Research on the Impact of Agricultural Mechanization on Farmers' Income

-Based on the Mediating Effect of Crop Sown Area and Agricultural Electrification

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Abstract. At present, "the three rural issues: agriculture, rural areas, and peasants" constitute the core problem for farmers, and the essence of farmers' problems lies in income. Promoting an increase in farmers' income is not only the top priority of "the three rural issues" but also the starting point and endpoint of agricultural mechanization. To achieve this new goal in the new era, further improvement of the level of agricultural mechanization and its popularity is crucial. We test the relationship between mechanization and farmers' incomes using a sample of China for 2013-2020. We also test the mediating effects of agricultural sown area and agricultural electrification. The results show a significant positive contribution of mechanization to farmers' income. In the mechanism test, we found significant mediating effects of sown area and agricultural electrification. Therefore, we make the following policy recommendations: it is proposed to improve the level of agricultural mechanization and its popularity through diversified means of science and technology innovation, and then promote the expansion of the total sown area of crops, the increase of farmers' income, and the improvement of farmers' living standard and quality of life.

Keywords: agricultural mechanization level; total sown area of crops; agricultural electrification; farmers' income; mediation effect

1 Introduction

Currently, the development of agricultural mechanization has shown a positive trend. With the continuous advancement of science and technology and ongoing innovation in agricultural machinery, the level of agricultural mechanization has been consistently enhanced, providing crucial support for farmers to increase their income. The significance of mechanization in relation to farmers' income is primarily manifested in the following aspects: Firstly, agricultural mechanization can significantly improve agricultural production efficiency by reducing production cycle and increasing output. Secondly, agricultural mechanization helps to reduce various costs associated with agriculture. Furthermore, agricultural mechanization can promote the transfer of rural labor

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force. Due to the continuous development of agricultural mechanization, rural labor force is liberated from heavy manual labor and can find employment opportunities or engage in other business activities

2 Literature Review

Prior to this, relevant scholars have also done some empirical analysis and research on this issue. Peng et al.(2022)discovered mechanization has a significant positive impact on agricultural production and income by utilizing a sample-modified endogenous merging model and a threshold effect model.[1] Olatunji et al. (2022) discovered agricultural mechanization had a significant influence on crop production and farmers' income by employing investigative research approach method through a structured questionnaire.[2] Wang et al. (2022) conducted an analysis of the agricultural mechanization of 31 provinces in China by using the grey weighted clustering assessment tool.[3] Guo (2016) investigate the impact of farmers' investment in agricultural mechanization on agricultural efficiency and farmers' income.[4] Qiao (2023) made an empirical analysis using provincial panel data confirm that the mechanization has a positive impact on grain crops . [5]Xu et al. (2021) used the quantile grey model (FGM (1,1)) to forecast farmers' income from 2020 to 2024 in Hebei Province.[6] Based on the 2018 Chinese household panel study data, Xiumei et al. (2022) analyze the mechanism and extent of the impact of data capital on farmers' income using.[7] Kata & Leszczyńska (2021) analyzed the available income of Polish farmers' households in 2003-2020 in terms of income levels, variability and differentiation[8]. By analyzing the relationship between agricultural mechanization and agricultural labor, Zhou & Lu (2012) discover that when agricultural mechanization reaches a certain level, it will effectively replace the agricultural labor force.[9]

3 Research Design

3.1 Data Description

Data related to agricultural mechanization and farmers' incomes are mainly from the National Bureau of Statistics, provincial statistical yearbooks and the China Rural Statistical Yearbook. These data cover 30 provinces, municipalities and autonomous regions of China for the period 2013-2020. All data were standardized.

3.2 Variable Measurement

Following the screening of indicators, disposable income per rural household was chosen as a representative measure of farmers' income. Agricultural mechanization was selected as the explanatory variable, measured by the total power of agricultural machinery. Agricultural electrification and crop sown area were chosen as mediating variables, facilitating the study of the impact of agricultural mechanization on farmers' income. Descriptive statistics are presented in Table 1.

Table 1. descriptive statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
AREA	248	5,356.072	3,973.747	88.550	14,910.130
INC	248	13,648.706	5,338.440	5,589.000	34,911.000
FER	248	185.814	146.821	4.400.00	716.090
PES	248	25,924.764	21,716.694	828.200	111,151.600
POP	248	4,487.581	2,920.920	317.000	12,624.000
MAC	248	3,340.615	2,910.727	93.970	13,353.020
ELE	248	283.371	407.661	1.080	1,949.110

3.3 Modelling

Combined with the results of hausman test, it can be seen that the fixed effect model is better than the random effect model. The model settings are shown below:

$$INC = \beta_0 + \beta_1 \text{MAC} + \beta_2 Controls + \varepsilon_1 \quad (1)$$

$$MED = \beta_4 + \beta_3 MAC + \beta_5 Controls + \varepsilon_2 \quad (2)$$

$$INC = \beta_8 + \beta_6 \text{MAC} + \beta_7 \text{MED} + \beta_9 Controls + \varepsilon_3 \quad (3)$$

In the above equation, INC is the per capita disposable income of rural households; MAC is the level of agricultural mechanization; MED is the total sown area of crops; Controls is the control variable; ε is the random error; $\beta_0, \beta_4, \beta_8$ is the intercept of the model (1), model (2), and model (3), respectively; and $\beta_1, \beta_2, \beta_3, \beta_5, \beta_6, \beta_7, \beta_9$ are all coefficients. As show in figure 1.

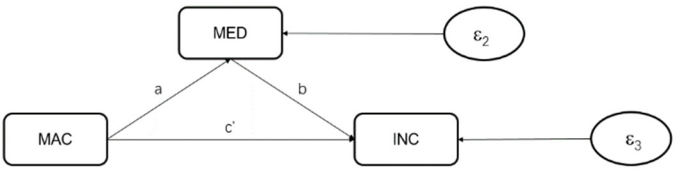

Fig. 1. Theory Framework

4 Empirical Analysis

4.1 Main Regression

Table 2 reports the results of the main regression. Column (1) reports the result without the control variables. The coefficient of MAC is 0.104, which is significant at 1%. And in columns (2)-(4), we gradually add control variables, namely, PES, FER, and POP. We found that the fit of the model gradually increases. And the coefficient of MAC remains significant in columns (2)-(4). The empirical results indicate that agricultural

mechanization can increase farmers' income. While initial investment in machinery can be significant, mechanization often leads to long-term cost savings.

Table 2. main regression

VARIABLES	(1) INC	(2) INC	(3) INC	(4) INC
MAC	0.104***	0.064**	0.074***	0.087***
	(0.039)	(0.025)	(0.027)	(0.027)
PES		0.804***	0.797***	0.670***
		(0.047)	(0.047)	(0.069)
FER			-0.048	-0.078
			(0.052)	(0.052)
POP				0.373**
				(0.149)
Constant	-0.888***	-0.666***	-0.665***	-0.691***
	(0.011)	(0.015)	(0.015)	(0.018)
Year FE	√	√	√	√
Province FE	√	√	√	√
Observations	248	248	248	248
R-squared	0.990	0.996	0.996	0.996
Number of id	31	31	31	31

4.2 Mediating Model

Columns (1) - (2) report the mediating effect test of crop sown area. The coefficient of MAC in column (1) is 0.094, which is significant at 1% level, indicating that agricultural mechanization will promote farmers to increase crop sown area. The coefficient of ARE in column (2) is 0.161, which is significant at the 1% level, indicating that the increase of crop sown area will significantly increase farmers' income. This suggests that ARE plays a significant mediating role. This is mainly due to: (1) The increase in the sown area of crops can directly expand the scale of agricultural production, thereby increasing the household income of farmers. (2) The increase in the sown area of crops will also prompt farmers to adjust the planting structure and increase the planting proportion of cash crops.

Columns (3) - (4) report the test of the mediating effect of electrification. The coefficient of MAC in column (3) is 0.324, which is significant at the 10% level, indicating that agricultural mechanization will promote the construction of agricultural electrification. The coefficient of ELE in column (4) is 0.023, which is significant at the 5% level, indicating that the development of agricultural electrification can promote farmers' income. This suggests that ELE plays a significant mediating role. This is mainly due to: (1) Agricultural electrification realizes the automation and intelligence of agricultural production through the introduction of advanced electrification equipment and

systems. (2) Agricultural electrification can reduce energy consumption and labor costs in the process of agricultural production. As show in table 3.

Table 3. mediating effect regression

VARIABLES	(1) ARE	(2) INC	(3) ELE	(4) INC
ARE		0.161***		
		(0.057)		
ELE				0.023**
				(0.010)
MAC	0.094***	0.072***	0.324*	0.080***
	(0.033)	(0.027)	(0.188)	(0.027)
PES	-0.069	0.681***	1.152**	0.644***
	(0.083)	(0.068)	(0.473)	(0.069)
FER	0.659***	-0.184***	0.566	-0.091*
	(0.063)	(0.064)	(0.360)	(0.052)
POP	0.341*	0.318**	-0.644	0.388***
	(0.180)	(0.148)	(1.022)	(0.148)
Constant	-0.029	-0.687***	0.193	-0.696***
	(0.021)	(0.018)	(0.122)	(0.018)
Year FE	√	√	√	√
Province FE	√	√	√	√
Observations	248	248	248	248
R-squared	0.480	0.996	0.110	0.996
Number of id	31	31	31	31

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5 Conclusions

The results show that agricultural mechanization can directly promote the increase of farmers' income significantly; agricultural mechanization can affect the increase of farmers' income by increasing the sown area of crops and promoting the construction of agricultural electrification. Based on the conclusions, we can draw the following policy recommendations:

As for enhancing agricultural mechanization, the government can establish dedicated funds to subsidize farmers' acquisition of agricultural mechanization equipment, thereby reducing the economic burden and encouraging the widespread adoption of advanced machinery. Regarding the assurance of farmers' sown area, it's crucial to improve land laws and regulations, including clearly defining boundaries for cultivated land protection and implementing strict measures to prevent non-agricultural land oc-

cupation. When promoting the construction of agricultural electrification, the government should increase investment in agricultural electrification projects, supporting research, development, and promotion of electrification equipment and systems.

The implementation of the above policy recommendations can effectively promote agricultural mechanization, ensure farmers' sown area, and increase electrification. This comprehensive approach fosters the process of agricultural modernization, ultimately leading to improvements in farmers' income levels and quality of life.

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