Article

Can Government-organized Training in the Agricultural Industry Promote Sustainable Increases in Smallholder Farmer Income? — Evidence from rural household survey data in Shandong Province, China

Yunxing Sun[1], Yifeng Zhang[2,]*

[1] School of Economics and Management; Yantai University；Yantai, China.

[2] School of Economics and Management; Nanjing Forestry University；Nanjing, China.

*Correspondence: yifzhang@njfu.edu.cn；Tel:86-25-8547-7373.

Foundation item: National Social Science Foundation of China (18BJY142).

Abstract: This article explores the impact of farmers' vocational training on their income. Survey data concerning agricultural product quality and agricultural product sales were collected by the research team in Yantai City, China. An endogenous transformation regression model (ESR) was then used to analyze the impact of training on farmers' family income, and the income mechanism was further tested. The results from the empirical analysis suggest that (1) Participating in training can significantly increase farmers' income; (2) Farmers who pay more attention to the quality of their agricultural products during the production process are more likely to see their incomes increase after participating in the training.

Keywords: Smallholder farmer; Vocational training; Income; Endogenous transformation regression model; Moderating effect

1. Introduction

An important part of China's rural revitalization strategy is to provide farmers with vocational training, a policy expected to help improve China's agricultural quality and competitiveness. In 2012, the official document issued by the CPC Central Committee and the State Council entitled "Several Opinions on Accelerating the Innovation of Agricultural Science and Technology and Continuously Enhancing the Supply and Guarantee Ability of Agricultural Products" suggested that, in support of this proposed revitalization strategy, China "will vigorously cultivate a new type of professional farmer." At present, the Central

Committee has formed and is leading a farmer vocational training system, mainly operating at the county level agricultural broadcasting and television school. This is also a national project that has been continuously carried out every year for farmers' vocational training since 2012 and has special funding support supported by local government. However, with the improvement of the external economies of scale (Go to the city to work for higher returns), the ways in which farmers can increase their income have become more diversified. This expansion of opportunity has also deployed affected the vocational training of farmers organized by the government, the focus of peasant work is to work outside, not agricultural production. Faced with such a dilemma, the central government still emphasizes the importance of vocational training for farmers, the purpose is to increase the income of farmers whose main source of income is agricultural production(Shoaib et al., 2019). Following previous research, this article attributes the factors affecting farmers' vocational training to the following four aspects: farmers' survival and development(Yuko et al., 2018), environmental protection and ecosystem restoration(Finbarr & Enoka, 2020; JIA et al., 2013), improved production technology(Pan et al., 2017), and agricultural policies(Kari & Gro, 2018; Pan et al., 2017).

In the research affecting farmers' vocational training, the research area of survival and development is mainly concentrated in Southeast Asia and sub-Saharan Africa(Yuko et al., 2018). The results show that natural and market risks pose the most significant risk to farmers' livelihoods in agricultural production. To address these challenges, most farmers choose to make adjustments to their crop variety, water and fertilizer management, agricultural finance, and agrotechnical support(Kuang et al., 2020). The vocational training in question is blended with actual farm production and mainly involves improving basic agricultural knowledge, guiding farmers to introduce pesticides and fertilizers into agricultural production to ensure basic survival. In comparison to complex training methods, the methods used are both simpler and more easily accepted by farmers(Ibrahim L. Kadigi, 2020). In many underdeveloped areas, FFS (Farmer field schools) are used as an important way to improve agriculture. They can help farmers adjust agricultural practices and livelihood situation to local changing development circumstances (Such as some small natural disasters)(Henk et al., 2020). Providing expert teaching at FFS requires a lot of manpower and resources, a necessary condition that can be impossible to meet in many areas. However, research has shown significant indirect benefits arising from farmers who have been trained by FFS, who disseminate their new knowledge, for instance, by teaching other farmers(Kazushi et al., 2019). In addition, farmer training needs to be tailored to reflect local conditions. In many places, for example, crop yields of rice and wheat are very low. In this case, the training may play a limited role, though diversification of crop varieties would be a more appropriate way to resolve this problem(Md et al., 2020).

In the research affecting farmers' vocational training, Environmental protection and ecological restoration are becoming more and more important in China, and related training is gradually increasing. The purpose is to promote the sustainable development of agriculture and reduce the damage of environmental pollution to agricultural production(Hashimi et al., 2020). China has solved the problem of food through the household contract responsibility system for land production (This system has greatly stimulated farmers' enthusiasm for production, but because Chinese farmers generally own very little land, it is necessary to increase the input of production materials on limited land to increase production). However, over the years, excessive input of pesticides, fertilizers, and other chemicals has also led to heavy metal pollution and compaction of the land. As the economy has developed, people have begun expecting a higher quality of the agricultural products they purchase. The excessive use of pesticides and fertilizers, however, increases the toxicity of these very agricultural products. By training farmers to understand the harm caused by excessive use of chemical fertilizers, pesticides, and other chemicals, and to consciously reduce their use(Dan et al., 2017), would significantly contribute to improving the ecological environment and, as a consequence, the quality of agricultural products. In severely polluted areas, it has been found that farmers tend

to have a higher acceptance of training and a more proactive attitude to implementing the lessons(Zhangyifeng, 2020), and so have found that participating in the training is beneficial to their own interests(Zhenning et al., 2020). In areas where pollution is not serious, however, a different set of methods and ideas are more relevant. For example, we advocate green production(The kind of production is to save energy, reduce consumption and reduce pollution), introducing high-quality buyers(they can offer Product classification acquisition and cause producer can focus on quality of agri-product) and improving the crop yield per unit area; the research also shows that joining some agricultural organizations can be beneficial to the realization of green production(Mingyue et al., 2020).

Research about improving agricultural production technology mainly appears in Europe, where farmers tend to have more land, and it makes more sense for them to introduce new crop varieties and improve their technology. They have more funding and land to experiment with new technologies and new varieties and to learn from their experiences in a lower risk environment.

In Europe, the improvement of technology, mainly in the field of agricultural machinery, improves the safety of agricultural production. Through training, the safety of agricultural production can likewise be improved. In China, technical training mainly follows a small and refined route, which is different from the production of field crops that rely on machinery. It requires a lot of labor time to grow cash crops, but the gains are also considerable.

In terms of agricultural policies, it has been found that, although the current vocational training for farmers has achieved results, there is still significant room for improvement. The current problems include the mismatch between career development ability (Ability to improve the quality of agricultural products) and modern agricultural development needs, the lack of professional development planning awareness, and the weak initiative awareness of self-improvement(Lamin et al., 2019; Ping et al., 2019). Training has different effects on different age groups, with current research showing that the positive impact is greater on young people(Balezentis et al., 2019). Though there may be many problems, results from empirical studies show that vocational training plays an irreplaceable role in improving skills and increasing farmers' incomes(Julia & Stéphane, 2018).

This paper finds that existing research has not found adequate solutions to the following problems: (1) Finding the most effective ways to train farmers; (2) Determining whether farmers participate actively or passively in the training; (3) Specifying the factors affecting farmers' participation in the training; and (4) Determining the income differences between trained and untrained farmers. This paper focuses on the third and fourth issues.

The contributions of this article include the following: First, from the perspective of innovation, this paper starts by analyzing the factors affecting farmers' participation in vocational education and training. Second, we studied the factors affecting the incomes of farmers who participated in the training and those who did not. Third, the results of this paper suggest what kind of vocational training is more suitable for smallholder farmers, and make a timely correction to deviations in the farmer vocational training system, which is beneficial to improving the government's ability to offer farmers vocational training and the overall effect of the training itself.

2. Mechanism analysis and model setting

2.1 Analysis on the influence mechanism of smallholder farmer participation in training on household income

In theory, farmers participating in vocational training will improve the quality of their

produce and increase their own proprietary assets(Yang et al., 2020). In agricultural production, farmers who participate in the training will have more opportunities to increase their income than those who do not. However, we make the case in this paper that a farmer's participation in the training is first driven by the market; farmers need this training. Second, under the influence of village political pressure, farmers find a need to participate in training to complete the task (For example: unwritten tradition; rural politics).

Different sources of family income also have different effects on farmers' participation in training. Specifically, when agricultural income accounts for a relatively high proportion of the total family income, one can expect increases in income from agricultural activities to significantly improve quality of life. In these cases, farmers tend to be especially motivated to participate in training and apply their new knowledge to training-specific areas of agricultural production. When agricultural income accounts for a small part of the family's total income, however, farmers tend to be more passive members of the training. Regardless, whether a farmer actively (Or passively) participates in training has no substantial impact on the quality of their family's life.

Although most current studies show that vocational training for farmers has a positive impact, we find that such results in China need a more specific analysis. First, because China is a typical smallholder economy, every family owns a small amount of land; the amount of land in each family is essentially the same. Each family is encouraged to carefully manage its own small piece of land. For many farmers, the social value of this land is in fact greater than the economic value. Second, because China's economy is developing at such a high speed, the external economic environment has been significantly improved, most of the young and middle-aged people from rural areas have gone out to work (Leave the country to work in the city), so their household income is mainly derived from non-agricultural work. Third, as the agricultural portion of income decreases, the risk inherent to agricultural management and, therefore, uncertainty increases. Based on these stated reasons, this paper looks to answer some questions about the theoretical basis of increasing farmers' income through vocational training in China. In this case, vocational training alone is far from enough, so a series of supporting measures, such as on-site guidance and financial support, are needed to achieve the intended results. This system of training and support, we find, is better organized through agricultural organizations.

2.2 Model setting of the influence of training on smallholder farmer household income

1. Reference model. Participatory and non-participatory training represent a typical binary choice model. As a rational broker, farmers' participation or non-participation in training is the result of weighing advantages and disadvantages and maximizing their own interests. Assuming that the potential income from farmer i training is A_{ia}^* and the potential income for farmers who did not participate in the training is A_{in}^*, then the conditions for farmers to choose to participate are $A_{ia}^* - A_{in}^* = A_i^* > 0$. In other words, they will participate if the income earned by participating farmers is greater than that obtained by farmers who are not. A_i^* is a latent variable that cannot be directly observed, but it can be represented by a set of observable variables. From the above, the decision-making model of whether farmers participate in training can be expressed as

$$A_i = \begin{cases} 1, A_i^* > 0 \\ 0, A_i^* \leq 0 \end{cases}. \quad (1)$$

In formula (1), A_i is the decision of whether farmers should participate in the training, $A_i = 1$ indicates that the farmer participated in the training (Referred to as a "training farmer"),

and $A = 0$ indicates that farmers have not participated in the training (Called "untrained farmers"). In this paper, the following model is constructed to evaluate the impact of training on farmers' income:

$$Y_i = \beta' X_i + \gamma' A_i + \varepsilon_i. \quad (2)$$

In formula (2), Y_i represents the farmers' income level. X_i refers to the individual's characteristics, family characteristics, production characteristics, sales characteristics, and other external characteristic factors that affect the income level of farmers. β' and γ' are the coefficients to be estimated, and ε_i is the random error term. If farmers are randomly assigned to the training group and the non-training group, then parameter γ' in formula (2) can accurately quantify the impact of farmers' participation in training on their income. However, the decision variable A_i is not an exogenous variable because the choice to participate in the training is a self-selection, and while it is based on an analysis of expected income, there are some unobservable factors that affect the decision to participate in the training. These factors include the farmers' personal preferences, village politics, the external economic environment, available free time, amongst a number of others. Therefore, the sample is going to be self-selecting. After considering the endogeneity of selective bias and missing variables, we decided to use the endogenous transformation model (ESR) proposed by Maddala (G., 1996) to analyze the impact of training on income. This approach has several advantages: First, the influence of observable factors and unobtainable factors can be considered simultaneously when solving the problem of self-selection and endogenous in making the decision to participate in training. Second, the income influencing factor equation of outsourcers can be estimated to observe the differential influence of each factor. Third, the method of estimating the maximum likelihood of full information can deal with the problem of effective information omission. Fourth, counterfactual analysis can also be implemented.

The ESR model generally contains two stages of estimation: In the first stage, Probit or Logit models are used to estimate the selection equation of a farmer's participation in the training. In the second stage, a model for determining the farmers' income level was established to estimate the changes in the income level caused by farmers' participation in training. Specifically, the ESR model estimates the following three equations simultaneously.

Behavior equation (Whether to participate in training):

$$A_i = \delta' Z_i + K' I_i + \mu_i. \quad (3)$$

Result equation 1 (Income level equation of farmers who participated in the training):

$$Y_{ia} = \beta_a' X_{ia} + \varepsilon_{ia}. \quad (3a)$$

Result equation 2 (Treatment, income level equation of farmers without training):

$$Y_{in} = \beta_n' X_{in} + \varepsilon_{in}. \quad (3b)$$

In formula (3), A_i represents the binary choice variable of whether farmers participate in training. Z_i represents all kinds of factors that affect whether farmers participate in training; μ_i is the error term; I_i is the vector of the instrumental variables, to ensure the identification of the ESR models. In this paper, we selected the presence of unmarried children in the family as the instrumental variable based on two main considerations: first, having unmarried children does not have a direct impact on whether to participate in training, and second, there was no direct correlation between the presence or absence of unmarried children and income. In formulas (3a) and (3b), Y_{ia} and Y_{in} represent the welfare levels of two sample groups of farmers who participate in training and those who do not, respectively; X_{ia} and X_{in} are a

series of factors affecting farmers' income; and ε_{ia} and ε_{in} are the error terms of the resulting equation.

2.3 Evaluation of the impact of training on income

The assessment of the treatment effects of training is considered. A natural approach would be to compare the future income of the experimental group directly with that of the control group. However, it often appears that farmers who participate in training earn less than those who do not. Does this mean that training is harmful? The training is self-selected, and those who did not participate in the training are mostly those who have been working outside the city for years. They mainly earn non-agricultural income, which is usually relatively high, so they do not need to participate in the training. The farmers that attend training give more priority to agricultural production, as they cannot go out because of a number of work-related reasons. Their income from agricultural production is comparatively low.

The estimation results from the ESR model show the differential effects of various factors on the income levels of trained and untrained farmers. However, due to the above reasons, it is necessary to use the estimated coefficients of the ESR model and further apply the counterfactual analysis framework. The average treatment effect of training on farmers' income was estimated by comparing the expected income levels of trained farmers and untrained farmers in real and counterfactual scenarios.

Trained farmers' expected income (Treatment group):

$$E[Y_{ia}|A_i = 1] = \beta_a' X_{ia} + \sigma_{\mu a}\lambda_{ia}. \tag{4}$$

Untrained farmers' expected income (Control group):

$$E[Y_{in}|A_i = 0] = \beta_n' X_{in} + \sigma_{\mu n}\lambda_{in}. \tag{5}$$

Expected income of trained farmers not participating in training:

$$E[Y_{in}|A_i = 1] = \beta_n' X_{ia} + \sigma_{\mu n}\lambda_{ia}. \tag{6}$$

Expected income of untrained farmers participating in training:

$$E[Y_{ia}|A_i = 0] = \beta_a' X_{in} + \sigma_{\mu a}\lambda_{in}. \tag{7}$$

The average treatment effect of the income status of farmers who actually participated in the training can be seen from the above, and the average treatment effect on the treated (ATT) can be expressed as the difference between equation (4) and equation (6):

$$\begin{aligned} ATT_i &= E[Y_{ia}|A_i = 1] - E[Y_{in}|A_i = 1] \\ &= (\beta_a' - \beta_n')X_{ia} + (\sigma_{\mu a} - \sigma_{\mu n})\lambda_{ia} \quad . \end{aligned} \tag{8}$$

The same can be said for the average treatment effect of farmers who did not participate in the training, the average treatment effect on the untreated (ATU) can be expressed as the difference between equation (5) and equation (7):

$$\begin{aligned} ATU_i &= E[Y_{in}|A_i = 0] - E[Y_{ia}|A_i = 0] \\ &= (\beta_n' - \beta_a')X_{in} + (\sigma_{\mu n} - \sigma_{\mu a})\lambda_{in} \quad . \end{aligned} \tag{9}$$

To sum up, this paper will use the average value of ATT_i and ATU_i to investigate the average treatment effect of training on farmers' income. Next, we analyze the factors affecting income through the adjustment effect model.

3 Data origins and descriptive analysis

3.1 Data origins

The data used in this paper are from the research group. The data code is SJ201902 (The team of Yifeng Zhang investigated the quality of agricultural products and e-commerce sales of agricultural products). The survey was conducted by the research team in Yantai during the busy agricultural period in autumn 2019. The content is divided into four modules, namely, farmers' personal information, characteristics of agricultural production, sales of agricultural products. The questionnaire mainly investigates the quality and e-commerce sales of agricultural products. The respondents are mainly middle-aged and young people in agricultural production and represent the current backbone of agricultural production. After screening the data and processing the missing value and error values, 552 samples were obtained.

3.2 Variable selection

1. Treatment variable. According to the model set in this paper, the regression analysis equation contains two variables, namely the decision of farmers to participate in the training and their income. For the decision to participate, scholars often use virtual variables for quantitative analysis. Based on the existing research, this paper adopts the same treatment method, that is, if the farmer has participated in any behavior such as employing new production safety techniques, diversified with new crop varieties, or improved the quality of their agricultural products in some way relevant to the training, the behavior is assigned a value of 1. Otherwise, the behavior is assigned a value of 0. Table 1 presents a histogram of farmer participation in the training; it can be seen that the proportion of farmers covered by training is very high. A total of 68.32% farmers participated in the training about pesticides, and 71.98% participated in the training concerning agricultural product quality. The overall proportion of the above training, in fact, reached as high as 75.88%.

2. Outcome variable. For the household income indicators, the previous studies mainly used consumption expenditure, annual household net income, per capita household net income, and other indicators(Jozelin & Chizu, 2019). Considering the availability and reliability of the data, we chose for this paper the family per capita annual income as the main indicator to evaluate participation in the training. In this paper, in order to more accurately reflect the real situation and reduce the errors in the survey process, the questionnaire sets the options of family income and number of family members, which reduces the difficulty of the survey. The average annual income of the farmers who participated in the training was 42,770 yuan, while the average annual income of the farmers who did not participate in the training was 32,060 yuan, yielding an average difference of 10,710 yuan, which was significant at the 1% confidence interval.

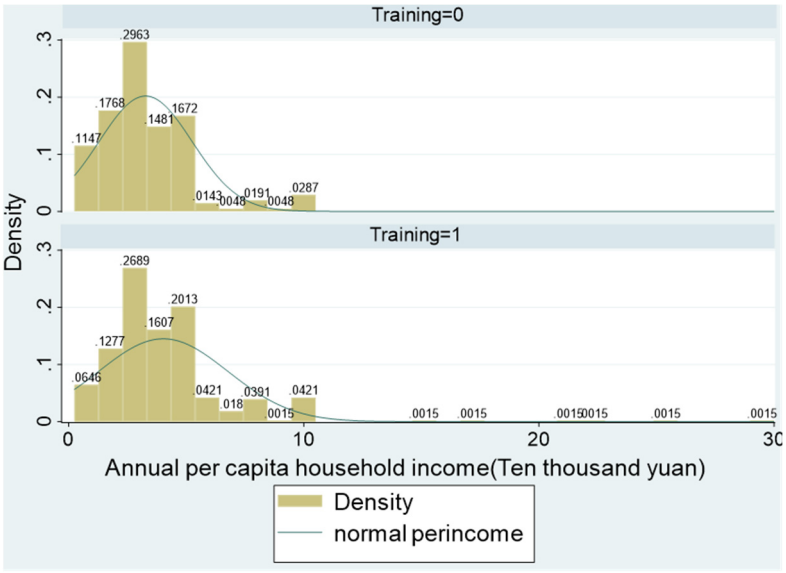

Figure 1. Histogram: Training participation and non-participation, against annual per capita income

3. Control variable. Previous studies often refer to gender as an important explanatory variable, but this paper finds in the survey that participation in vocational education training has a certain randomness; it is not necessarily the main decision-maker of the family. Based on previous research, a total of 21 items in 6 categories were determined, including personal characteristics, family characteristics, land characteristics, quality of agricultural products, agricultural production technology, and sales of agricultural products, and one instrumental variable was used as the explanatory variable. Personal characteristics include age and education; the characteristics of the family include the number of working age members, the proportion of agricultural income, returning home for farming, and serving as leading cadres, major agricultural products. The Chinese government promotes the circulation of rural land, and this paper takes the land characteristics as an important category, including the amount of land owned, whether the land is circulated, and the main source of land. As China's income level has improved, the problem of food and clothing has been basically solved. The quality of agricultural products is an important factor affecting agricultural income; growing agricultural products also used for household consumption is one of the most important aspects of the quality of agricultural products. This article focuses on the self-evaluation of quality, whether the farmed agricultural products are consumed by the family, edible agricultural products and to sell yourself whether there's a difference as a measure. Production technology in agriculture is also an important way to gauge the improvement of production efficiency and includes the introduction of new crop varieties, soil formula testing, and water-saving irrigation. The assessment of the sales link for agricultural products mainly comprises two variables: the first is whether there are buyers in the village who have high requirements for the quality of agricultural products, and the other is whether graded sales is adopted. To ensure the recognizability of the model, in this paper, the presence of unmarried children in the household was taken as the instrumental variable. The definition and descriptive statistical results of each variable are shown in Table 1.

Table 1. Variable definition and descriptive statistics

Varname	Variable description	No train	Train	mean-diff

Training	Income: Annual per capita income (10 thousand/year)	0.000	1.000	-1.000
Perincome	Decisions: Attended the training	3.206	4.277	-1.072***
Age	Personal: Age(years)	47.730	47.744	-0.015
Edu	The stage of education reached	2.385	2.449	-0.064
Labor	Family: labor force(people)	2.172	2.153	0.019
ProportionAgri	The proportion of agricultural income	3.811	3.702	0.109
Agrpro	Major agricultural products	1.730	1.835	-0.105
Worker	Whether to go out for work	0.238	0.284	-0.046
Lead	Is it a village leader	0.115	0.279	-0.164***
Land	Soil: Land quantity (acre yield)	17.721	19.036	-1.315
Landcir	Land transfer or not:	0.484	0.465	0.018
Lansuo	Land source	1.107	1.181	-0.075
Quality	Agricultural product quality self-evaluation	3.721	3.923	-0.202*
Procon	Do you eat your own produce	0.811	0.872	-0.061
Difference	Is there a difference between the quality of food consumed at home and sold out	0.320	0.274	0.045
Attention	Agricultural production focus	1.639	1.891	-0.251
Newproduct	Technology: Acceptance of new varieties	3.607	3.695	-0.089
Soiltesting	Soil testing formula	0.336	0.626	-0.290***
Savewater	Water-saving irrigation	0.484	0.591	-0.107
PCO	TongFang rule	0.648	0.767	-0.120*
Buyer	Sale: high standard purchaser	0.246	0.516	-0.270***
Hierarchical	Hierarchical sales	0.779	0.898	-0.119***
Married	Family: Whether the children are married or not	0.803	0.814	-0.011
Sample size	—	122	430	—

Note : *, ** and *** respectively represent the significance level of 10%, 5% and 1%

4. Analysis of causality between training and income

This article aims to verify the relationship between training and income, using causality equations for analysis. Table 3 shows that the impact of training on income in the basic regression equation is significant at a 5% confidence level; the estimated coefficient is positive. To test the robustness of the impact, we performed hundreds of sampling regressions, the results of which were consistent. It shows that training farmers will help increase their income levels. The influence relationship is explained below using ESR.

Table 2. Analysis of causality between training and average income

Varname	Perincome (reg)	Perincome (bootstrap reg)
Training	0.485**(2.388)	0.485**(2.267)
Age	-0.036**(-2.079)	-0.036**(-2.048)
Edu	0.119(0.671)	0.119(0.717)

Labol	-1.431***(-5.938)	-1.431***(-6.193)
ProportionAgri	0.029(0.306)	0.029(0.296)
Agrpro	1.003***(4.411)	1.003***(4.472)
Worker	0.155(0.575)	0.155(0.582)
Lead	0.679**(2.385)	0.679**(2.418)
Land	0.016*(1.809)	0.016(1.270)
Landcir	0.289(1.327)	0.289(1.366)
Lansuo	0.206(0.526)	0.206(0.520)
Quality	0.368**(2.585)	0.368**(2.416)
Procon	0.056(0.225)	0.056(0.219)
Difference	0.144(0.557)	0.144(0.573)
Attention	-0.180(-1.583)	-0.180(-1.466)
Newproduct	-0.019(-0.124)	-0.019(-0.122)
Soiltesting	0.498**(2.492)	0.498**(2.539)
Savewater	0.294(1.535)	0.294(1.512)
PCO	0.084(0.359)	0.084(0.346)
Buyer	0.156(0.665)	0.156(0.693)
Hierarchical	0.415(1.631)	0.415(1.625)
Married	-0.170(-0.613)	-0.170(-0.627)
_cons	3.443**(2.056)	3.443**(1.992)
N	552	552

Note : *, ** and *** respectively represent the significance level of 10%, 5% and 1%

5. Empirical results and analysis

Farmers' participation in training decision-making and the estimated results of the income impact model are shown in Table 3. The fourth column contains the estimated results of factors affecting farmers' participation in training decision-making, the second and third columns are the estimated results of factors affecting the income levels of trained and untrained farmers.

5.1 Model estimation for participation in the training decision

The estimated coefficient of the variable "ProportionAgri" (The proportion of agricultural income) was found to be negative and significant at the 5% confidence level. While this result is different from our usual understanding, it is also possible to see from another perspective: specifically the relationship between higher proportions of agricultural income and increased costs of agricultural production. In order to ensure their own interests, the farmers need to continuously learn new knowledge and introduce new methods in their production. The popular science training organized by the government cannot meet the personal needs of people with a higher proportion of agricultural income, which results in a lower proportion of groups with higher agricultural income who participated in training.

In terms of families, the estimated coefficient of the variable "lead" (Is it a village leader) is positive and significant at the 1% confidence level. The reason for this is inseparable from China's political system. Many trainings are treated as a political task to complete, among them,

village leaders must play their leading role (Village cadres are directly or indirectly under the leadership of the higher-level government). Moreover, as the elite class of the village, village cadres will inevitably receive more and different training in their work than other farmers.

In the land option, the estimated coefficient of the variable "lansuo" (Land source) is positive and significant at the 10% confidence level. China's farmland has identity attributes, farmers only have land use rights, and land is collectively owned by the village. In this case, in order to acquire more land, it can only be rented from other farmers. Farmers who rent land will invest more in production to ensure that the rented land can bring more benefits. These farmers will be more likely to participate in training, increase their own knowledge, and provide a possibility for increasing income.

In terms of the quality of agricultural products, the estimated coefficient of the variable "attention" (Agricultural production focus) is positive and significant at the 1% confidence level. Farmers who pay more attention to the quality and health of their agricultural products are more inclined to participate in the training, which is inseparable from the advanced ideas and concepts that training may bring to their practices.

In terms of agricultural production technology, the estimated coefficient of the variable "soiltesting" (Soil testing formula) is positive and significant at the 1% confidence level. Farmers who adopt soil testing techniques are more inclined to accept the impact of new technologies on agricultural production. Soil testing technology helps farmers refine their production and increase crop yields. It also helps reduce the need to use chemical fertilizers, and therefore reduces the cost of production.

In terms of sales, the estimated coefficient of the variable "buyer" (High standard purchaser) is positive and significant at the 1% confidence level. Although the high-standard purchases in the village have higher requirements for the quality of agricultural products, the income obtained per unit also increases significantly. With high-standard purchasers, farmers can find that improving the quality of agricultural products can get higher income. How to improve the quality of agricultural products, as a result, training can be used as a bridge to help farmers improve the quality of agricultural products, farmers are more willing to participate in training.

Table 3. Results of joint estimation of farmer's participation in training and farmer's income model

Variable	The income effect equation of training		Select to equation
	Training of farmers	No training	training or not
Age	-0.023(-1.024)	-0.090***(-3.194)	0.006(0.541)
Edu	0.094(0.404)	0.371(1.165)	-0.005(-0.040)
Labor	0.318(1.061)	0.641(1.401)	-0.063(-0.608)
ProportionAgri	-1.737***(-7.719)	-0.506**(-2.188)	-0.161**(-2.345)
Agrpro	0.354(1.278)	0.372(1.195)	0.190(1.259)
Worker	0.199(0.637)	-0.350(-1.012)	0.083(0.495)
Lead	0.032(0.243)	-0.038(-0.192)	0.576***(3.163)
Land	1.222***(3.627)	0.165(0.464)	0.001(0.258)
Landcir	0.136(0.441)	0.321(0.828)	-0.226(-1.590)
Lansuo	0.056(0.198)	0.853*(1.781)	0.399*(1.831)
Quality	0.546*(1.750)	0.887(1.528)	0.016(0.168)
Procon	0.020***(3.795)	0.010**(1.994)	0.227(1.264)
Difference	0.424(1.461)	-0.110(-0.328)	-0.224(-1.522)
attention	0.137(0.341)	-0.631(-1.113)	0.175**(2.425)

Soiltesting	0.303(1.524)	0.502**(2.520)	0.603***(4.304)
savewater	0.130(0.330)	-0.249(-0.596)	0.014(0.101)
PCO	-0.160(-0.472)	0.005(0.013)	0.124(0.827)
Buyer	0.255(0.849)	-0.345(-1.000)	0.564***(3.948)
Married	-0.252*(-1.821)	0.063(0.324)	0.113(0.653)
Newproduct	-	-	0.161(1.341)
Hierarchical	-	-	0.275(1.539)
_cons	4.414**(2.321)	6.712***(3.207)	-1.629*(-1.648)
lns1: cons	-	-	0.973***(26.498)
lns2: cons	-	-	0.498***(3.416)
Rho_1: cons	-	-	0.211(1.217)
Rho_2: cons	-	-	0.449(0.979)
N	552	552	552
			Prob > chi2=0.0000

Note : *, ** and *** respectively represent the significance level of 10%, 5% and 1%

5.2 Analysis of the estimation results of farmer income impact model

The selection variables in ESR are "new kind product" (Acceptance of new varieties) and "hierarchical" (hierarchical sales). These two variables have an influence on the treatment variable "training" but have no direct influence on the outcome variable "perincome." The entire model is statistically significant at 1%, indicating that the model is effective in its explanatory power. In this model, Rho_1 is positive, explain the farmer household that attends training if did not attend training, income can drop, training has a positive impact on farmers' income. Rho_2 is positive and close to zero, which indicates that the per capita income of farmers who have not participated in the training is higher than the counterfactual income(Michael & Zurab, 2004).

Personal characteristics such as the age of untrained farmers have a negative impact on income and are significant at the 1% confidence level. The older the farmer, the greater the negative impact on income. This is consistent with our usual expectations, but the model shows that the age of the trained farmers has no significant impact on income. However, in this model, the relationship between the trained farmer's age and income is uncertain.

The family variable ProportionAgri for the trained farmers is significant at the 1% confidence level, and for untrained farmers, the estimated coefficient for ProportionAgri is significant at the 5% confidence level; all are negative. This situation appears to be closely related to the improvement of the farmer's external economic environment and the decline of agricultural comparative income. This situation can also be described by a social phenomenon: at present, the main population living in rural China is sometimes referred to as the "386199 troop," meaning that most of the young and middle-aged men in the village go out to work, and the people who stay in the village are mainly women, children, and the elderly(Yuzhu et al., 2020).

In land options, the estimated coefficient for trained farmers is positive and significant at the 1% confidence level in the variable "Land" (land quantity). The results of the model show that participation in training by farmers who plant more land can effectively increase their income. This shows that farmers with more land should participate in the training. Training can broaden their knowledge base and familiarize them with the use new technologies and

varieties to improve the quality and efficiency of their production. The gains from participating in the training far outweigh the losses, essentially meaning that participating in the training is beneficial to them.

In terms of the quality of agricultural products, for trained farmers, the coefficient of the variable "procon" (Do you eat your own produce) is positive and significant at the 1% confidence level; for untrained farmers, the coefficient of "procon" is positive and significant at 5% confidence. The variable assessing if farmers eat their own produce shows that the quality of the agricultural products grown is better than for other farmers who do not. The cultivated agricultural products are of good quality and can be sold at higher prices and allow the farmers to earn higher incomes. Farmers that do not eat their own produce do not enjoy this benefit, which has a negative impact on their income, a finding consistent with our usual expectations.

In terms of agricultural production technology, for untrained farmers, the coefficient of the variable "soiltesting" (Soil testing formula) is positive and significant at the 5% confidence level. Soil testing technology helps to reduce the need to use chemical fertilizers and improve the effect of those already in use. It also helps reduce the cost of agricultural production and increase crop yield, and has a positive impact on their income. However, the impact of the use of soil testing technology on the income of training farmers is not certain.

In order to more clearly reflect the impact of training on farmers' family income, this article introduces the probability density distribution of two groups of farmer family income and a corresponding counterfactual income (Figure 2). The graph on the left is the income probability density graph of "training income" and "counterfactual income." It can be seen that if farmers do not participate in the training, their income probability density distribution curve will shift to the left, indicating that farmers' participation in training can effectively improve their income levels. The graph on the right is the income probability density graph of "untrained income" and "counterfactual income." It can be seen that, if farmers participate in the training, their income probability density distribution curve will shift to the right, indicating that the participation of farmers who have not previously participated in the training will also effectively increase their income level. Therefore, a basic policy inspiration is to encourage farmers to participate in vocational training.

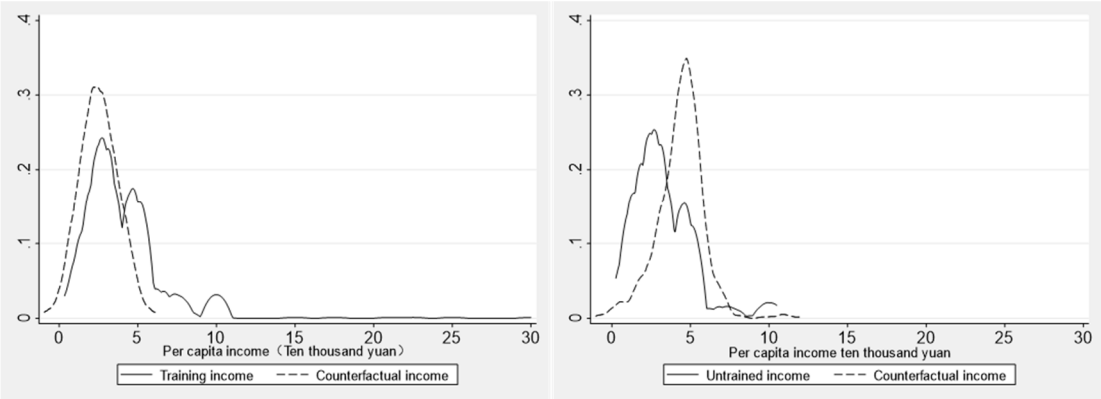

Figure 2. The probability density of household income in both cases

6. Regulation effect analysis

6.1 Regulation effect measurement equation

In order to further analyze the data, we find the variables that have a moderating effect on income during training and establish a model for this moderating effect (10). In this model, the resulting variable "perincome" is standardized to generate the variable "stdperincome." The first part, b_0, is the error term, and the second part "person" represents personal characteristics, including age, age square, and education level. The third parts "training" and "attention" are the main variables, and the fourth part is the interactive variable formed by "training*attention":

$$Y_{tj} = b_0 + b_1 person + b_2 training + b_3 attention + b_4 (training * attention). \quad (10)$$

Table 4. Moderating effect estimation

Varname	Stdperincome
Age	0.041(0.839)
Age2	-0.001(-1.231)
Edu	0.156**(2.394)
Worker	0.139(1.532)
Labor	-0.473***(-7.259)
Lead	0.304***(3.275)
Training	-0.169(-0.840)
attention	0.102(1.019)
Training- YES *Attention-Yield	-
Training- YES * Attention-Quality	0.499**(2.266)
Training- YES * Attention-Health	0.452**(2.051)
_cons	-0.120(-0.104)
N	552

Note : *, ** and *** respectively represent the significance level of 10%, 5% and 1%

6.2 Analysis of regulation effect results

The regulation effect results show that the coefficient of the interaction terms "Training-YES*Attention-Quality" and "Training-YES*Attention-Health" is positive and significant at the 5% statistical level (Table 4). As can be seen from Figure 3, farmers who pay attention to yield in the production process and participate in the training see a greater impact on their income than non-participating farmers. For those who pay attention to quality in the production process after participating in training, the impact on their income tends to increase rapidly. For farmers who pay attention to health in the production process, regardless of whether they participate in training, the impact on their income is lower than that of their attention to quality. This shows that the current thinking of this group of farmers is advanced, the market has not been widely recognized, or the market does not have the corresponding purchasing power. This also shows that improving farmers' knowledge about agricultural production is also one direction to ensure success from future efforts.

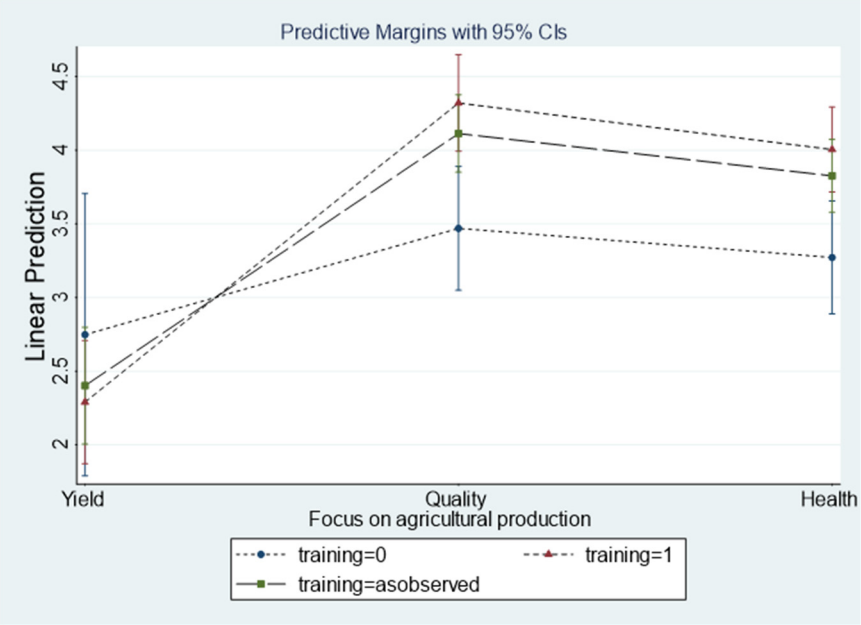

Figure 3. Moderating effect

7. Results

To develop agriculture and implement the rural revitalization strategy, need talent support. In order to verify the effectiveness of the current mainstream farmer vocational training organized by the Chinese government, this paper conducted an independent questionnaire survey on the influencing factors of participation in training and the impact of training on income. This article uses survey data from 552 farmers in Yantai, China, and adopted ESR to analyze the impact of training on farmers' income under the counterfactual framework. Then, using the moderating effect model, we analyzed which type of farmers are more effectively able to transform their practice after participating in the training. The results of our research show that participating in vocational training can increase the income level of a farmer's family. Among the farmers participating in the training, farmers who paid more attention afterward to the production quality of their agricultural products were more likely to see their incomes increase. We found the variable "attention" to have a significant regulating effect. In order to make better use of the effects of farmers' vocational training, therefore, this article suggests that vocational training for farmers should realize the diversification of training forms and training subjects. Based on the empirical results, this article makes the following recommendations.

1. Government training on its own is missing something important; that is, it is difficult to integrate with the market. The government can therefore also make efforts to introduce high-standard buyers and encourage farmers to transform and upgrade through the market, so that they can increase their profits and put their learned skills to use in a timely manner.

2. The specific training content should be given to family farms, cooperatives, and other types of agricultural operators. This category of subjects is closer and more sensitive to the market. Farmers can also see the demonstration effect of agricultural production and operation subjects. They have certain expected benefits for learning skills and are more motivated to

actively learn.

3. Thoughtful farmers are more likely to benefit from training, and they should be paid attention to when choosing training objectives. This part of the training group is likely to be the backbone of future agricultural development and has the potential to develop into "professional farmers." The training of these farmers is more conducive to the application of new agricultural technologies and the improvement of the quality of their agricultural products.

Acknowledgments：We thank LetPub (www.letpub.com) for its linguistic assistance during the preparation of this manuscript.

Author Contributions: Conceptualization, YXS and YFZ; data curation, YXS and YFZ; methodology, YXS and YFZ; formal analysis, YXS and YFZ; writing—original draft, YXS and YFZ; project administration, YFZ; supervision, YFZ; validation, YXS and YFZ; writing—review and editing, YXS and YFZ. All authors have read and agreed to the published version of the manuscript.

Funding: National Social Science Foundation of China (18BJY142).

Conflicts of Interest: The authors declare no conflict of interest.

References:

Balezentis, T., Ribasauskiene, E., Morkunas, M., Volkov, A., Streimikiene, D., & Toma, P. (2019). Young farmersa?? support under the Common Agricultural Policy and sustainability of rural regions: Evidence from Lithuania. *LAND USE POLICY*, 94 http://doi.org/https://doi.org/10.1016/j.landusepol.2020.104542

Dan, P., Fanbin, K., Ning, Z., & Ruiyao, Y. (2017). Knowledge training and the change of fertilizer use intensity: Evidence from wheat farmers in China. *JOURNAL OF ENVIRONMENTAL MANAGEMENT*, 197 http://doi.org/https://doi.org/10.1016/j.jenvman.2017.03.069

Finbarr, G. H., & Enoka, P. K. (2020). Farming on the edge: Farmer training to mitigate human-wildlife conflict at an agricultural frontier in south Sri Lanka. *CROP PROTECTION*, 127 http://doi.org/https://doi.org/10.1016/j.cropro.2019.104981

G., S. M. (1996). 19 Applications of limited dependent variable models in finance. *Handbook of Statistics*, 14 http://doi.org/https：//doi.org/10.1016/S0169-7161（96）14021-9

Hashimi, R., Matsuura, E., & Komatsuzaki, M. (2020). Effects of Cultivating Rice and Wheat with and without Organic Fertilizer Application on Greenhouse Gas Emissions and Soil Quality in Khost, Afghanistan. *Sustainability*, 12(16), 6508. http://doi.org/10.3390/su12166508

Henk, V. D. B., Jan, W. K., Marcel, D., & Marjon, F. (2020). Is the farmer field school still relevant? Case studies from Malawi and Indonesia. *NJAS - Wageningen Journal of Life Sciences*, 92 http://doi.org/https://doi.org/10.1016/j.worlddev.2017.12.013

Ibrahim L. Kadigi, K. D. M. (2020). An Economic Comparison between Alternative Rice Farming Systems in Tanzania Using a Monte Carlo Simulation Approach. *Sustainability* http://doi.org/10.3390/su12166528

JIA, X., HUANG, J., XIANG, C., HOU, L., ZHANG, F., CHEN, X., CUI, Z., & Holger, B. (2013). Farmer's Adoption of Improved Nitrogen Management Strategies in Maize Production in China: an Experimental Knowledge Training. *Journal of Integrative Agriculture*, 12(02), 364-373. http://doi.org/https://doi.org/10.1016/S2095-3119(13)60237-3

Jozelin, M. S. A., & Chizu, S. (2019). Enacting peasant moral community economies for sustainable

livelihoods: A case of women-led cooperatives in rural Mexico. *WORLD DEVELOPMENT*, 115 http://doi.org/https://doi.org/10.1016/j.worlddev.2018.11.005

Julia, M. L. L., & Stéphane, M. M. (2018). Learning communities and new farmer knowledge in Canada. *GEOFORUM*, 96 http://doi.org/https://doi.org/10.1016/j.geoforum.2018.07.022

Kari, A. H., & Gro, F. (2018). Making occupational health and safety training relevant for farmers: Evaluation of an introductory course in occupational health and safety in Norway. *SAFETY SCIENCE*, 109 http://doi.org/https://doi.org/10.1016/j.ssci.2018.05.020

Kazushi, T., Yukichi, M., & Keijiro, O. (2019). Learning from experts and peer farmers about rice production: Experimental evidence from Cote d ' Ivoire. *WORLD DEVELOPMENT*, 122 http://doi.org/https://doi.org/10.1016/j.worlddev.2019.05.004

Kuang, F., Jin, J., He, R., Ning, J., & Wan, X. (2020). Farmers' livelihood risks, livelihood assets and adaptation strategies in Rugao City, China. *JOURNAL OF ENVIRONMENTAL MANAGEMENT*, 264

Lamin, I. K., Peter, D., Baqir, L., & Erwin, W. (2019). Unpacking the drivers behind the use of the Agricultural Innovation Systems (AIS) approach: The case of rice research and extension professionals in Sierra Leone. *AGRICULTURAL SYSTEMS*, 176 http://doi.org/https://doi.org/10.1016/j.agsy.2019.102673

Md, A. I., Nigel, W., Richard, K., Md, N. A., & Lisa, L. D. B. (2020). The importance of farmers' perceptions of salinity and adaptation strategies for ensuring food security: Evidence from the coastal rice growing areas of Bangladesh. *SCIENCE OF THE TOTAL ENVIRONMENT*, 727 http://doi.org/https://doi.org/10.1016/j.scitotenv.2020.138674

Michael, L., & Zurab, S. (2004). Maximum Likelihood Estimation of Endogenous Switching Regression Models. *The Stata Journal*, 4(3) http://doi.org/https://doi.org/10.1016/j.jeconom.2007.10.002

Mingyue, L., Jingjing, W., Pujie, Z., Kai, C., & Lianbei, W. (2020). Factors affecting the willingness of agricultural green production from the perspective of farmers' perceptions. *SCIENCE OF THE TOTAL ENVIRONMENT*, 738 http://doi.org/https://doi.org/10.1016/j.scitotenv.2020.140289

Pan, D., Kong, F., Zhang, N., & Ying, R. (2017). Knowledge training and the change of fertilizer use intensity: Evidence from wheat farmers in China. *JOURNAL OF ENVIRONMENTAL MANAGEMENT*, 197 http://doi.org/https://doi.org/10.1016/j.jenvman.2017.03.069

Ping, Y., Xiao-rui, Z., & Shouzhen, Z. (2019). Extenics based Innovation of New Professional Farmer Cultivation under the Strategy of Rural Vitalization. *Procedia Computer Science*, 162 http://doi.org/https://doi.org/10.1016/j.procs.2019.11.268

Shoaib, A., Gu-cheng, L. I., Adnan, N., Amar, R., Raza, U., Muhammad, F., Muhammad, A. U. R. N., & Muhammad, H. R. (2019). Maize production under risk: The simultaneous adoption of off-farm income diversification and agricultural credit to manage risk. *Journal of Integrative Agriculture*, 18(2) http://doi.org/https：//doi.org/10.1016/S2095-3119（18）61968-9

Yang, G., Duanyang, Z., Lili, Y., & Haoran, Y. (2020). Influence of a new agricultural technology extension mode on farmers' technology adoption behavior in China. *JOURNAL OF RURAL STUDIES*, 76 http://doi.org/https://doi.org/10.1016/j.jrurstud.2020.04.016

Yuko, N., Takuji, W. T., Takeshi, A., & Valerien, O. P. (2018). Is farmer-to-farmer extension effective? The impact of training on technology adoption and rice farming productivity in Tanzania. *WORLD DEVELOPMENT*, 105 http://doi.org/https://doi.org/10.1016/j.worlddev.2017.12.013

Yuzhu, Z., Yansui, L., Yuanyuan, Y., Michael, W., & Francesca, F. (2020). Rural decline or restructuring? Implications for sustainability transitions in rural China. *LAND USE POLICY*, 94

http://doi.org/https://doi.org/10.1016/j.landusepol.2020.104531

Zhenning, Y., Lan, Y., & Mengya, W. (2020). Farmers' attitude towards the policy of remediation during fallow in soil fertility declining and heavy metal polluted area of China. *LAND USE POLICY*, 97 http://doi.org/https://doi.org/10.1016/j.landusepol.2020.104741

Zhang Yifeng; Sun Yunxing New-type professional farmer entrepreneurship and the integrated development of agricultural industry: Taking the entrepreneurial development of Jinfeng Farmer Professional Cooperative in Wenfeng Road Street, Laizhou City, Shandong Province as an example. Journal of Nanjing Forestry University (Humanities and Social Sciences Edition) 2020, 20, 93-102.