relationship of aging, off-farm employment, social network, technology cognition and farmers' adoption behavior of soil and water conservation technology. The third part introduces research methods, variable selection and descriptive statistics analysis of variables. The fourth part, based on the data of Shaanxi, Gansu and Ningxia provinces in the Loess Plateau in 2016, empirically analyzes the impact of aging, off-farm employment and social network on the farmers' adoption behavior of soil and water conservation technology. This paper further examines the moderating effect of social network and the mediating effect of technology cognition in this influence relationship. Finally, based on the findings of the empirical study, this paper puts forward countermeasures and suggestions.

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Findings – First, aging and off-farm employment have a significant negative impact on farmers' adoption behavior of soil and water conservation technology, while social network has a significant positive effect. Second, social network has alleviated the effect of aging and off-farm employment on restraining farmers' adoption behavior of soil and water conservation technology. Third, aging and off-farm employment have restrained farmers' cognition of soil and water conservation technology. Social network has promoted farmers' cognition of soil and water conservation technology. Social network plays a moderating role in the impact of aging and off-farm employment on farmers' cognition of soil and water conservation technology. Technology cognition plays a mediating role in the impact of social network on farmers' adoption behavior of soil and water conservation technology.

Originality/value – This paper integrates the aging, off-farm employment and social network into the same analytical framework and reveals their impact on farmers' adoption behavior of soil and water conservation technology and its action mechanism, which enriches the impact of human capital and social network on farmers' adoption behavior of soil and water conservation technology. Then taking the social network as a moderator variable, the paper verifies its moderating effect on the relationship of aging, off-farm employment and farmers' adoption behavior of soil and water conservation technology. Farmers' technology cognition should be included in the analysis framework to examine the impact of aging, off-farm employment and social network on farmers' cognition of soil and water conservation technology. Taking the technology cognition as a mediator variable, the paper verifies its mediating effect on the relationship of aging, off-farm employment and farmers' adoption behavior of soil and water conservation technology.

Keywords Social network, Aging, Off-farm employment, Soil and water conservation technology, Technology cognition

Paper type Research paper

1. Introduction

China is one of the countries with the most serious soil erosion in the world. The Loess Plateau is the most serious area of soil erosion in China. The Loess Plateau is facing serious ecological and environmental problems such as soil erosion. Farmers' unreasonable agricultural production activities aggravate soil erosion and restrict the sustainable development of agriculture. Practice shows that soil and water conservation technology can promote rural economic development, increase land productivity and farmers' income (Shao and Jiang, 2008), reduce soil erosion and poverty (Kuang and Luo, 2010). Therefore, promoting soil and water conservation technology is the main way to control soil erosion in the Loess Plateau. However, in reality, the adoption rate of soil and water conservation technology in the Loess Plateau is low, and the effect is not ideal, which puts the popularization of water and soil conservation technology in a dilemma (Liu *et al.*, 2009).

Farmers are the main body of agricultural management and the direct adopters and beneficiaries of soil and water conservation technology. However, with the continuous development of the social economy and urbanization, rural areas are facing increasingly serious problems of aging and labor transfer. The National Statistics Bureau's third National Agricultural Census's main data bulletin shows that, in 2016, 33.6 per cent of the agricultural production and operation personnel were 55 years old or more. Only 19.2 per cent of them aged 35 years old or younger. The situation of rural population aging is serious. At the same time, the huge income gap between urban and rural areas leads to the transfer of the rural labor force. The migrant workers monitoring survey report showed that the total number of migrant workers in 2016 was 281.71 million, an increase of 4.24 million over 2015, (i.e. an increase of 1.5 per cent). Then, does rural aging and off-farm employment hinder farmers' adoption behavior of soil and water conservation technology in the Loess Plateau and make the extension of soil and water conservation technology in a dilemma?

In view of the reasons for the low adoption rate of soil and water conservation technology, scholars at home and abroad have conducted a lot of research. The results show that the main factors affecting farmers' adoption behavior of soil and water conservation technology are individual characteristics, family management characteristics and environmental factors and so on (Zhong and Huang, 2004; Kassie *et al.*, 2013; Zhang *et al.*, 2015; Ji, 2017). However, under the new situation of rural aging and non-agricultural transfer of rural labor force, the influence of rural aging and off-farm employment on farmers' adoption behavior of soil and water conservation technology should also be paid enough attention, because the level of human capital plays an important role in the promotion and application of agricultural technology (Schultz, 1964). At present, most studies focus on the influence of education level on farmers' technology adoption behavior. However, there are few studies concerning the impact of rural aging and off-farm employment on farmers' technology adoption behavior. In recent years, with the development of social network theory, relevant scholars began to pay attention to the role of social network in the adoption of agricultural technology (Wang and Lu, 2015). Research shows that social network mainly influence farmers' technology adoption behavior through social learning, information acquisition (Qiao *et al.*, 2017), service complementarity and help support mechanisms (Genius *et al.*, 2014). However, during popularization of soil and water conservation technology, how does social network affect farmers' adoption behavior of soil and water conservation technology? Under the background of rural aging and non-agricultural transfer of the rural labor force, can social network effectively improve the human capital constraints of rural aging and off-farm employment on technology adoption? This aspect of research is rare. In addition, farmers' technology cognition will affect farmers' technology adoption behavior (Li *et al.*, 2017). Aging and off-farm employment will affect farmers' technology cognition (He and Zhang, 2014). Thus, we investigate whether aging and off-farm employment will affect farmers' adoption behavior of soil and water conservation technology through influencing farmers' cognition of soil and water conservation technology. That is, we want to determine whether technology cognition plays a mediating role in the impact of aging and off-farm employment on farmers' technology adoption behavior, and whether social network plays a moderating role in the impact of aging and off-farm employment on farmers' cognition of soil and water conservation technology, and then affect farmers' technology adoption. To the best of the authors' knowledge, this research does not yet exist in the literature.

Based on the above analysis, Section 2 of this paper is based on relevant theories, and constructs a theoretical model of the relationship of aging, off-farm employment, social network, technology cognition and farmers' adoption behavior soil and water conservation technology. Section 3 introduces research methods, variable selection and descriptive statistics analysis of variables. Using 2016 data of Shaanxi, Gansu and Ningxia provinces in the Loess Plateau, Section 4 empirically analyzes the impact of aging, off-farm employment and social network on farmers' adoption behavior of soil and water conservation technology. We then further examine the moderating effect of social network and the mediating effect of technology cognition on this aforementioned relationship. Finally, based on the findings of the empirical study, we put forward countermeasures and suggestions. The contributions of this paper are as follows:

- This paper integrates aging, off-farm employment and social network into the same analytical framework, and reveals their impact on farmers' adoption behavior of soil and water conservation technology, along with its action mechanism, which enriches the impact of human capital and social network on farmers' adoption behavior of soil and water conservation technology.

- This paper adds the interaction items of aging and social network, off-farm employment and social network. The goal is to verify if social network can effectively improve the human capital constraint of rural aging and off-farm employment on soil and water conservation technology adoption, that is, we test the moderating effect of social network.
- Farmers' technology cognition should be included in the analysis framework, to examine the impact of aging, off-farm employment and social network on farmers' cognition of soil and water conservation technology. We test whether aging, off-farm employment and social network will affect farmers' technology adoption behavior through farmers' cognition of soil and water conservation technology, that is, we test the mediating effect of farmers' technology cognition.

2. Theoretical analysis

2.1 Impact of aging on farmers' technology adoption behavior

Academia has focused on the impact of aging on agricultural output performance and land productivity. However research on the impact of aging on the adoption of agricultural production technology is rare. Li and Zhao (2009) showed that the aging of agricultural labor is not conducive to the adoption of agricultural technology. Meanwhile, Yang (2018) showed that the aging of agricultural labor will inevitably bring about the weakening of agricultural human capital, which will hinder the adoption of green production technology. Finally, Li *et al.* (2017) showed that household age has a significant negative effect on farmers' adoption behavior of conservation tillage.

2.2 The impact of off-farm employment on farmers' technology adoption behavior

Through combing the literature, we found that off-farm employment mainly affects technology adoption by changing family income and labor quantity.

Off-farm employment will affect farmers' technology adoption through the "labor force effect." It mainly includes the loss effect of agricultural labor force and the improvement effect of human capital. Ma *et al.* (2004) revealed that labor shortage is one of the factors that restrict water and soil conservation investment. Zhou (2010) showed that migrant workers return to home provide opportunities for the implementation of biotechnology. Moreover, Han (2017) believed that entrepreneurs returning home are more focused on new technology applications. It has injected a new impetus into the transformation and upgrading of agriculture, improving quality and increasing efficiency. At the same time, labor mobility aggravating the aging of the agricultural labor force will inhibit farmers' technology adoption (Lin and Deng, 2012).

Off-farm employment will also affect farmers' technology adoption through the "income effect." The income growth brought by off-farm employment can expand the income constraint boundary of family members so that they can buy more capital-intensive and labor-saving agricultural production factors, increase the number of agricultural workers and introduce new production technologies (Qian and Hong, 2016). However, some scholars have come to different conclusions. Ma *et al.* (2004) and Wu *et al.* (2004) showed that the higher the degree of concurrent farming, the non-agricultural income becomes the main source of income. Therefore, farmers will reduce investment in water and soil conservation. Ultimately, it is not yet clear whether the increased income from off-farm employment can make up for the loss caused by the labor force transfer and thus effectively enhance the adoption of technology.

As seen from the above analysis, off-farm employment has a positive and negative impact on farmers' technology adoption behavior (Figure 1). The comprehensive effect of off-farm employment on farmers' adoption behavior of soil and water conservation technology needs to be further tested.

2.3 Influence of social network on farmers' technology adoption behavior
Academic circles have studied this from different angles. Through combing the existing literature, we found that social network mainly affect the adoption behavior of farmers through social learning, information acquisition (Qiao *et al.*, 2017), service complementarity and helper support mechanisms (Genius *et al.*, 2014).

2.4 Alleviating the impact of social network on the relationship between aging, off-farm employment and farmers' soil and water conservation technology adoption behavior
Aging and off-farm employment exists the weakness of labor supply, cognitive ability and agricultural investment, which restrict farmers' adoption behavior of soil and water conservation technology. Related studies show that social network can break through this constraint and promote farmers' technology adoption. In view of the aging problem, Yang (2018) showed that social network mitigate the negative impact of aging on farmers' adoption behavior of green production technology. Furthermore, in view of the shortage of labor force caused by the transfer of labor force, social network can help farmers to get support from workers and promote technology adoption behavior (He *et al.*, 2016).

2.5 Mediating effect of technology cognition
He and Zhang (2014) showed that farmers' age has a negative impact on value perception of resource agricultural waste recycling. Wang and Gu (2012) showed that farmers with agricultural income as the main source of income have a higher perception of environment. Li *et al.* (2017) showed that farmers' cognition of water-saving irrigation technology promote farmers to adopt water-saving irrigation technology. Social network not only directly affect farmers' willingness to adopt low-carbon agriculture technology, but also have an indirect effect on farmers' willingness to adopt low-carbon agriculture technology through perceived usefulness (Hu, 2016). Aging has a negative impact on technology cognition. Through social network, farmers often communicate with other farmers; and learning from other people's technical experiences increases one's cognition of technology (Yang, 2018). It can be seen

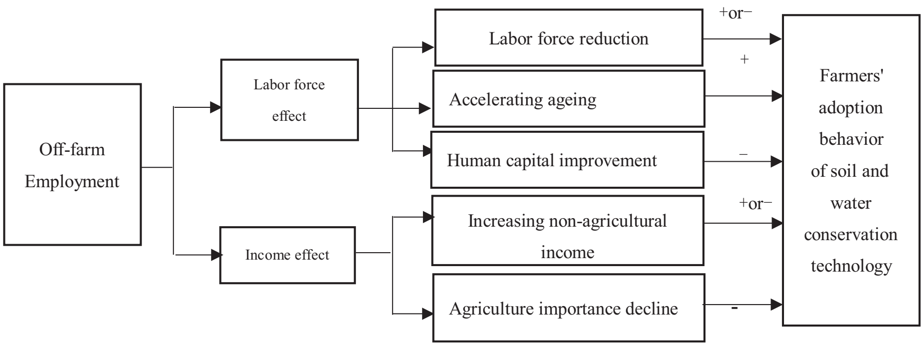

Figure 1.
Influencing mechanism of off-farm employment on farmers' adoption behavior of soil and water conservation technology

that aging and off-farm employment may affect farmers' technology adoption by influencing farmers' technology cognition. At the same time, social network can alleviate and deepen farmers' cognition of technology and promote technology adoption.

Based on the above theoretical analysis, this paper constructs models including aging, off-farm employment, social network, technology cognition and farmers' adoption behavior of soil and water conservation technology (Figure 2).

3. Data sources, variable selection and model methods

3.1 Data sources

The data used in this study came from the large-scale field survey conducted by the project team in the Loess Plateau from October to November 2016. Shaanxi, Gansu and Ningxia provinces were selected as the research areas. Sample selection was representative. The concrete reasons are as follows. First, according to the national soil and water conservation plan (for 2015-2030) promulgated by the State Council in 2015, of the 23 key national soil erosion prevention areas and 17 key management areas identified in China, the Loess Plateau region accounted for 7 and 5 respectively, which was a large proportion, mostly distributed in Shaanxi and Gansu provinces. Second, in 1998, the construction of a soil and water conservation demonstration zone in Xifeng city of Gansu Province and Suide County of Shaanxi Province played a typical exemplary role in the areas of governance and development. Since the implementation of the World Bank's loan project for soil and water conservation in 1994, systematic and complete scientific work systems have been established for project management, investment operation, monitoring evaluation and technology popularization. It has played a good role in guiding the management of soil and water conservation and ecological environment construction in the Yellow River basin. The government provided preferential policies such as preferential technical services and material supply, and further mobilized the community to invest in soil and water conservation. Three provinces (regions) have implemented the Grain for Green project, which compensates farmers who participate in afforestation. Third, the research area is not only the main area of agricultural development in the Loess Plateau, but also a serious area of soil erosion. Farmers are greatly affected by soil erosion. Soil erosion is related to food security. Farmers adopt certain soil and water conservation technologies to control soil erosion. Thus the study of farmers' adoption behavior of soil and water conservation is of great practical significance.

A combination of cluster, stratified and random sampling was used to select the research areas, namely: Mizhi County, Yuyang District and Suide County in Yulin city of Shaanxi

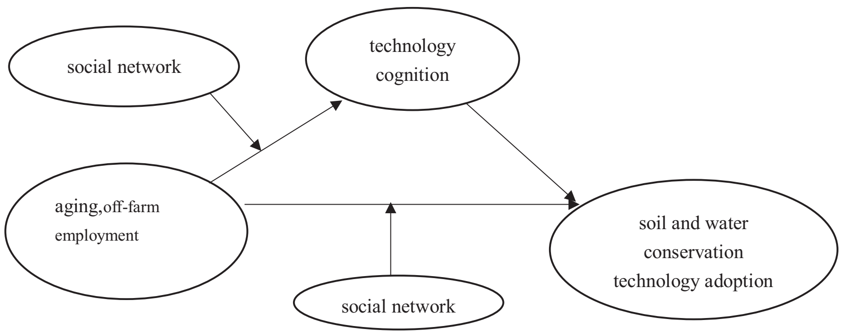

Figure 2.
Influence mechanism of aging, off-farm employment, social network and technology cognition on farmers' adoption behavior soil and water conservation technology

Province; Xifeng District and Huan County in Qingyang city of Gansu Province; and Yuanzhou District, Pengyang County and Xiji County in Guyuan city of Ningxia Province. Through the stratified random sampling method, we selected one to five towns in each of the above counties, and each town randomly selected two to five villages. Then, each village randomly selected 15-20 farmers. The survey sample eventually included 8 counties, 30 towns, 72 villages and 1,200 farmers in 3 provinces (Shaanxi, Gansu and Ningxia). The survey was a one-on-one interview with farmers. Finally, 1,152 valid questionnaires were obtained, and the effective rate of the questionnaire was 96 per cent. The survey mainly included the characteristics of farmers and family endowments, social network, farmers' cognition of soil and water conservation technology and the adoption of soil and water conservation technology. The basic situation of sample farmers is shown in Table I. As shown in Table I, 96.7 per cent of the households interviewed are male. Because men have certain final decision-making power in the family, men's wishes can represent the final decision-making intention of the family. A total of 58.07 per cent of the respondents were over 51 years old, the trend of the aging of rural labor force was obvious, 89.83 per cent of them were junior middle school students and below, and the education level was generally low. A total of 42.45 per cent of the farmers interviewed were engaged in off-farm employment, and the level of household farming was relatively high. The proportion of household labor force in 2-4 households was 78.82 per cent, at a medium scale level. The proportion of agricultural income is relatively low, and 70.66 per cent of rural households' income mainly comes from non-agricultural income. Farmers have a higher degree of concurrent business. From the characteristics of the sample farmers, we can see that the sample farmers show the basic characteristics of low education level, aging and low proportion of agricultural income.

The specific distribution of sample farmers and the technical application of soil and water conservation for farmers in counties (districts) are shown in Table II. According to the

Variable	Classified	Household	Ratio/(%)
Gender	Men	1,114	96.7
	Female	38	3.3
Age	Under 30 years old	21	1.83
	31-40 years old	128	11.11
	41-50 years old	334	28.99
	50 years old and above	334	58.07
Labor quantity	1 and below	94	8.16
	2	451	39.15
	3	201	17.45
	4	256	22.22
	5 and above	150	13.02
Education level	Illiteracy	250	21.70
	Primary school	267	23.18
	Junior middle school	519	45.05
	High school	109	9.46
	College graduate or above	7	0.61
Agricultural income ratio	25% and below	600	52.08
	25-49%	214	18.58
	50-74%	128	11.11
	75% and above	210	18.23
Off-farm employment	Yes	489	42.45
	No	663	57.55

Table I.
The basic situation of the sample farmers

survey, 63.63 per cent of the sample farmers adopt engineering soil and water conservation technology.

3.2 Variable settings and descriptive statistical analysis

- *Dependent variable*: The dependent variable of the model built in this study is whether the farmers adopt the engineering soil and water conservation technology. This is measured by asking farmers whether they adopt engineering soil and water conservation technology.
- *Core explanatory variables*: Off-farm employment-referring to the relevant research practice, this paper uses the proportion of household non-agricultural income to total household income to represent off-farm employment. Aging – the head of household aged 60 or older is an elderly farmer, assigned a value of 1, and the head of household aged less than 60 years old is a non-aged farmer, assigned a value of 0.
- *Moderating variable*: Social network – Referring to the relevant literature and theory (Wang and Lu, 2015), this paper divides the social network into three dimensions: so, network learning, network interaction and network reciprocity can be expressed as social network factors. Increasing production value cognition, increasing income value cognition and improving ecological environment value recognition can be expressed as technology cognition factors..
- *Mediator variable*: Technology cognition – The measurement of technology cognition is estimated through three aspects: increasing production value cognition, increasing income value cognition and improving ecological environment value cognition. Social network and technology cognition variables were measured on a five-point Likert scale.
- *Control variables*: This paper selects farmers' educational level, gender, number of agricultural machines, cultivated land area, whether they are village cadres, government investment, severity of soil erosion and other variables as control variables.

Variable definitions and statistical descriptions are shown in Table III.

Table II. Distribution of sample farmers' adoption behavior of soil and water conservation technology

Province	County (district)	No. and proportion of sample households (%)	No. and proportion of households adopting soil and water conservation technology (%)
Shaanxi	Mizhi County	228 (19.79)	82 (35.96)
	Yuyang District	75 (6.51)	15 (20)
	Suide County	80 (6.94)	17 (21.25)
Gansu	Xifeng District	185 (16.06)	88 (47.57)
	Huan County	200 (17.36)	178 (89)
Ningxia	Yuanzhou District	151 (13.11)	140 (92.72)
	Pengyang County	200 (16.06)	185 (92.5)
	Xiji County	33 (2.86)	28 (84.85)
Total	–	1,152	733 (63.63)

Variable	Variable specification	Mean	SD
Dependent variable			
Soil and water conservation technology adoption	Whether a farmer has adopted or not? Yes = 1 and no = 0	0.64	0.48
Core explanatory variables			
Aging	The age of the head of household: age >60 years old = 1 and age < 60 years old = 0	0.30	0.46
Off-farm employment social network	The proportion of non-agricultural income to total household income	0.65	0.33
Network learning	Do you often communicate with others about soil and water conservation measures? 1 = never, 2 = occasionally, 3 = generally, 4 = often and 5 = very frequently	2.35	1.27
Network interaction	Do you often walk with your relatives and friends? 1 = never, 2 = occasionally, 3 = generally, 4 = often and 5 = very frequently	2.37	1.22
Network reciprocity	Is the information and guidance provided by neighbors useful? 1 = never, 2 = occasionally, 3 = generally, 4 = often and 5 = very frequently	3.06	1.21
Technology cognition			
Increase production value cognition	1 = no effect, 2 = less effect, 3 = general, 4 = greater effect and 5 = very large effect	3.48	1.01
Increase revenue value cognition	1 = no effect, 2 = less effect, 3 = general, 4 = greater effect and 5 = very large effect	3.39	1.02
Improving ecological environment value cognition	1 = no effect, 2 = less effect, 3 = general, 4 = greater effect and 5 = very large effect	3.78	0.84
Control variables			
Educational level	Illiteracy = 1, Primary school = 2, Junior middle school = 3, High school = 4 and College graduate or above = 5	2.44	0.95
Gender	1 = male and 0 = female	0.97	0.18
Agricultural machines quantity	Number of household farm machinery (unit)	0.44	0.55
Village cadres	Yes = 1 and no = 0	11.01	10.95
Cultivated land area	Your cultivated and land area (mu)	0.18	0.38
Government investment	Yes = 1 and no = 0	0.64	0.499
Severity of soil erosion	Soil erosion severity perception: 1 = no soil erosion, 2 = less serious, 3 = general, 4 = more serious and 5 = very serious	2.57	1.12

Table III.
Variable definitions and statistical descriptions

3.3 Reliability and validity of variables

In this paper, we use SPSS22.0 to test the consistency of the two latent variables (social network and technology cognition) and examine their credibility. It is generally believed that when the Cronbach's alpha is greater than 0.6, the data is reliable. The Cronbach's alpha value of the social network was 0.646, and the technology cognition Cronbach's alpha was 0.830; both are over 0.6. This shows that the observation index has good consistency and the reliability of the questionnaire is relatively high. Then, Kaiser-Meyer-Olkin (KMO) test and Bartlett's sphere test were used to carry out validity analysis, to test the degree of proximity between measured and real values. By testing, it was found that the KMO was 0.66 (which is greater than 0.6), and the Bartlett's sphere test value was significant at the 1 per cent level, indicating that the variable has higher validity and can be used in factor analysis. Principal component analysis was used to extract the common factors, with the characteristic value greater than 1 as the extraction standard (Table IV). It can be seen that two principal components can be extracted, which account for 67.136 per cent of the total variance.

Table V shows that each index's load on the corresponding factor is much larger than on the cross-load of other factors. It shows that each index can effectively reflect its corresponding factors.

3.4 Research methods

Referring to Wen Zhonglin's mediation effect test method (Wen and Ye, 2014), the basic regression equation is as follows:

$$TA_i = \alpha AGE + \beta LT + \delta SN_i + \theta X_i + \varepsilon_i \tag{1}$$

$$VC_i = \alpha' AGE + \beta' LT + \delta' SN_i + \theta' X_i + \varepsilon_i' \tag{2}$$

$$TA_i = \alpha'' AGE + \beta'' LT + \delta'' SN_i + \theta'' X_i + \gamma VC_i + \varepsilon_i'' \tag{3}$$

In the above formula, *TA* means that the farmers adopt water and soil conservation technology, AGE means aging, *LT* indicates off-farm employment, *SN* indicates social network and *VC* indicates technology cognition. X_i is the selected control variable, $\alpha, \alpha', \alpha'', \beta, \beta', \beta'', \gamma$ are the regression coefficients of the corresponding variables and $\varepsilon_i, \varepsilon_i', \varepsilon_i''$ are the disturbance terms.

In this paper, we use Formula (1) to examine the direct impact of aging, off-farm employment and social network on farmers' adoption behavior of soil and water conservation technology. Then, on the basis of Formula (1), we add the interaction items of

	Initial eigenvalue			Extracting squared sum loading			Rotation squared sum loading		
Component	Total	Variance (%)	Cumulative (%)	Total	Variance (%)	Cumulative (%)	Total	Variance (%)	Cumulative (%)
1	2.522	42.028	42.028	2.522	42.028	42.028	2.233	37.224	37.224
2	1.506	25.108	67.136	1.506	25.108	67.136	1.795	29.911	67.136
3	0.805	13.411	80.547						
4	0.579	9.644	90.191						
5	0.423	7.044	97.235						
6	0.166	2.765	100.00						

Table IV. Total variance of the explanation and factor contribution rate

Factor	Factor 1	Factor 2
Network learning	0.068	*0.838*
Network interaction	0.131	*0.828*
Network reciprocity	0.046	*0.602*
Increase production value cognition	*0.906*	0.145
Increase revenue value cognition	*0.902*	0.151
Improving ecological environment value cognition	*0.758*	−0.003

Table V. Component matrix after rotation aging, off-farm employment and social network to examine the moderating effect of social network on aging and off-farm employment affecting farmers' adoption behavior of soil and water conservation technology. Next, we use the Formula (2) to test the direct influence of aging, off-farm employment and social network on farmers' cognition of soil and water conservation technology. We add the interaction item of aging, off-farm employment and social network on the basis of Formula (2) to test the moderating effect of social network on aging and off-farm employment affecting farmers' cognition of soil and water conservation technology. Formulas (2) and (3) test the mediating effect of farmers' cognition of soil and water conservation technology.

4. Estimated results and analysis

In this section, we use Stata14.0 software to estimate models. The results are shown in Table VI. In Table VI, Model 1 is the estimation result obtained from Formula (1). Model 2 is an estimate of the interaction between aging and social network. Model 3 is an estimate of the interaction between off-farm employment and social network, this model investigates the moderating effect of social network on the impact of aging and off-farm employment on farmers' adoption behavior soil and water conservation technology.

4.1 Effects of aging, off-farm employment and social network on farmers' adoption behavior of soil and water conservation technology

In Table VI, Model 1's estimated coefficient of aging is negative and at a 1 per cent significance level, indicating that aging can inhibit farmers' adoption behavior of soil and water conservation technology. According to the survey, 71.9 per cent of farmers who are under 50 years old adopt soil and water conservation technology.

Table VI. Model estimation of the impact of aging, off-farm employment and social network on farmers' adoption behavior of soil and water conservation technology

	Model 1		Model 2		Model 3	
Variable	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Aging	−0.613***	0.163	−1.706***	0.414	−0.619***	0.164
Off-farm employment	−0.775**	0.259	−0.771**	0.261	−1.195***	0.297
Social network	0.279***	0.075	0.271***	0.075	0.262**	0.076
Aging × social network	–	–	0.344**	0.118	–	–
Off-farm employment × social network	–	–	–	–	0.077**	0.026
Educational level	−0.021	0.021	−0.018	0.021	−0.020	0.021
Gender	−0.032	0.389	−0.066	0.393	−0.026	0.393
Agricultural machinery quantity	0.186	0.143	0.154	0.144	0.132	0.145
Cultivated land area	0.109***	0.012	0.106***	0.012	0.109***	0.012
Village cadres	−0.055	0.197	−0.034	0.198	−0.043	0.198
Government investment	1.053***	0.145	1.079***	0.146	1.089***	0.146
Severity of soil erosion	0.201**	0.069	0.209**	0.069	0.203***	0.069
Constant	−1.801**	0.563	−1.747**	0.568	0.077**	0.026
LR chi^2	351.54		360.02		359.91	
Prob > chi^2	0.0000		0.0000		0.0000	
Pseudo R^2	0.2328		0.2385		0.2384	
Log likelihood	−579.3948		−574.70385		−574.75934	

Notes: ** and *** respectively represented significant tests at 5 and 1% levels

The proportion of farmers 51-65 years old adopting water and soil conservation technology was 62.3 per cent, and the proportion of farmers who were 65 years or older adopting soil and water conservation technology was 43.64 per cent. It can be seen that the proportion of farmers adopting soil and water conservation technology decreases with age. The estimated coefficient of off-farm employment is negative, and statistically significant at 1 per cent, indicating that off-farm employment can inhibit farmers' adoption behavior of soil and water conservation technology. We found that for farmers with less than 50 per cent of the proportion of their non-agricultural income, 73.76 per cent adopt water and soil conservation technology. Meanwhile, for farmers with more than 50 per cent of the proportion of their non-agricultural income, 58.86 per cent adopt water and soil conservation technology. It can be seen that with the increase in the proportion of non-agricultural income, the proportion of farmers adopting soil and water conservation technology declines. Furthermore, social network was statistically significant at 1 per cent, and the estimated coefficient was positive, indicating that social network significantly improved farmers' adoption behavior of soil and water conservation technology.

4.2 Social network alleviate the influence of aging and off-farm employment on farmers' adoption behavior of soil and water conservation technology

Model 2 is an estimate of the interaction between aging and social network. The coefficient of interaction item (aging $\times$ social network) is significantly positive and at the significance level of 5 per cent, indicating the moderating effect of social network on aging. Model 3 is an estimate of the interaction between off-farm employment and social network. The coefficient of interaction item (off-farm employment $\times$ social network) is significantly positive and at the significance level of 5 per cent, indicating the moderating effect of social network on off-farm employment.

4.3 Mediating effect of technology cognition

Another problem that this article is interested in whether the impact of aging and off-farm employment on cognition soil and water conservation technology is one of the mechanisms of its negative impact on farmers' adoption behavior of soil and water conservation technology. That is, whether technology cognition has a mediating effect on this process. In this section, we use Stata14.0 software, and the results are shown in Table VII, Model 1 is the estimation resulting from Formula (2). Model 2 is an estimation of the interaction between aging and social network. Model 3 is an estimate of the interaction between off-farm employment and social network to investigate the moderating effect of social network on the relationship of aging and off-farm employment on farmers' technology cognition. To further examine the promoting effect of farmers' technological cognition on the adoption of soil and water conservation technology through social network, we should examine the mediating effect of technology cognition. The estimated results are shown in Table VIII.

4.4 The influence of aging, off-farm employment and social network on farmers' cognition of soil and water conservation technology

In Table VII, Model 1 has a negative estimated coefficient of aging that is statistically significant at the 10 per cent level, indicating that aging can inhibit farmers' soil and water conservation technology cognition. The estimated coefficient of off-farm employment is negative and is statistically significant at the 10 per cent level, which indicates that off-farm employment can restrain farmers' soil and water conservation technology cognition, that is, the higher the proportion of non-agricultural income, the lower the farmers' soil and water conservation technology cognition. Social network was statistically significant at 1 per cent, and the estimated coefficient was positive, indicating that social network significantly

Table VII. Model estimation of the impact of aging, off-farm employment and social network on farmers' cognition of soil and water conservation technology

	Model 1		Model 2		Model 3	
Variable	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Aging	−0.229*	0.128	−1.160***	0.317	−0.238*	0.128
Off-farm employment	−0.394*	0.202	−0.386*	0.202	−0.792***	0.227
Social network	0.279***	0.075	0.390***	0.060	0.379***	0.060
Aging × social network	–	–	0.290**	0.090	–	–
Off-farm employment × social network	–	–	–	–	0.078***	0.021
Educational level	−0.004	0.016	−0.001	0.016	−0.002	0.016
Gender	0.286	0.312	0.249	0.312	0.294	0.312
Agricultural machinery quantity	0.168	0.109	0.138	0.109	0.119	0.109
Cultivated land area	0.023***	0.005	0.021***	0.005	0.022***	0.005
Village cadres	0.182	0.149	0.208	0.150	0.193	0.149
Government investment	0.316***	0.112	0.334**	0.113	0.336**	0.113
Severity of soil erosion	0.008	0.052	0.017	0.052	0.009	0.052
LR chi^2	126.51		137.15		141.26	
Prob > chi^2	0.0000		0.0000		0.0000	
Pseudo R^2	0.0441		0.0478		0.0493	
Log likelihood	−1,371.2155		−1,364.9836		−1,362.9306	

Notes: *, ** and *** respectively represented significant tests at 10, 5 and 1% levels

Table VIII. Effect of social network and technology cognition on farmers' adoption behavior of soil and water conservation technology

Variable	Coefficient (standard error)
Core explanatory variables	
Social network	0.199* (0.077)
Technology cognition	0.539*** (0.092)
Control variables	Controlled
Pseudo R^2	0.2571
Log likelihood	−561.00934
LRχ^2	388.31
Prob > chi^2	0.0000

Notes: * and *** respectively represented significant tests at 10 and 1% levels

improved farmers' cognition of soil and water conservation technology. A possible explanation for this is that, the wider the social network of farmers, they can be easer to get resources, information and social support from the government, research institutes and other extension agencies. This can deepen their understanding of soil and water conservation technology. They can better understand the value of soil and water conservation technology. Additionally, in a social network, many farmers are willing to share their experiences and the effects of technology, which can improve farmers' cognition of soil and water conservation technology.

4.5 Social network alleviating the impact of aging and off-farm employment, on farmers' cognition of soil and water conservation technology

In Model 2, the coefficient of interaction between aging and social network is significantly positive at the 5 per cent level, indicating the mitigating effect of social network on aging. Meanwhile Model 3's coefficient of interaction between off-farm employment and social network is significantly positive at the 1 per cent level, indicating the mitigation effect of social network on off-farm employment.

As shown in Table VIII, the estimation coefficient of social network is positive, and is significant at the 10 per cent level. The estimated coefficient of technology cognition is positive, and is significant at the 1 per cent level. The results show that social network can directly affect farmers' adoption behavior of soil and water conservation technology, and it can indirectly affect farmers' adoption behavior of soil and water conservation technology by affecting farmers' technology cognition. In other words, technology cognition has a mediation effect on the impact of social network on farmers' adoption behavior of soil and water conservation technology.

5. Conclusions and enlightenment

Based on a rural survey data in the Loess Plateau consisting of 1,152 farm households in Shaanxi, Gansu and Ningxia provinces, this article empirically analyzes the effects of aging, off-farm employment, social network and technology cognition on farmers' adoption behavior of soil and water conservation technology. The main conclusions are as follows: first, aging and off-farm employment restrained farmers' adoption behavior of soil and water conservation technology. Social network has promoted farmers' technology adoption behavior. Second, social network has alleviated the effect of aging and off-farm employment on restraining farmers' soil and water conservation technology adoption behavior. Third, aging and off-farm employment restrained farmers' soil and water conservation technology cognition, social network plays a role in alleviating the relationship of aging and off-farm employment on farmers' cognition of soil and water conservation technology. Technology cognition plays a mediating role in the impact of social network on farmers' adoption behavior of soil and water conservation technology.

Based on our findings, the following policy implications are drawn. First, under the background of aging, we should actively build public social networking platforms, cooperative organizations, mutual aid agencies, activity centers and clubs in the community to create conditions for the younger farmers to assist the older farmers. So as to improve the human capital of the aged labor force and promote the technology adoption rate of the aged labor force. Second, while promoting this technology, the government should broaden the social network of farmers so that farmers can make full use of resources such as political party members and village cadres, as well as agricultural cooperatives in organizations. This would also help promote technology adoption. Third, we should publicize the benefits of soil and water conservation technology and strengthen farmers' technology cognition. Through mutual communication of such benefits between farmers within the social network, farmers' cognition of technology can be improved; farmers exchanged the benefits of soil and water conservation technology, thus increasing the adoption of conservation technology. Fourth, under the background of labor transfer, guiding land transfer to improve farmers' technology adoption behavior.

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