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EDITED BY
Rengui Gong,
Anhui University of Technology, China

REVIEWED BY
Qi Luo,
Guangdong University of Finance and Economics, China
Hailan Qiu,
Jiangxi Agricultural University, China

*CORRESPONDENCE
Xian Kai Lei
leixiankai@xynu.edu.cn

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The impact of migrant work experience on the adoption behavior of green production technologies among new professional farmers: evidence from Jiangxi and Guangdong provinces, China

Xian Kai Lei[1,2]*, Wen Li Zhao[1], Gui Hua Zhang[1] and Yong Xin Chen[1]

[1]Business School, Xinyang Normal University, Xinyang, China, [2]Dabie Mountain Economic and Social Development Research Center, Xinyang Normal University, Xinyang, China

Based on the analytical framework of imprinting theory, this study employs survey data from 1,707 new professional farmers in Guangdong and Jiangxi provinces (2019–2021) and econometric methods to empirically examine the impact and mechanisms of migrant work experience on their adoption of green production technologies. The findings reveal three key insights: First, migrant work experience significantly increases the probability of adopting green production technologies. Robustness checks through replacing core explanatory variables and propensity score matching (PSM) confirm the stability of this conclusion, underscoring the critical role of migrant work experience in technological adoption. Second, mechanism analysis demonstrates that migrant work experience enhances farmers' adoption behavior by elevating their technical cognition levels. Such experience not only exposes farmers to advanced external production practices and concepts but also strengthens their cognitive understanding and receptivity to new technologies, thereby positively facilitating green technology adoption. Third, heterogeneity analysis reveals differentiated effects: Migrant work experience exhibits stronger promotion effects on the adoption of water-saving technologies compared to energy-saving and environmental protection technologies, a disparity linked to variations in application costs, technical barriers, and learning curves across technology types. Age-specific differences emerge, with migrant work experience exerting a greater influence on middle-aged farmers than on younger counterparts.

KEYWORDS

migrant work experience, green production technology, new professional farmers, probit model, propensity score matching (PSM) method

1 Introduction

The 2025 Central No.1 Document reiterates its focus on agricultural green production, marking the seventh consecutive year of prioritizing agricultural green development. Through digital empowerment and ecological compensation mechanisms, China aims to systematically advance a green transformation in agriculture and rural areas (Li and Guan, 2023). Notably, current agricultural practices exhibit contradictions such as excessive chemical inputs and inefficient resource allocation (Ju et al., 2023), posing threats to soil quality, water security, and biodiversity (Guan et al., 2022). In smallholder farming, constrained by land fragmentation, weak capital accumulation, and limited technological absorption capacity, green technology adoption rates are only one-third of those observed in large-scale operations, revealing a pronounced "green gap." During this critical transition, new professional farmers emerge as core agents of modern agriculture, demonstrating three transformative dynamics: achieving economies of scale through land transfers, enabling cost-effective technology adoption; leveraging cooperatives to establish technology diffusion networks, addressing "last-mile" promotion challenges (Gao et al., 2020); and through their higher participation rate in vocational skills training, this group develops cognitive advantages in technology, and their technology adoption decisions often generate positive neighborhood demonstration effects. Empirical evidence indicates that green technology adoption by this cohort drives regional agricultural total factor productivity (TFP) growth and reduces carbon footprint intensity (Gao et al., 2022). Such multiplier effects position them as pivotal actors in resolving the dual challenges of "green transition and efficiency enhancement." Against this backdrop, as rural revitalization enters a quality-driven phase, constructing a multi-level analytical framework using planned behavior theory and technology acceptance models to systematically deconstruct the mechanisms influencing green technology adoption among new professional farmers will not only inform policy optimization (e.g., green credit, technology subsidies, digital platforms) but also activate endogenous drivers of agricultural green development through a "capacity-building—technology adaptation—institutional innovation" triad.

Academic research on green technology adoption by farmers has established a systematic body of work, primarily focusing on two dimensions. First, in terms of influencing factors, studies have developed a "micro-meso-macro" analytical framework. At the micro level, individual characteristics such as generational age differences (young farmers exhibit 12–15% higher adoption rates than traditional farmers) (Sui and Gao, 2023), educational attainment (Liu and Liu, 2024), and risk preferences (Chen et al., 2022), as well as household features like labor structure (non-agricultural employment ratio) and economic capital (fixed asset value), show significant correlations. At the meso level, research highlights "neighborhood effects" in technology diffusion, with demonstration effects from new agricultural entities being 3.7 times stronger than those of ordinary farmers. At the macro level, beyond policy orientation (the National Agricultural Sustainable Development Plan increased adoption rates by 29% in pilot zones) (Li et al., 2025) and subsidy mechanisms (Zhao et al., 2018), digital technology-enabled extension systems (e.g., agricultural apps) (Abiri et al., 2023) have emerged as recent research hotspots. Second, regarding adoption effects, scholars have developed an "economic-ecological-social" tripartite evaluation system. Economically, beyond direct income increase effect (Qiu et al., 2024), adoption fosters sustained revenue growth through total factor productivity improvements (Frederiks et al., 2019) and product quality premiums. Empirical results demonstrate reductions in fertilizer/pesticide usage, carbon emission intensity decline (He et al., 2021), with pronounced non-point source pollution mitigation in southern rice-growing regions. Socially, recent studies reveal that adoption reshapes rural human capital structures and governance networks, generating spillover effects beyond technology itself.

Under rural revitalization, agricultural labor mobility exhibits a "two-way circulation" trend. From 2018 to 2022, the number of new professional farmers grew at an annual rate of 11.3%, with 68.7% possessing urban work experience (Yu et al., 2017). The new professional farmer refers to modern agricultural practitioners who make agriculture their profession, possess relevant professional skills, and earn a significant portion of their income from agricultural production and operation, reaching a considerable level. This includes key operators such as large-scale professional farmers, family farm owners, and leaders of farmers' cooperatives (Lei and Yang, 2024). The "modernity construction" theory in migration studies posits that migrant work experience is not merely spatial relocation but a cognitive reconstruction process: industrial standardization fosters technical rationality (Asiedu-Ayeh et al., 2022), urban living enhances environmental quality demands, and organizational work experience improves risk management capabilities. This raises critical questions: Does cognitive transformation mediate the impact of migrant work experience on green technology adoption? Do transmission pathways vary by technology type? Addressing these questions will refine theoretical frameworks linking labor mobility and agricultural transformation while guiding targeted strategies to cultivate "green-literate" farmers and tailor technology promotion, essential for overcoming the "last-mile" challenges of agricultural green transition.

Compared with existing research literature, the marginal contributions of this paper may be manifested in the following aspects: First, in theoretical mechanisms, it transcends traditional individual characteristic analysis frameworks by innovatively incorporating migrant work experience into the study of farmers' green technology adoption. A mediating effect model of "migrant work experience → cognitive level → technology adoption" is constructed to unveil the black box of its operational pathways. Second, in research methodology, the Propensity Score Matching (PSM) counterfactual analysis method is employed to eliminate selection bias through multi-dimensional matching, thereby ensuring the validity of causal inference in research conclusions. Third, in research dimension expansion, the study not only conducts heterogeneity analyses by distinguishing five technology types (e.g., water-saving and fertilizer-saving) but also investigates the differential impacts of migrant work experiences across life stages based on WHO's new age standards (youth ≤44, middle-aged 45–59). This provides granular evidence for targeted policy interventions.

2 Theoretical analysis

2.1 The impact of migrant work experience on the adoption of green production technologies by new professional farmers

With the continuous promotion of agricultural modernization and the concept of sustainable development, green production technology, as an important way to improve agricultural production efficiency and reduce environmental burden, has become the key to the development of modern agriculture. As the core force of this transformation, the behavior and attitude of new professional farmers in the process of green production technology adoption have an important impact. As one of the main growth experiences of many new professional farmers', migrant work experience can often shape their production concept, technology acceptance and behavior to a certain extent. Experience refers to certain events that an individual has personally witnessed, engaged in, or encountered. When these events are characterized by their extensive scope of influence, profound impact, or prolonged duration, they imprint "psychological imprints" on an individual's psychological traits, cognition, and abilities (Malmendier and Nagel, 2011), subsequently influencing their productive behaviors and outcomes. First, the migrant work experience has provided farmers with increased opportunities to access modern agricultural knowledge and techniques. During their time working in other regions, they may have gained relevant knowledge and hands-on experience through direct exposure to modern farm management, advanced agricultural techniques, and sustainable production methods. The accumulation of such knowledge has enhanced their understanding and acceptance of green production techniques, thereby increasing their willingness to adopt these technologies (Li et al., 2022). By learning advanced management philosophies and practices, they gain better comprehension of the advantages of green production technologies and become more inclined to implement these technologies in their own production processes. Secondly, migrant work experience exerts profound influence on farmers' value systems and production philosophies. Through employment, farmers broaden their perspectives when exposed to diverse cultures and ideas, particularly regarding environmental protection and sustainable development (Zhao et al., 2024). This cognitive shift makes them more inclined to embrace green production techniques while reducing reliance on traditional high-pollution, high-input production methods. Finally, during their migrant work experience, particularly when engaging in non-agricultural production activities, farmers often accumulate fundamental technical operational skills. These competencies lay the foundation for adopting and applying green production techniques upon returning to rural areas (Varshney et al., 2022). Concurrently, migrant work experience strengthens their confidence in operating new technologies. Proficiency in operational skills and trust in novel technologies serve as critical factors promoting technology adoption, helping them overcome skepticism and uncertainty about new methods, thereby facilitating smoother integration of green production technologies into their agricultural practices.

2.2 The influence of cognitive level on the adoption behavior of green production technologies among new professional farmers

Cognitive level, reflecting the knowledge structure demonstrated by new professional farmers in agricultural production and management processes, constitutes a fundamental factor influencing their decision-making paradigms (He et al., 2023). On the one hand, cognition is the basis of decision-making. From the perspective of behavioral economics, disparities in cognitive capacity significantly determine decision quality. When confronting the complex decision-making scenario of green technology innovation, farmers with lower cognitive levels frequently encounter bounded rationality constraints, manifesting three critical limitations in technological evaluation: First, inadequate information processing capabilities lead to ambiguous perceptions of technological benefits, hindering their ability to overcome the cognitive anchoring effect shaped by traditional practices (Furnham and Boo, 2011). Second, imperfect risk anticipation mechanisms predispose them to overestimate transitional costs while undervaluing long-term ecological returns. Third, their decision frameworks remain confined to neighborhood demonstration effects, lacking systematic cost–benefit analytical structures. In contrast, high-cognition cohorts exhibit distinct technological decision-making advantages: by constructing multidimensional evaluation models incorporating environmental benefits, policy orientations, and market trends, they effectively identify the latent value of green technologies. Their decision-making processes demonstrate characteristics of sunk cost avoidance and opportunity cost sensitivity, enabling strategic adoption aligned with sustainable development goals.

For farmers who have lived in rural areas for extended periods, the influence of traditional small-scale farming ideologies and environmental factors can lead to "cognitive traps," potentially resulting in irrational decision-making regarding agricultural production practices. For instance, if new professional farmers lack sufficient understanding of green production technologies, this may foster resistance toward such technologies, thereby reducing the likelihood of their adoption (Sun et al., 2022). On the other hand, enhanced cognitive levels help deepen new professional farmers' comprehension of subjects (Yu et al., 2020). When these farmers improve their cognitive understanding of green technologies and overcome cognitive limitations, they can better recognize the beneficial impacts of green technologies on agricultural activities. This heightened awareness enables them to more effectively grasp agricultural production techniques, thus promoting their adoption of green production technologies.

2.3 Migrant work experience can improve the cognitive level of new professional farmers and promote their adoption of green production technology

First, migrant work experience broadened the vision of new professional farmers. There are various ways to improve individual cognitive level, such as participating in academic education and technology related training, among which work experience is also one of the ways to improve individual cognitive level. Due to the change of work environment, work content and individual role, the people and things that individuals contact also change accordingly. At this point, work experience leaves a cognitive imprint on the individual. For example, when individuals transfer employment from agriculture to non-agricultural industries, their work content has also changed from a single agricultural field to a diversified non-agricultural field, and the number of individuals and things they come into contact with has also increased, broadening their horizons and increasing their insights to a certain extent (Li et al., 2024). At the same time, the change of the degree of competition in the working environment also increases the pressure of their active learning. When individuals with work experience return to rural areas to engage in agricultural production activities, they are more inclined to apply new methods and technologies in agricultural production activities. For example, actively use the advantages of Internet technology to solve the problem of difficult sales of agricultural products and promote the increase of income (Yu et al., 2024). Secondly, employment experiences have altered new professional farmers' narrow perception of agriculture. The extent to which farmers recognize agriculture's critical importance directly influences their motivation to adopt green production technologies (Lyu et al., 2024). As the foundation of the national economy, agriculture is undergoing a functional diversification—shifting from solely providing economic and social benefits to incorporating cultural, tourism, and multifunctional roles. Working in non-agricultural sectors exposes these farmers to novel perspectives and ideas, dismantling their previously limited understanding of agriculture. In essence, off-farm employment drives new-type professional farmers to explore multifunctional development of agricultural products, fully leverage their value, enhance economic returns, and indirectly incentivize the adoption of green production technologies. Details are shown in Figure 1.

3 Data sources and model setting

3.1 Data sources

According to data from the Third National Agricultural Census, by the end of 2016, Guangdong Province had 12.3335 million agricultural practitioners, but the workforce faced severe aging and generally low educational levels. Guangdong has prioritized the cultivation of new professional farmers. By the end of 2018, the province designated 265 "Demonstration Bases for New Professional Farmer Training" and launched campaigns such as selecting the "Top Ten Most Outstanding New Professional Farmers." Benefiting from robust policy support and favorable economic conditions, both the number and operational efficiency of new professional farmers in Guangdong have grown rapidly. By 2018, the province had cultivated 740,000 new professional farmers. In 2020, the Department of Agriculture and Rural Affairs of Guangdong proposed training an additional 70,000 high-quality farmers over the next 3 years to advance rural development. Similarly, as a major agricultural province, Jiangxi reported a grain cultivation area of 3.7724 million hectares in 2019, with the primary industry's output value reaching 205.756 billion yuan and employment in the primary industry totaling 7.008 million people. The number of new professional farmers in Jiangxi also grew rapidly. By 2020, the province's tally of new professional farmers exceeded 1 million. Against this backdrop, this study focuses on Guangdong and Jiangxi provinces.

The data used in this study were derived from the new-type professional farmer survey conducted by the research team in Jiangxi and Guangdong provinces between 2019 and 2021 (covering survey content from 2018, 2019, and 2020 respectively). Based on the three-year survey data, pooled cross-sectional data required for this research was constructed. A total of 1,800 questionnaires were distributed, with 1,750 returned. After excluding samples containing outliers and applying the indicators required for this study, 1,707 valid samples of new professional farmers were ultimately utilized for analysis, achieving a questionnaire utilization rate of 97.54%.

3.2 Variable selection

Dependent variable: based on the availability of survey questionnaires and data, this paper focuses on the adoption of water-saving technologies, energy-saving technologies, and environmental protection technologies by new professional farmers during agricultural production. New professional farmers who have not adopted any of these technologies are assigned a value of 0, while those who have adopted at least one green technology are assigned a value of 1. To further explore the heterogeneous effects of migrant work experience on new professional farmers' adoption of green production technologies, the subsequent analysis examines how migrant work experience influences their adoption of specific green technologies, including water-saving, energy-saving, and environmental protection technologies.

Core independent variable: migrant work experience. Based on the survey questionnaire design, new professional farmers with migrant work experience lasting 6 months or longer are assigned a value of 1, while those with <6 months are assigned a value of 0.

Mediating variable: cognitive level. The depth of an individual's understanding of a specific industry or subject positively correlates with their ability to make informed decisions. As theoretically established earlier, new professional farmers' heightened awareness of agriculture's significance enhances their agricultural cognition and strengthens their commitment to the sector. Consequently, this chapter employs recognition of agriculture's importance as a proxy variable for cognitive level. Additionally, when individuals transition from agricultural to non-agricultural employment, their work content diversifies beyond farming, exposing them to broader social networks and multidimensional experiences. This occupational shift effectively broadens perspectives, enriches knowledge reserves, and elevates cognitive capacities. Therefore, horizon expansion through occupational mobility is selected as another proxy variable for farmers' cognitive level.

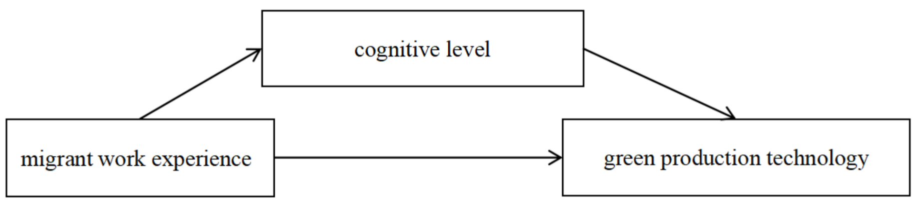

FIGURE 1
Theoretical analysis diagram.

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TABLE 1 Variable definitions, coding, and descriptive statistics.

Variables	Variable name	Variable meaning	Mean	Std. Dev.
Dependent variable	Green production technology adoption	(0 = non-adoption, 1 = adoption)	0.623	0.485
Core independent variable	Migrant work experience	No = 0; Yes = 1	0.163	0.369
Mediating variable	Recognition of agriculture's importance	No = 0; Yes = 1	0.427	0.494
	Expansion horizon	No = 0; Yes = 1	0.277	0.447
Control variables	Gender	Female = 1; Male = 2	1.707	0.455
	Age	Actual age (in years)	39.6	7.775
	Education level	Primary school and below = 1; Secondary school or high school = 2; College or above = 3	2.344	0.687
	Village cadres	No = 0; Yes = 1	1.262	0.440
	Years of agricultural production	Time (in years)	9.156	7.875
	Number of family members engaged in agricultural production	Number of people (in individuals)	2.164	1.126
	Geographical environment of the village	Plain = 1; Hill = 2; Mountainous = 3	2.312	0.801
	Urban or suburban area	No = 0; Yes = 1	0.489	0.500
	Internet access	No = 0; Yes = 1	0.916	0.277
	Water conservancy and irrigation facilities in the village meet the needs of agricultural planting and breeding	1 = Cannot satisfy; 2 = Basically meet; 3 = Fully satisfied	1.755	0.660

Control variables: drawing on established research (Mao et al., 2021; Lemecha, 2023), this study selects control variables across three dimensions: individual characteristics, household attributes, and external environmental factors, including gender, age, educational attainment, years engaged in agricultural production, whether village cadres, number of family members engaged in agricultural production, distance to township government and other variables. Detailed variable definitions and measurement methods are systematically presented in Table 1.

3.3 Model setting

To investigate the impact of migrant work experience on the adoption behavior of agricultural green technologies by new professional farmers, this paper constructs the following baseline regression model:

$$gpt_i = \alpha_0 + \alpha_1 mwe_i + \alpha_2 controls_i + \varepsilon_i \quad (1)$$

In Equation 1: gpt_i is the dependent variable, representing the agricultural green technology adoption behavior of new-type professional farmers; mwe_i is the core explanatory variable, indicating the migrant work experience of new professional farmers; *controls* denotes a set of control variables that may influence agricultural green technology adoption behavior; α_0, α_1, and α_2 represent the intercept term, the coefficient of the explanatory variable, and the coefficients of the control variables, respectively; i indexes different new-type professional farmers; ε_i is the random disturbance term.

4 Results and analysis

4.1 Baseline regression

Potential multicollinearity among variables was rigorously examined through variance inflation factor (VIF) tests. The results demonstrate excellent model specification, with a mean VIF of 1.15 and maximum VIF of 1.54—both well below the critical threshold of 10. This confirms minimal multicollinearity concerns in our regression models. Table 2 reports the regression results of the impact of migrant work experience on the adoption of green production technology by new professional farmers. First, migrant work experience is conducive to the adoption of green production technology by new professional farmers. In the first and second columns, the influence coefficients of working experience on the green production technology adoption behavior of new professional farmers were 0.176 and 0.194, respectively, which passed the significance test at the level of 5%, and were positive. The reason may be that farmers' access to new knowledge is limited due to the impact of contacting individuals and activities in rural areas. For migrant workers who break through the regional restrictions and transfer from rural areas to cities, their work content has changed, and their original ideas will be changed or reshaped in the new environment. And with the increase of working time, the deeper the degree of accepting the influence of urban civilization, the more likely the original concept will change, and promote the new professional farmers to change the mode of agricultural production and actively adopt green production technology.

Secondly, the influence of control variables on the adoption behavior of green production technologies by new professional farmers varies significantly. Within the dimension of individual

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TABLE 2 Regression analysis of the effect of migrant work experience on green production technology adoption among new professional farmers.

Variable	I		II	
	Coefficient	Standard error	Coefficient	Standard error
	Probit model		Probit model	
Migrant work experience	0.176**(0.085)		0.194** (0.087)	
Gender	–		0.026 (0.069)	
Age	–		0.010** (0.005)	
Education level	–		0.105** (0.049)	
Village cadres	–		0.111 (0.075)	
Years of agricultural production	–		0.003 (0.005)	
Number of family members engaged in agricultural production	–		0.001 (0.028)	
Geographical environment of the village	–		−0.028 (0.040)	
Urban or suburban area	–		−0.116* (0.063)	
Internet access	–		0.258** (0.113)	
Water conservancy and irrigation facilities in the village meet the needs of agricultural planting and breeding	–		0.103** (0.049)	
R^2	0.0019		0.0149	

* and ** indicate significance at the 10% and 5% levels, respectively.

characteristics, the age variable demonstrates a significant positive impact ($p < 0.1$). This may be attributed to the tendency of older farmers to adopt production methods with long-term benefits, particularly when confronting global challenges such as climate change and ecological degradation, making them more willing to engage in green technology applications. The education level variable shows a strong positive correlation with green technology adoption ($p < 0.05$), corroborating the critical role of educational attainment in technology adoption as posited by human capital theory. Highly educated farmers exhibit better comprehension of the scientific principles and long-term advantages of green technologies, thereby demonstrating greater enthusiasm for learning and implementing these techniques. Regarding infrastructure, both internet access ($p < 0.05$) and water infrastructure adequacy ($p < 0.05$) significantly positively influence green technology adoption. This benefits from the technological diffusion function of digital platforms and the adaptive support of water-saving irrigation systems. The internet provides farmers with extensive learning resources and technical support for green technologies, particularly through online platforms that facilitate convenient access to information and operational guidelines for new technologies. In geographical characteristics, suburban areas exhibit a significant negative effect ($p < 0.1$), which may stem from three major constraints unique to these regions: (1) Land fragmentation in suburban zones impedes agricultural scaling and the realization of economies of scale, thereby restricting green technology implementation; (2) Increased non-agricultural employment opportunities reduce farmers' agricultural engagement, creating a technology substitution effect where farmers may opt for alternative industries rather than agricultural technological transformation; (3) Urban expansion often coincides with short-term agricultural production trends, prompting farmers to prioritize immediate economic benefits over long-term green technology applications.

4.2 Robustness test

This study employs the following methods to address endogeneity issues and conduct robustness checks. The migrant work experience of new professional farmers exhibits endogenous characteristics, which may stem from sample self-selection bias or omitted variable problems. Specifically, work participation decisions are often systematically correlated with exogenous factors such as regional characteristics and industrial policy environments-factors that may simultaneously influence their adoption decisions regarding green production technologies. Given this context, simple OLS estimation might yield biased inferences, which necessitates the adoption of more rigorous econometric methods to ensure the reliability of the research findings.

To verify the robustness of the baseline regression results, this study employs the alternative indicator approach for re-examination. As shown in Table 3, the core explanatory variable is replaced from the binary measure of migrant work experience to a continuous indicator of work duration, which more objectively reflects human capital accumulation effects. The re-estimation yields three key findings: First, the coefficient signs remain stable, with each additional year of work experience increasing the probability of

TABLE 3 Regression results with replaced variables.

Variable	I	
	Coefficient	Standard Error
	Probit model	
Working years	0.013* (0.007)	
Control variables	Controlled	
R^2	0.0140	

* indicate significance at the 10% levels, respectively.

technology adoption by 13% ($p < 0.01$), fully consistent with the marginal effect direction in baseline regressions. Second, the significance level withstands 1% statistical testing, demonstrating parameter stability. Third, the model's overall goodness-of-fit ($R^2 = 0.0140$) shows no significant difference from the baseline model in Table 2 ($R^2 = 0.0149$), indicating structural consistency after variable substitution. This cumulative evidence confirms the econometric robustness of work experience's promoting effect on green production technology adoption.

PSM methodology. Table 4 presents the results of robustness checks using the Propensity Score Matching (PSM) method. Constrained by data availability and variable selection, and given that the migrant work experience of new professional farmers in agricultural production activities does not satisfy the requirements of random sampling but rather stems from self-selection, the analysis still faces potential sample selection bias. To address this, we adopt the Propensity Score Matching (PSM) approach to construct a counterfactual framework for correction. This methodology rigorously verifies whether the positive effect of off-farm work experience on green production technology adoption by new professional farmers demonstrates consistent and stable effects.

This study employs matching methods such as K-nearest neighbor matching, radius matching, and kernel matching to pair the treatment group (new professional farmers with migrant work experience) and the control group (new professional farmers without migrant work experience) based on propensity scores. The results show minimal differences among the three matching approaches, with all post-matching outcomes passing the 5% significance level test. Consistent effect directions and significance levels across methods demonstrate the robustness of the findings. Overall, the results align with the fundamental conclusions presented earlier: even after addressing sample self-selection issues using the propensity score matching method, migrant work experience still exerts a significant positive influence on green production technology adoption among new professional farmers. Furthermore, the consistency of research findings across different matching methods verifies the robustness of the empirical results regarding the impact of migrant work experience on green production technology adoption behaviors, indicating that the conclusions remain unaffected by variations in matching approaches.

4.3 Mediation mechanism test

Table 5 reports the results of testing the mediation effect mechanism of cognitive levels. Both the baseline regression and robustness tests indicate that work experience positively influences the adoption of green production technology by new professional farmers. To examine the mechanism through which cognitive levels mediate the relationship between work experience and the adoption of green production technology by new professional farmers, the mediation effect model is applied in the following sections (Wen and Ye, 2014). Based on the preceding theoretical analysis, it can be understood that farmers who have long resided within the close-knit social networks of rural communities have their cognitive levels shaped not only by their personal resource endowments, but also profoundly influenced by traditional beliefs, informal rural institutions, and interactions with neighbors. Migrant work experience may enhance the cognitive capacities of new professional farmers. Particularly after transitioning into this modern agricultural role, they develop distinctive perspectives toward novel concepts and demonstrate proactive acceptance of innovations. Empirical verification reveals that migrant work experience enhances new professional farmers' awareness of agriculture's strategic importance and broadens their horizons, thereby facilitating their adoption of green production technologies.

From a specific perspective, first, we examine the mediating effect of agricultural importance perception between migrant work experience and new professional farmers' adoption of green agricultural production technologies (Columns I, II, IV). Column I shows that migrant work experience has a significant positive impact on green production technology adoption by new professional farmers. Column II demonstrates that migrant work experience enhances farmers' perception of agricultural importance. Furthermore, Column IV reveals that after introducing the agricultural importance perception variable, migrant work experience passes the significance test regarding green technology adoption. Simultaneously, the agricultural importance perception variable exerts a positive influence on production efficiency. According to traditional mediating effect test methods, agricultural importance perception plays a partial mediating role in the relationship between migrant work experience and production efficiency of new professional farmers. Second, similarly, empirical results from Columns I, III, and IV indicate that broadened perspectives also serve as partial mediators between migrant work experience and farmers' adoption of green production technologies.

4.4 Heterogeneity analysis

From the perspective of environmental cognition theory, the capability to perceive information environments constitutes a critical factor influencing decision-makers' technology adoption behaviors (Henry and Dietz, 2012). When new professional farmers lack sufficient awareness of their policy, market, and technological environments, their decision-making horizons become significantly constrained. This limitation not only diminishes their capacity to assess the value of green production technologies but may also lead their technology adoption decisions to deviate from optimal pathways. Notably, green production technology systems inherently exhibit multidimensional heterogeneity. Specifically, water-saving technologies, energy-saving technologies, and environmental protection technologies demonstrate significant differences in technical complexity, cost structures, and return cycles. This difference in technical attributes may lead to the differential impact of labor experience, a human capital element, on different types of technology

TABLE 4 Estimation results.

Variable	Matching method		Treatment group	Control group	ATT	Standard error	*T*-value
Migrant work experience	Kernel matching method	Before	0.677	0.612	0.065	0.032	2.06
		After	0.676	0.610	0.066	0.031	2.13
	Radius matching method	Before	0.677	0.612	0.065	0.032	2.06
		After	0.676	0.602	0.074	0.032	2.34
	Nearest neighbor matching method	Before	0.677	0.612	0.065	0.032	2.06
		After	0.676	0.610	0.066	0.033	1.98

TABLE 5 Test results of mediating effect mechanism of cognitive level.

Variable	I	II	III	IV
	Green production technology	Recognition of agriculture's importance	Expansion horizon	Green production technology
	Probit	Probit	Probit	Probit
	Coefficient (standard error)	Coefficient (standard error)	Coefficient (standard error)	Coefficient (standard error)
Migrant work experience	0.194** (0.087)	0.531*** (0.087)	0.320*** (0.088)	0.152* (0.088)
Recognition of agriculture's importance	–	–	–	0.121* (0.067)
Expansion horizon	–	–	–	0.165** (0.074)
Control variables	Controlled	Controlled	Controlled	Controlled
R^2	0.0149	0.0465	0.0473	0.0197

*, **, and *** indicate significance at the 10, 5, and 1% levels, respectively.

TABLE 6 Heterogeneity test results.

Variables	I	II	III
	Water saving technology	Energy saving technology	Environmental protection technology
	Probit	Probit	Probit
	Coefficient (standard error)	Coefficient (standard error)	Coefficient (standard error)
Migrant work experience	0.256*** (0.087)	0.154* (0.087)	0.155* (0.084)
Control variables	Controlled	Controlled	Controlled
R^2	0.0141	0.0128	0.0075

* and *** indicate significance at the 10% and 1% levels, respectively.

adoption behavior, thereby providing theoretical justification for the heterogeneity analysis in this study.

The regression results in Table 6 reveal the differentiated mechanisms through which migrant work experience influences the green production technology adoption behaviors of new professional farmers. First, in the dimension of water-saving technology adoption, off-farm employment experience exhibits a significant positive effect at the 1% significance level ($\beta = 0.256$, $p < 0.01$), indicating that practitioners with migrant work experience are more inclined to invest in capital-intensive technologies such as water-saving irrigation facilities. Second, the coefficient of migrant work experience on energy-saving technology adoption is 0.154 ($p < 0.1$), showing significance at the 10% level but with relatively weaker impact intensity. This may stem from the requirement for stronger technological absorptive capacity in retrofitting energy-saving equipment. Finally, the regression coefficient for environmental protection technology adoption is 0.155 ($p < 0.01$), demonstrating comparable effect magnitude to energy-saving technologies but higher statistical significance. A comprehensive comparison reveals that migrant work experience exerts the largest marginal effect on water-saving technology adoption. This phenomenon is likely closely tied to the enhanced urban water conservation awareness and capital accumulation effects fostered by migrant work experience. These findings carry significant implications for refining agricultural technology extension systems and formulating differentiated subsidy policies.

According to the latest classification by the World Health Organization, individuals under 44 years old are considered youth,

TABLE 7 Impact of migrant work experience on green production technology adoption among new professional farmers across age groups.

Variable	≤ 44 years		45–59 years	
	Coefficient	Standard error	Coefficient	Standard error
	Probit model		Probit model	
Migrant work experience	0.027*	0.015	0.018**	0.008
Control variables	Controlled		Controlled	
Regional effects	Controlled		Controlled	
R^2	0.159		0.173	
Sample size	1,187		512	

* and *** indicate significance at the 10% and 5% levels, respectively.

those aged 45–59 are classified as middle-aged, and those over 60 are defined as elderly. Based on this categorization, this study examines how migrant work experience affects the adoption of agricultural production technologies among new professional farmers under 44 and those aged 45–59. As the sample size of new professional farmers aged 60 and above is limited to only 8 individuals (statistically insignificant), they are excluded from further analysis. The analytical results are presented in Table 7.

The findings reveal that: In the youth group (≤ 44 years old), the impact of migrant work experience on green technology adoption passes the significance test at the 10% level. This could be attributed to young farmers' exposure to new technologies and concepts during migrant work, which enhances their awareness and acceptance of green agricultural technologies. Additionally, younger farmers generally demonstrate stronger learning capabilities and adaptability, enabling faster application of new technologies in practical production. In the middle-aged group (45–59 years), the impact of migrant work experience on green technology adoption shows higher significance at the 5% level. This may relate to middle-aged farmers accumulating substantial practical experience and technical knowledge through migrant work. Their work experience often allows observation of advanced agricultural production methods and management practices, thereby stimulating interest and willingness to adopt new technologies. Comparative analysis indicates that migrant work experience exerts a stronger influence on green production technology adoption among middle-aged new professional farmers than their younger counterparts.

5 Conclusion

Under the overarching context of rural revitalization, the phenomenon of labor forces returning to rural areas for entrepreneurship and employment has become an undeniable reality, with a significant portion reengaging in or newly undertaking agricultural production and management activities. The distinct working environments, cultural atmospheres, and lifestyles inherent in non-agricultural occupations differ fundamentally from farming practices. These external characteristics interact with individuals' pre-existing traits through daily life and social interactions, ultimately reshaping their cognitive frameworks. As direct decision-makers in agricultural operations, new professional farmers' production and management decisions—spanning information collection, processing, and final implementation—inevitably bear imprints of their personal cognitive capacities. Sample data reveal that 62.3% of these farmers have adopted green production technologies in their agricultural practices. Building upon imprint theory analysis, this study empirically examines how migrant work experiences and cognitive levels influence their green technology adoption behaviors.

Working experience can promote the adoption of green production technologies among new professional farmers. Empirical analysis results indicate that migrant work experience has a positive impact on the adoption of green production technologies by new professional farmers. Individual behaviors do not occur randomly, but rather emerge based on the mastery of relevant knowledge. Therefore, corresponding actions will only be taken after individuals understand the specific content of a subject and recognize its importance. The higher farmers' cognitive level of grain's role and the greater emphasis they place on food production, the more proactively they will adopt new agricultural technologies, increase agricultural investments, expand production scales, and enhance grain yields. Conversely, once farmers develop certain misconceptions—such as simply increasing pesticide and fertilizer inputs during agricultural production—this may lead to environmental damages like water source contamination.

Migrant work experience leaves an "imprint" on the cognition of new professional farmers, elevating their cognitive levels and thereby promoting their adoption of green production technologies. Cognition encompasses aspects such as individual sensation, perception, and comprehension. Differences in cognitive levels lead to variations in new professional farmers" receptiveness to innovations and behavioral patterns. For farmers who have long been engaged in agricultural production, their limited educational backgrounds often result in resistance or sluggish responses to new ideas or innovations. Influenced by non-agricultural work requirements, their existing knowledge becomes insufficient, compelling them to actively acquire new knowledge to adapt to unfamiliar environments. In this context, farmers with work experience continuously absorb new knowledge and concepts during non-agricultural employment, fostering the establishment of updated knowledge frameworks. This imprinting effect drives returning farmers to maintain proactive learning attitudes and openness to new technologies when re-engaging in rural entrepreneurship or employment. Consequently, compared to farmers without work experience, those with such experience demonstrate enhanced adaptability and creativity in subsequent agricultural activities, exhibiting a greater likelihood of adopting green production technologies.

In terms of heterogeneity analysis, the study found that migrant work experience exerts differential promotion effects on the adoption of various green technology types. Specifically, its facilitating effect on water-saving technology adoption is stronger than that on energy-saving and environmental protection technologies. This discrepancy is closely related to differences in application costs, technical thresholds, and learning curves across technology categories. Furthermore, the research revealed variations in the impact of migrant work experience on green production technology adoption among farmers of different age groups. More specifically, migrant work experience demonstrates a greater influence on technology adoption among 45–59-year-old (middle-aged) farmers compared to those aged 44 and below (younger farmers).

Therefore, it is evident that first, we should actively eliminate institutional barriers hindering laborers from returning to their hometowns for innovation and entrepreneurship. This will create a favorable environment for migrant workers with urban employment experience to engage in agricultural production and management activities, thereby enhancing the agricultural industry's appeal to this group. Second, during agricultural technical training, differences in migrant work experience should be fully considered, and training methods should be innovated. Targeted agricultural technical training should be strengthened for farmers with migrant work experience, particularly middle-aged farmer groups, to improve their technical awareness and application capabilities in green production technologies. Through organizing training sessions, field visits, and other methods, farmers can better understand and master green production technologies, thereby increasing technology adoption rates. Finally, green technology support policies should be optimized. Governments should formulate more flexible and targeted subsidy policies for green technologies, especially in promoting water-saving, energy-saving, and environmental protection technologies. Differentiated support should be provided based on the cost and technical threshold variations among different technologies. Support for water-saving technologies could be appropriately increased to incentivize broader farmer adoption.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

XL: Conceptualization, Writing – original draft. WZ: Writing – review & editing. GZ: Writing – review & editing, Writing – original draft. YC: Writing – review & editing, Methodology.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2025.1597571/full#supplementary-material

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