Does High-standard Farmland Construction Increase Farmer's Income?

Wenyan Xu, College of Economics and Management, China Agricultural University, 100083, China, xuwenyan@cau.edu.cn
Ming Gao, Rural Economic Research Center, Ministry of Agriculture and Rural Affairs, 100810, China, gaoming313@126.com
Shenggen Fan, College of Economics and Management, Academy of Global Food Economics and Policy (AGFEP), China Agricultural University, 100083, China, s.fan@cau.edu.cn
Chen Zhu, College of Economics and Management, Academy of Global Food Economics and Policy (AGFEP), China Agricultural University, 100083, China, zhuchen@cau.edu.cn

Selected Paper prepared for presentation at the 2024 Agricultural & Applied Economics Association Annual Meeting, New Orleans, LA; July 28-30, 2024

Does High-standard Farmland Construction Increase Farmer's Income?

Wenyan Xu[1] Ming Gao[2] Shenggen Fan[13] Chen Zhu[13*]

[1]College of Economics and Management, China Agricultural University, 100083, China

[2]Rural Economic Research Center, Ministry of Agriculture and Rural Affairs, 100810, China

[3]Academy of Global Food Economics and Policy (AGFEP), China Agricultural University, 100083, China

Abstract: The construction of high-standard farmland is an essential measure to promote the high-quality development of modern agriculture, and it is expected to become a new path for increasing farmers' income. However, limited research systematically analyzes the impact and mechanisms of high-standard farmland construction on farmers' income and income structure. Our paper constructs a theoretical analytical framework for promoting farmers' income through high-standard farmland construction. Using 49414 valid samples from the National Rural Fixed Observation Sites between 2019 and 2021, we explore the impact and mechanisms of high-standard farmland construction on farmers' income at the micro level. Our findings reveal that high-standard farmland construction promotes an increase in farmers' wage income and disposable income. Specifically, according to our data, the average construction of high-standard farmland in each village implementing the project is 1966 mu. It would increase by 4109 CNY and 1990 CNY in annual disposable income and wage income per household, respectively. Mechanism verification indicates that high-standard farmland construction promotes farmers' income mainly through three pathways: changing household factor allocation, promoting the modernization of agriculture, and improving agricultural production capacity. Heterogeneity analysis results show that from the perspective of income structure, high-standard farmland construction is more effective in increasing agricultural operating income for large-scale farmers and farmers with low levels of off-farm employment but has a negative

* Corresponding author

effect on the net farm income of low-income farmers. From the perspective of marginal effects, the marginal impact of high-standard farmland construction on increasing residents' income is greater for high-income group farmers and farmers in hilly areas. Therefore, we should be alert that constructing high-standard farmland may cause vulnerable farmers to have no land to plant. Moreover, it would be better to promote the construction of high-standard farmland according to local conditions and smooth the two-way flow of urban and rural factors to increase farmers' income effectively.

Key Words: High-standard Farmland Construction; Farmer's Income; Land Management

1. Introduction

Raising farmers' income is one of the general requirements for implementing the rural revitalization strategy, and it is also the most arduous task to promote the common prosperity of all the people. Since the beginning of the 21st century, the state has persisted in increasing farmers' income as the central task of "agriculture, rural areas, and farmers" work. It has repeatedly emphasized that it is necessary to establish a long-term mechanism to promote farmers' income by improving agricultural production efficiency and guiding rural labor transfer for employment. The targeted poverty alleviation, agricultural supply-side reform, rural revitalization strategy, and "ten million projects" implemented under the leadership of the Chinese Central Committee are all ultimately aimed at helping farmers increase production and income (Wu et al., 2022). Farmers' income continues to grow rapidly in this context, but they still face two major problems: weak income growth momentum and a widening internal income gap (Cheng and Zhu, 2020; Du, 2021). At the same time, on the one hand, China's agriculture is still dominated by smallholder farmers, and the increasing climate risk has brought many uncertainties to agricultural production (Gao, 2018), which undoubtedly affects the sustainability of the farmer economy to a large extent and is not conducive to the stability of farmer family income. On the other hand, under the influence of climate change and improper fertilization, the quality of cultivated land has been rapidly degraded, which has become a bottleneck restricting agricultural

production (Nie, 2015; Tang, 2023) and then affects the growth of farmers' agricultural income.

In order to ensure food security and farmers' income, China began to build high-standard farmland with guaranteed harvests during drought and flood. High-standard farmland is mainly funded by the government through a series of comprehensive measures such as leveling the land, improving the soil, improving the farmland infrastructure, etc., to build high-yield and stable farmland adapted to modern agricultural production and management mode. Since central document No. 1 first proposed the construction of high-standard farmland in 2005, the implementation of high-standard farmland construction has achieved remarkable results. By 2022, the cumulative construction of high-standard farmland has exceeded 1 billion mu, ensuring that the grain production capacity is stable at more than 500 billion kilograms. This is essential in ensuring China's food security. Subsequently, the central document No. 1 in 2023 proposed that 1.546 billion mu of permanent basic farmland should be gradually built into high-standard farmland. The No.1 Central Document in 2024 further pointed out that the supervision of the whole process of high-standard farmland construction should be strengthened. New agricultural business entities should be encouraged to participate directly in managing and protecting high-standard farmland construction. It can be seen that the construction of high-standard farmland is an important measure to implement the strategy of "storing grain in the land and storing grain in technology."

Existing studies have explored the reasons for rural household income growth from multiple perspectives, such as land transfer (Zhu et al., 2024), informatization (Zhu et al., 2022), and education and training (Luan et al., 2015), which can effectively improve rural household income. In fact, constructing high-standard farmland as a policy that benefits and supports agriculture may also increase farmers' income. Existing literature has confirmed that high-standard farmland construction can improve agricultural production conditions, promote new agricultural quality productivity, and increase total factor productivity (Li et al., 2023), which may encourage increased agricultural output and income. On the one hand, high-standard farmland construction promotes land

transfer, social services (Chen and Hong, 2022; Qian et al., 2023; Sun, 2023) and significantly improves grain yield and quality. On the other hand, the implementation of high-standard farmland policies can also help reduce the use of pesticides and fertilizers (Liang et al., 2021; Zhang et al., 2023), curb agricultural pollution (Wang et al., 2023), promote green agricultural development (Zhang et al., 2023), and consolidate sustainable growth of agricultural production and income. In addition, the construction of high-standard farmland can also optimize the allocation of production factors, reduce the input of agricultural labor factors, and increase the input of agricultural machinery factors (Sun et al., 2023), which may enhance the non-farm labor time of farmers and thus increase non-farm income. However, some scholars found in field research that although the agricultural farming conditions have improved after the construction of high-standard farmland, some vulnerable farmers have been excluded from agricultural scale management, and migrant workers face strict restrictions on age and health. Therefore, it may be difficult for this group to achieve the dual-income increase goal of acquiring both land transfer rent and migrant worker income. In addition, some scholars have found that the quality of farmland construction is difficult to guarantee due to the unprofessional construction team and lack of supervision. The phenomenon of "heavy construction, light management, and protection" is widespread, which directly affects the long-term effective play of high-standard farmland construction projects (Li et al., 2022; Liu et al., 2022). Given this, it is still debatable whether high-standard farmland construction can effectively improve farmers' income.

Existing studies help us to understand the impact of high-standard farmland construction on farmers' income, but there are still shortcomings. First, most of the existing literature focuses on the effect of high-standard farmland construction on grain production and factor input, and some scholars pay attention to the design, current problems, and supervision models of high-standard farmland construction. However, the impact and mechanism of high-standard farmland construction on income have yet to receive due attention. Second, due to data availability, existing studies mostly use macro or small-scale survey data to analyze the policy effects of high-standard farmland construction. Few studies use large-scale, nationally representative micro-data analysis,

which may mask the heterogeneous impacts of high-standard farmland construction on different micro-subjects. Due to differences in production skills, operation scale, and economic conditions, not all farmers may benefit from it. Micro-data is more helpful for in-depth analysis of the impact and mechanism of high-standard farmland construction on farmers' income.

Based on the above considerations, this paper will answer the following questions: First, can high-standard farmland construction effectively increase farmers' income? If it can, how will it affect the income structure of farmers? Secondly, does the construction of high-standard farmland have the same effect on the income and income structure of different types of farmers? Therefore, based on the data of fixed observation points in rural areas throughout the country from 2019 to 2021, this paper empirically analyzes the impact of high-standard farmland construction on household wage income, net income of agricultural operation, and disposable income of rural households, and uses various methods to test the robustness of the results. Secondly, it is estimated whether there are differences in the income structure and marginal effects of high-standard farmland construction on farmers in different regions, operation scales, income groups, and part-time employment degrees.

Compared with the existing studies, this paper has four possible marginal contributions: First, this paper adopts the data of a large sample of farmers across the country to provide nationally representative micro-empirical evidence for assessing whether the construction of high-standard farmland can promote the improvement of farmers' income. Secondly, the income structure of farmers was decomposed. Based on the scale of operation, the degree of part-time employment, and the region where the village is located, we discuss whether the impact of high-standard farmland construction on the income structure among different types of farmers is different, providing empirical support for subsequent precision policies. Third, most of the previous studies used panel data from the 31 provinces and cities in China from 2005 to 2017, and the land consolidation area of each province and city was used as a proxy variable for the construction area of high-standard farmland. However, high-standard farmland construction not only includes land consolidation but also covers major

measures such as ecological protection and farmland water conservancy construction, and the use of land consolidation areas may cause certain bias in the results. In addition, in recent years, China's high-standard farmland construction projects have entered the stage of improving quality and efficiency, so it is necessary to use data covering this new stage for analysis. Fourthly, this paper explores the possible mechanism of the impact of high-standard farmland construction on farmers' income from three aspects: changing the allocation of household factors, promoting agricultural modernization and improving agricultural production capacity, and enriching the corresponding mechanism interpretation.

2. Theoretical analysis

The theoretical analysis focuses on the impact of high-standard farmland construction on rural residents' income from three perspectives: factor allocation, agricultural modernization development, and agricultural production capacity. According to the induced technological change theory, high-standard farmland construction facilitates factor substitution and improves labor efficiency, thus increasing rural residents' income. Additionally, the development of large-scale farming and mechanization, promoted by high-standard farmland construction, enhances agricultural modernization, leading to income growth. Moreover, by improving soil quality and agricultural infrastructure, high-standard farmland construction strengthens agricultural production capacity, further boosting rural income.

Factor allocation theory suggests that high-standard farmland construction reallocates resources, benefiting both large-scale and small-scale farmers. Agricultural modernization theory highlights the importance of scale and mechanization in income growth, which high-standard farmland construction facilitates. Furthermore, enhanced agricultural production capacity resulting from such construction positively affects farmers' income. Consequently, the article hypothesizes that high-standard farmland construction will increase farmers' income and influence their income structure differently based on farm scale.

Based on the above analysis, this article puts forward the following hypothesis:

H1: High-standard farmland construction will help increase farmers’ income.

H2: High-standard farmland construction can increase farmers' income by changing the allocation of factors, promoting the development of agricultural modernization, and improving agricultural production capacity.

H3: There are differences in the impact of high-standard farmland construction on the income structure of different types of farmers. It helps to increase the agricultural operating income of large-scale farmers and the wage income of small farmers.

3. Data, variables, and models

3.1 Data Sources

The data used in this article come from the nationwide rural fixed observation point data that the Ministry of Agriculture and Rural Affairs began to survey in 1986. Except for 1992 and 1994, which were not surveyed for some reason, it has been continuously tracked for 36 years (1986-2021). Since 2003, the survey has been divided into two levels of questionnaires: farmer households and family members. The survey covers 31 provinces and cities across the country except Hong Kong, Macao, and Taiwan, and it involves 360 administrative villages. Currently, more than 20,000 households are surveyed every year. The survey includes many aspects, such as production and operations, annual income and expenditure, employment, and farmers' food consumption. Since agricultural fixed observation points only began to investigate the implementation of high-standard farmland construction projects in villages in 2019, this article will use three-period panel data from 2019 to 2021. After excluding samples with missing data on the main variables, 49,414 valid samples were finally obtained.

3.2 Variable

3.2.1 Explained variable. The explained variable in this article is farmer household income. Among them, income selects farm household disposable income, wage income, and agricultural net income as the main variables explained. Household disposable income comes from national rural fixed observation point survey indicators, wage and agricultural net income are calculated. Wage income is obtained by adding up the wage income of rural households as rural cadres, teachers, working outside the home, and working locally. Agricultural net income is obtained by subtracting the operating income of the secondary and tertiary industries from the household operating income

and then subtracting the total agricultural production expenses.

3.2.2 Core explanatory variables. The core explanatory variable in this article is the high-standard farmland construction area in the village has passed the inspection. There are two main reasons for selecting the high-standard farmland construction area variable at the village level: First, high-standard farmland construction is usually carried out on a village basis. Secondly, it reduces the endogeneity problems caused by reverse causation. The construction of high-standard farmland in China mainly implements plans coordinated and guided by the central or provincial governments, implemented by cities and counties, and then assisted by local village committees. That is, whether a village implements high-standard farmland construction is mainly related to the land planning of governments at the county level and above. So, it is exogenous to the income level of individual farmers. Although this may be related to the local economic level and agricultural production conditions, the financial level of villages within a county is not directly related to the income level of individual farmers. At the same time, considering the differences in cultivated land area in different villages, villages with the same high-standard farmland construction area may have different high-standard farmland construction levels. Therefore, in the robustness test, the proportion of the village's high-standard farmland construction area that accounts for the village's total cultivated land is used to measure the level of construction and serves as a proxy variable for the core explanatory variable.

3.2.3 Control variables. Theoretically, variables such as household resource endowment and regional economic development will affect rural household income. Therefore, in order to control other household characteristics and village characteristics that may affect household disposable income, wage income, and net agricultural income, this paper selects as control variables the gender of the household head and whether the household head receives agricultural technical education and training to reflect the characteristics of the household head; select the proportion of household labor force, per capita age, per capita education level, per capita health status, the main business of the family, whether the household is a village cadre and whether the family is connected to the internet to reflect the family resource endowment and family structure; the

distance of the village from the main highway, the village's per capita income, the village economic development level at the county and city, and the farmland area in the town is used to control village characteristics that may affect both high-standard farmland construction and farmers' income.

3.2.4 Mechanism variables. Based on the previous theoretical analysis, this article will mainly verify the mechanism of high-standard farmland construction on farmers' family income through three paths: changing the allocation of factors of farmers' households, promoting the development of agricultural modernization, and improving agricultural productivity. Among them, the factor allocation of farmers' households is represented by the family's per capita non-agricultural labor time; the agricultural modernization development is represented by the two variables of agricultural mechanization level and land circulation; the agricultural production capacity is represented by grain output.

The specific meaning and the descriptive statistical analysis of the main variables are shown in Table 2

Table 2 Descriptive statistics of main variables

Variable	Variable explanation	Mean	Standard error
Explained variable			
Family wage income	Annual wage income of rural households (yuan)	40624.900	41499.280
Family farming net income	Annual net income from agricultural operations of rural households (yuan)	9830.158	31345.030
Family disposable income	Annual disposable income of rural households (yuan)	66293.480	47628.000
Core explanatory variables			
High-standard farmland construction areas in villages	(mu)	387.456	1350.896
Control variables			

Gender of head of household	0 = female; 1 = male	0.914	0.281
Whether the head of the household has participated in education or training in agricultural technology	0 = no; 1 = yes	0.082	0.274
Per capita age	(age)	47.640	1 4.473
Per capita years of education	(Year)	6.903	2.473
Per capita health status	1=Excellent ; 2=Good ; 3=Medium ; 4=Poor ; 5=Loss of working ability	1.883	0.865
Share of the family labor force	%	0.6 43	0.3 24
Per capita contracted land area	(mu)	2.733	3.888
Family business	0 = non-agricultural; 1 = agricultural	0.795	0.404
Whether the family is a rural cadre household	0 = no; 1 = yes	0.044	0.206
Whether the home has connected to the internet	0 = no; 1 = yes	0.793	0.405
Distance from village to main road	(km)	2.086	8 .172
Village per capita income	(Yuan)	15039.750	14965.510
Village economic development level at the county or city	1 = upper; 2 = upper-middle; 3 = medium; 4 = lower-middle; 5 = lower	2.805	0.803
Village cultivated land area	(mu)	4129.562	5003.186
mechanism variable			
Non-agricultural labor hours per capita	(day)	86.186	84.015
Whether to use agricultural machinery	0=no; 1=yes	0.288	0.453

Land transfer area	(mu)	4.988	59.948
Grain yield	(kilogram)	3043.902	7268.007

3.3 Model settings

This paper uses a panel data two-way fixed effects model for analysis. The advantage of this model is that it can eliminate individual and time heterogeneity, and alleviate the endogeneity problem to a certain extent. The specific form of the model is as follows:

$$Y_{it} = \beta_0 + \beta_1 hsland_{it} + \beta_2 X_{it} + \gamma_t + \mu_i + \varepsilon_{it} \quad (1)$$

Among them, Y_{it}represents the individual i's household disposable income, wage income, and net income from agricultural operations in the year t; $hsland_{it}$ represents the high-standard farmland construction area of the village where the farmer is located; X_{it} is the control variable mentioned above, including the characteristics of the household head, the farmer family characteristics, and village characteristics; $\gamma_t$and $\mu_i$are time dummy variables and village dummy variables, respectively, to control omitted variable problems caused by regional differences and time trends; ε_{it} are random disturbance terms.

4. Empirical results and analysis

4.1 The impact of high-standard farmland construction on farmers' income

Table 3 reports the estimated results of the impact of high-standard farmland construction on farmers' income. The results show that high-standard farmland construction increases farmers' disposable income and wage income. Hypothesis 1 has been preliminarily verified. Specifically, based on fixed observation point data, each village implementing the project has built an average of 1,966 mu of high-standard farmland, which will lead to an increase in the annual disposable income of rural households by 4,109 yuan and an increase in annual household wage income by 1,990 yuan. However, high-standard farmland construction does not significantly impact farmers' agricultural income. The reason may be that the funds for high-standard farmland construction in China mainly come from national investment and local financial matching. Still, local governments have limited financial resources and often cannot make up the corresponding parts. As a result, the investment level in high-standard farmland construction is low, and the quality of the constructed farmland has

been improved limitedly. Therefore, it may not significantly improve farmers' agricultural operating income.

Table 3 The impact of high-standard farmland construction on farmers' income.

variable	(1) Family wage income	(2) Family farming net income	(3) Family disposable income
High-standard farmland construction areas in villages	1.012 **	0.446	2.090 ***
	(0.369)	(0.366)	(0.588)
Gender of head of household	999.311	3657.958 ***	5338.026 ***
	(978.499)	(582.314)	(1216.193)
Whether the head of the household has participated in education or training in agricultural technology	-4524.212 **	2496.915	-155.239
	(1932.738)	(1845.172)	(1952.212)
Per capita age	-1035.452 ***	-189.936 ***	-1120.681 ***
	(79.801)	(38.453)	(68.844)
Per capita years of education	1547.596 ***	133.090	2010.886 ***
	(215.096)	(140.194)	(202.086)
Per capita health status	-2522.639 ***	-121.490	-2256.021 ***
	(546.576)	(532.674)	(493.460)
Share of the family labor force	11060.255 ***	3067.658 ***	6739.947 ***
	(1757.524)	(786.122)	(1202.589)
Per capita contracted land area	-1060.571 ***	774.673 ***	-97.088
	(210.093)	(171.927)	(172.644)
Family business	1065.245	12243.302 ***	-6477.696 ***
	(2626.074)	(1372.165)	(1816.183)
Whether the family is	7530.720 ***	3052.118 **	14062.029 ***

a rural cadre household			
	(1380.373)	(1395.108)	(1765.049)
Whether the home has connected to the internet	6873.198 ***	1304.215 **	11147.192 ***
	(958.148)	(595.183)	(899.191)
Distance from village to main road	-4.638	24.648	164.225
	(74.740)	(57.678)	(113.303)
Village per capita income	0.043	0.072	0.218 ***
	(0.056)	(0.063)	(0.073)
Village economic development level at the county or city	-264.114	-2067.775 ***	-3212.253 **
	(1099.906)	(717.997)	(1368.059)
Village cultivated land area	-0.501 **	0.413 **	-0.598 ***
	(0.185)	(0.185)	(0.201)
Constant term	74406.866 ***	2441.979	103854.016 ***
	(6068.671)	(3868.024)	(6318.125)
Year fixed effects	control	control	control
Village fixed effects	control	control	control
Observations	49414	49414	49414
R square	0.333	0.109	0.312

Note: ***, ** and * represent the significance levels of 1%, 5%, and 10% respectively, and the clustering standard errors (provincial level) are in parentheses.

4.2 Robustness check

As mentioned above, when the construction area of high-standard farmland is the same, the proportion may not be the same. The larger the area of cultivated land in a village, the lower the level of construction of high-standard farmland. Therefore, the core independent variable is replaced by the high-standard farmland construction level to analyze further the impact of the high-standard farmland construction level on farmers' income. The level of high-standard farmland construction is measured by the

proportion of the high-standard farmland construction area in the village accounts for the total cultivated land area. The results are shown in Table 5. After replacing the core independent variables, high-standard farmland construction increased the wage income and disposable income of farmers' households at the 1 % significance level, indicating that the effect of high-standard farmland policies on increasing farmers' income is robust. For every 1 % increase in the proportion of high-standard farmland construction in villages, the annual wage income of rural households will increase by 16.66 %, and the household disposable income will increase by 15.03 %.

Table 5 Robustness test: replacing core independent variables

Variable	(1) Family wage income	(2) Family farming net income	(3) Family disposable income
High-standard farmland construction level in villages	6768.206 ***	-1829.607	9966.831 ***
	(2305.935)	(1747.992)	(2732.937)
Control variables	control	control	control
Year fixed effects	control	control	control
Village fixed effects	control	control	control
Observations	49414	49414	49414
R square	0.332	0.108	0.310

Note: ***, ** and * represent the significance levels of 1%, 5%, and 10% respectively. The clustering standard errors (provincial level) are in parentheses. Since the core independent variable here is replaced by high-standard farmland construction at the village level, the village cultivated land area is eliminated from the control variables to avoid the influence of multicollinearity.

5 Heterogeneity analysis

5.1 The impact of high-standard farmland construction on the income of farmers of different land operating scales. Given the differences in resource allocation and operating strategies between small and large-scale farmers, high-standard farmland construction may have different impacts on the income structures of small and large-scale farmers. Table 10 reports the impact of high-standard farmland construction on large-scale and small farmers' income structure. According to Yang et al. (2022)

research, the classification standard for large-scale and small farmers is 30 acres. Those with a crop planting area of less than 30 acres during the year are small farmers. Otherwise, they are large-scale farmers. The results show that high-standard farmland construction has a negative and insignificant impact on the agricultural income of small farmers. Still, overall, it significantly increases wage income and disposable income. For large-scale farmers, high-standard farmland construction has significantly improved their wage income, agricultural operation net income, and disposable income. Hypothesis 3 has been verified. This shows that after the construction of high-standard farmland, small and large-scale farmers may have made different decisions in agricultural management. For small farmers, since agricultural returns are relatively low, one possible decision is to transfer their land and go out to work, thus making their agricultural income mainly dependent on land rental income. Therefore, high-standard farmland construction has reduced the net income of smallholder family agrarian operations. For large-scale farmers, high-standard farmland construction can help introduce modern planting technology, improving production efficiency. Therefore, large-scale farmers may transfer land to expand crop sowing areas to increase their net income from family agricultural operations to achieve economies of scale.

5.2 The impact of high-standard farmland construction on the income of farmers in different regions. Given the possible differences in the income-increasing effects of high-standard farmland construction on farmers in the different areas, villages were divided into plains, hills, and mountains according to their topography to examine. The results show that high-standard farmland construction has significantly increased farmers' income in plain and hilly areas and has a greater impact on farmers' income in hilly villages than in plain villages. The possible explanation is that high-standard farmland construction helps promote agricultural mechanization by leveling the land and carrying out mechanized farming. The land in plain areas is relatively flat, while the land in hilly areas is usually relatively steep and barren. Therefore, the construction of high-standard farmland in hilly areas may significantly improve the quality and productivity of the land. Thus, compared with plain areas, the incremental income from land leveling in hilly regions is higher, and the marginal effect of project construction

on increasing farmers' income is also greater.

5.3 The impact of high-standard farmland construction on the income of farmers in different income groups. The marginal effect of high-standard farmland construction on farmers' income in high, medium, and low-income groups may differ. In order to explore whether high-standard farmland construction will expand or narrow the income gap among farmers, our paper divides those household disposable income lower than the 25th percentile into low-income groups, and farmers above the 75th percentile are classified into the high-income group. The results show that high-standard farmland construction significantly promotes the increase in the disposable income of households in the middle-income group and those in the high-income group, and the marginal impact shows an increasing trend. However, it has no significant effect on the disposable income of households in the low-income group and even has a negative impact on the net income of agricultural operations of households in the low-income group, indicating that high-standard farmland construction has widened the income gap among farmers to a certain extent. The reason may be as mentioned by some scholars. During field research, they found that high-standard farmland construction squeezes disadvantaged farmers out of agricultural production to a certain extent, so it has a negative impact on the agricultural income of low-income groups. It should be alert to the negative effect of high-standard farmland construction on low-income groups, smooth the two-way flow of urban and rural factors, improve the security system for low-income groups, narrow the income gap between residents, and promote common prosperity.

5.4 The impact of high-standard farmland construction on the income of farmers with different levels of off-farm employment. There are significant differences in the income structure of farmers with different degrees of off-farm employment. Will this lead to different impacts of high-standard farmland construction? Referring to Gao and Wei (2022), the proportion of non-agricultural employment income in total household income is used to reflect the degree of farmers' off-farm employment. The higher the proportion, the lower the farmer's dependence on agricultural income. According to the median level of off-farm occupation of farmers in the sample, they are divided into low

level of off-farm employment farmers and high level of off-farm employment farmers. The results show that high-standard farmland construction has increased family agricultural operation net income and household disposable income of farmers with low levels of off-farm employment. For farmers with high levels of off-farm employment, high-standard farmland construction helps improve family wages and disposable income. Still, it has no significant impact on the agricultural income of farmers with high levels of off-farm employment. Since farmers with high levels of off-farm employment mainly rely on their income from non-agricultural fields, and high-standard farmland construction primarily focuses on improving agricultural production conditions, high-standard farmland construction has a different impact on farmers' income structures with low and high levels of off-farm employment.

Table 8 Impact of high-standard farmland construction on the income of different types of farmers

Independent variable: village high-standard farmland construction area	Family wage income	Family farming net income	Family disposable income
Large-scale farmers	0.730 ***	1.621 ***	2.343 ***
	(0.214)	(0.513)	(0.403)
Small farmer	1.683 **	-0.484	1.651 **
	(0.657)	(0.319)	(0.622)
Plain	0.271	0.580	1.476 **
	(0.613)	(0.799)	(0.623)
Hills	3.585 **	0.863	4.877 ***
	(1.334)	(1.104)	(1.372)
Mountainous area	1.286 **	-1.150	1.292
	(0.566)	(0.768)	(0.784)
Low-income farmers	-0.003	-0.661 ***	0.045
	(0.068)	(0.108)	(0.077)
Middle-income group farmers	0.389	0.164	0.650 ***
	(0.241)	(0.456)	(0.119)
High-income farmers	1.329 **	-0.884 *	0.712 *
	(0.583)	(0.445)	(0.374)
Low off-farm	0.541 **	0.670 **	1.745 ***

employment levels			
	(0.221)	(0.303)	(0.561)
High off-farm employment levels	1.681 *	-0.030	2.067 ***
	(0.929)	(0.244)	(0.714)

Note: ***, ** and * represent the significance levels of 1%, 5%, and 10% respectively, and the clustering standard errors (provincial level) are in parentheses. Control variables such as household head characteristics, family characteristics, village characteristics, and village and year-fixed effects are controlled.

6 Mechanism analysis

The analytical framework points out that the construction of high-standard farmland may increase the income of rural households through three mechanisms: changing the allocation of household factors, promoting the development of agricultural modernization, and improving agricultural production capacity. Table 11 shows that, with other conditions remaining unchanged, high-standard farmland construction significantly increases the per capita non-agricultural labor time of households and changes the allocation of household factors. Specifically, for every one mu increase in the average village construction area, a household's per capita non-agricultural labor time increases by 0.006 days. Regarding agricultural modernization development, high-standard farmland construction has significantly increased the probability of farmers using agricultural machinery and land transfer to achieve moderate-scale operations. For every one mu of village construction area increase, farmers' land transfer area will increase by 0.001 mu. Finally, constructing high-standard farmland has significantly increased food production and improved agricultural production capacity. The above three paths are established, indicating that high-standard farmland construction has positively contributed to increasing rural households' income, and hypothesis 2 has been verified.

Table 9 Mechanism test

	Feature configuration	Agricultural transformation and upgrading	agricultural production capacity

variable	(1) off-farm working time	(2) Whether to use agricultural machinery	(3) Land transfer area	(4) grain yield
High-standard farmland construction areas in villages	0.006 ***	0.020 **	1.125 ***	0.493 ***
	(0.001)	(0.010)	(0.234)	(0.175)
Control variables	control	control	control	control
Year fixed effects	control	control	control	control
Village fixed effects	control	control	control	control
Observations	4 9 414	4 9 414	4 9 414	4 9 414
R square	0. 236	0.19 7	0.022	0.3 46

Note: ***, ** and * represent the significance levels of 1%, 5%, and 10% respectively, and the clustering standard errors (provincial level) are in parentheses. After controlling for household head characteristics, family characteristics, village characteristics, and other control variables, as well as village and year fixed effects, regression models (2) and (3) divided the high-standard farmland construction area by 1,000.

7 Summary and Implications

As an essential policy to strengthen agriculture production, constructing high-standard farmland is a robust measure to consolidate national food security and increase farmers' income. Our paper builds an analytical framework on how high-standard farmland construction can promote farmers' income increase and uses national rural fixed observation point data from 2019 to 2021 to analyze the impact and its mechanism of high-standard farmland construction on farmers' income. We also find the heterogeneous effect of farmland construction on farmers' income with different business scales, regions, and levels of off-farm employment. Specifically:

First, high-standard farmland construction not only increases the farmers' wage income, agricultural operation income, and disposable income but also improves the quality of farmers' income. Based on fixed observation point data, each village

implementing the project has built an average of 1,966 acres of high-standard farmland, which will lead to an increase in the annual disposable income of rural households by 4,109 yuan and an increase in the annual wage income of the family by 1,990 yuan. Secondly, it increases the farmers' family income by changing the allocation of factors of farmers' households, promoting the development of agricultural modernization, and improving agricultural production capacity. Among them, the increase in the construction area of high-standard farmland will significantly increase the per capita non-agricultural labor time and grain output of rural households and improve agricultural mechanization and land transfer rate.

Finally, under realistic scenarios of different regions, land operating scales, income groups, and degrees of off-farm employment, the impact of high-standard farmland construction on farmers' income has significant heterogeneous effects. First, high-standard farmland construction can better promote the increase of agricultural operating income of large-scale farmers. For small farmers, it can further increase their wage income. Second, high-standard farmland construction has significantly improved farmers' income in plains and hilly areas and has a greater impact on farmers' income in hilly villages than in plain villages. Third, the marginal effect of high-standard farmland construction on farmers' income in the high-income group is greater than that of the middle- and low-income groups. This may widen the income gap among farmers to a certain extent. Therefore, we must be careful that high-standard farmland construction will leave disadvantaged farmers with no land to farm. Fourth, high-standard farmland construction has promoted an increase in the net income of family agricultural operations for farmers with low levels of off-farm employment. In contrast, for farmers with high levels of off-farm employment, it has mainly promoted an increase in wage income.

The results of this article are essential and significant policy references. First, the construction process of high-standard farmland should be sped up to play a better role in increasing production and income. From 2019 to 2021, the proportion of villages with high-standard farmland construction in the national rural fixed observation point sample has risen from 20.35 % to 25.1 %. Therefore, it is necessary to continue to

expand the coverage of high-standard farmland construction. Second, heterogeneity analysis shows that high-standard farmland construction has different impacts on villages with different terrains. Therefore, different engineering construction models must be implemented according to local conditions to avoid one-size-fits-all policy content. In addition, due to the high financial investment in constructing high-standard farmland, attention should be paid to improving policy accuracy and fund utilization. Third, high-standard farmland construction has strong positive externalities as a public good. A long-term protection mechanism for high-standard farmland construction should be established to encourage farmers, new business entities, etc., to directly participate in the construction and management of high-standard farmland and fully mobilize the enthusiasm of multiple entities to manage and protect high-standard farmland construction. Finally, the construction of high-standard farmland is related to the "ballast stone" of agriculture, ensuring investment in high-standard farmland construction, strengthening financial funding guarantees, and improving construction quality.

References

(1) Chen Jianghua and Hong Weijie: "Does high-standard farmland construction promote farmland transfer ? ", "Journal of Zhongnan University of Economics and Law", Issue 04 , 2022 .

(2) Cheng Guoqiang and Zhu Mande: " Increasing Farmers' Income in 2020: The Impact of the COVID-19 Epidemic and Response Suggestions", "Agricultural Economic Issues", Issue 04 , 2020 .

(3) Du Xin: "Current Income and Income Distribution of Rural Residents in China - Also Discussing the Income Level and Income Gap of Rural Residents in Various Grain Functional Areas", "China Rural Economy", Issue 07 , 2021 .

(4) Gao Ming: "Re-estimation of Agricultural Productivity under Climate Change", "China Soft Science", Issue 09 , 2018 .

(5) Gao Ming, Wei Jiasuo: "Income Subsidy and Grain Total Factor Productivity Growth", "Economic Research", Issue 12 , 2022 .

(6) Gong Yanling and Zhang Yingliang: "The Impact of High-Standard Basic Farmland

Construction Policy on Grain Production Capacity", "Journal of Huazhong Agricultural University (Social Science Edition) ", Issue 04 , 2023 .

(7) Hu Xinyan and Dai Minghong: "The Grain Production Increase Effect of High-Standard Farmland Construction Policy", "Journal of South China Agricultural University (Social Science Edition) ", Issue 05 , 2022 .

(8) Li Junjie, Li Jianping, and Mei Dong: "Problems and Suggestions on High-Standard Farmland Construction and Management Policies under the New Situation", "China Agricultural Resources and Zoning", Issue 05 , 2022 .

(9) Li Xiaohui, Li Gucheng, and Gao Yang: "Can high-standard farmland construction improve agricultural green total factor productivity?" ——Empirical test based on continuous double difference", "China Agricultural Resources and Zoning", 2023 .

(10) Liang Zhihui, Zhang Lu, and Zhang Junbiao: "Land Consolidation and Fertilizer Reduction—Quasi-natural Experimental Evidence from China's High-Standard Basic Farmland Construction Policy", "China Rural Economy", Issue 04 , 2021 .

(1 1) Liu Haoxuan, Zhao Huafu, Qi Rui: "Research on the Supervision and Management Mechanism of High-Standard Farmland Construction under Multi-center Governance", "China Agricultural Resources and Zoning", Issue 03 , 2022 .

(1 2) Lu Hua and Hu Hao: "Does land fragmentation increase agricultural production costs ? ——Microscopic survey from Jiangsu Province", "Economic Review", Issue 05 , 2015 .

(1 3) Nie Ying: "Analysis of cultivated land contribution to China's food security", "Economist", Issue 01 , 2015 .

(1 4) Pan Jingtao, Chen Chibo, and Gong Zheng: "Analysis of the Spatial Effect of Agricultural Mechanization on Increased Farmers' Income—Based on the Perspective of Cross-regional Agricultural Machinery Operations", "Chinese Journal of Agricultural Mechanization", Issue 11 , 2023 .

(15) Qian Long , Liu Cong, Zheng Linyi, Qian Wenrong: "How does high-standard farmland construction affect farmland transfer", "China Land Science", Issue 02 , 2023 .

(16) Qian Long , Yang Guang, and Zhong Yu: "Where there is soil, there is grain: Does high-standard farmland construction increase grain yields ? " "Journal of Nanjing Agricultural University (Social Science Edition) ", Issue 01 , 2024 .

(17) Scott James : " Farmers' Moral Economics Rebellion and Survival in Southeast Asia", Yilin Publishing House, 2001 .

(18) Sun Xuetao: "The Impact of High-Standard Farmland Construction on Agricultural Social Services", "Journal of Zhongnan University of Economics and Law", Issue 03 , 2023 .

(19) Sun Xuetao, Zhang Lijuan, and Wang Zhenhua: "The Impact of High-Standard Farmland Construction on Agricultural Production—Based on the Perspective of Agricultural Factor Elasticity and Agricultural Total Factor Productivity", "China Rural Observation", Issue 04 , 2023 .

(20) Tang Renjian: "Strive to improve the quality of cultivated land "Strive to consolidate the foundation of food security", "China Agricultural Comprehensive Development ", Issue 10 , 2023 .

(21) Wang Sangui, Ma Lan, and Sun Junna: "The Impact of Resettlement Location for Poverty Alleviation on the Income and Income Quality of Relocated Households—A Micro-Data Analysis Based on 16 Counties in 8 Provinces ", "China Rural Economy", Issue 10 , 2023 .

(22) Wang Bin, Wang Li, and Li Xingfeng: "Can high-standard basic farmland construction policies suppress agricultural non-point source pollution ? ", "Yangtze River Basin Resources and Environment", Issue 08 , 2023 .

(23) Wang Shukun and Lin Wensheng: "The transformation effect of farmland transfer market of high-standard farmland construction", "China Rural Economy", Issue 12 , 2023 .

(24) Wu Yaling, Yang Rudai, Wu Bi, and Lu Guoliang: "The evolution of total factor productivity and factor mismatch in China's agriculture—Analysis based on fixed observation point data in rural areas from 2003 to 2020 ", "China Rural Economy", No. 2022 12 issues.

(25) Yang Qing, Peng Chao, Xu Qing: "Has the "Three Subsidies" Reform in Agriculture Promoted the Land Transfer of Farmers? ", "China Rural Economy", Issue 05 , 2022 .

(26) Yang Shaoxiong, Su Lanlan, Kong Rong, and Wang Huiling: "Farmers' Income Quality: Logical Construction, Measurement Evaluation and Dynamic Evolution", "China Rural Economy", Issue 08 , 2023 .

(27) Yu Fawen, Sun Han Xiaoxue, and Liu Yueqing: "High-standard farmland construction: connotative characteristics, problem diagnosis and advancement path", "Economic Perspectives", Issue 01 , 2024 .

(28) Zhang Mengling, Weng Zhenlin, and Gao Xueping: "Research on the Impact of High-Standard Farmland Construction and Agricultural Social Services on Pesticide Investment - Based

on Survey Data of 605 Rice Farmers in Jiangxi Province", "China Land Science", Issue 09 , 2023 .

(29) Zhang Zhixin, Zhou Yanan, and Ding Xin: "Research on the Impact of High-Standard Farmland Construction Policies on Agricultural Green Development", "Journal of Agricultural and Forestry Economics and Management", Issue 01 , 2023 .

(30) Zhang Zongyi: "Several major issues and measures for mechanization of farmland in hilly mountainous areas during the "14th Five-Year Plan" period", "China Rural Economy", Issue 11 , 2020 .

(31) Zhou Yindi, Cai Liqun, Dong Bo, Wu Jun, Ma Qianqian, Liu Jiang: "Changes in cultivated land quality grades before and after the implementation of high-standard farmland construction projects - taking Lingtai County, Gansu Province as an example", "Journal of Lanzhou University (Natural Science Edition)" 》, Issue 03 , 2023 .

(32) Zhu Qiubo, Zhu Chen, Peng Chao, Bai Junfei: "Can informatization promote the increase of farmers' income and narrow the income gap ? " , "Economics (Quarterly) ", Issue 01 , 2022 .

(33) Zhu Shi'e, Yang Rudai, Wang Lu, and Wu Bi: "China's Rural Land Transfer and Agricultural Production Model Changes", "Management World", Issue 01 , 2024 .

(34) Imbert, C., Seror, M., Zhang, Y., & Zylberberg, Y. , 2022 , “Migrants and Firms: Evidence from China” *American Economic Review* , vol. 112(6), pp. 1885–1914.

(35) Kebede, H. A , 2022 , “ Risk Aversion and Gender Gaps in Technology Adoption by Smallholder Farmers: Evidence from Ethiopia” , *The Journal of Development Studies* , vol. 58(9), pp. 1668–1692.

(36) Luan, J., Chen, J., He, Z., Li, Q., & Qiu, H , 2015 , “The education treatment effect on the non-farm income of Chinese western rural labors” *China Agricultural Economic Review* , vol. 7(1), pp. 122–142.

(37) Pu, L., Zhang, S., Yang, J., Yan, F., & Chang, L , 2019 , “ Assessment of High-standard Farmland Construction Effectiveness in Liaoning Province During 2011–2015 ”, *Chinese Geographical Science* , vol . 29(4), pp. 667–678.