**The impact of capital endowment and ecological cognition on farmers' adoption of the environment-friendly technology-A case of Shandong Province, China**

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**Abstract**

Capital endowment and ecological cognition have a significant impact on fostering farmer's adoption of environmentally friendly technology. It could be critical for a country like China, where technological advancement is growing at a staggering speed. The government is also changing the policies frequently to cope with ever-increasing challenges like pollution control, maintaining ecological balance, and substantially supporting agricultural sectors. Based on the survey data of 471 apple growers in 9 counties (cities and districts) of Shandong Province, the study has been designed to explore the impact of capital endowment, ecological cognition, and compensation policies on adopting environmentally friendly technology among fruit farmers. The results showed that 52.02% of fruit farmers adopted two environmentally friendly technologies, and 23.99% of fruit farmers adopted three forms of environmentally friendly technologies. At the same time, we have traced that the capital endowment, planting scale, family income, and technical specialization of fruit farmers significantly impact adopting environmentally friendly technology. The study also revealed that understanding the ecological compensation policy has a significant positive effect on adopting environmentally friendly technology. In addition, ecological compensation policy has a specific regulatory effect on fruit farmers' capital endowment and ecological cognition. Based on this, this paper puts forward policy suggestions; the government should take proper initiative to promote rural farmers to adopt environmental behavior from the aspects of improving the training content of science and technology, improving the cognitive level of farmers on green development, and increasing the ecological compensation for fostering green development.

**Keywords:** Capital endowment; ecological cognition; environment-friendly technology; adoption level; hackman model.

1. **Introduction**

China has grown relatively swift development in agricultural sectors by employing intense inputs within the last decade. It has a long history of given priorities for intensifying agriculture production to support the humongous population with the limited arable land (Luo et al. 2016). For mitigating these challenges, widespread and overuse of chemical fertilizers and pesticides has been adopted by Chinese agriculture sectors (Kong et al. 2014). However, China is achieving the challenges of food security by employing intensive agro-productivity powered by intensive interactions of chemical components, but those activates has drawn exacerbated controversies for maintaining the sustainable development goals set by the united nations (UN) (Zhao et al. 2008; Lu et al. 2015; Veeck et al. 2020). The impermissible utilization of chemical components and overuse of natural resources resulted in extra production cost and staggering ecological issues from the soil, water, and air contaminations to greenhouse gas emissions (Huang and Jiang 2019). These concerns are not only slowing down sustainable development but also threatened human wellbeing and existence. Therefore, China is confronting significant sustainability issues as a densely populated and agriculture-based nation (Luo et al., 2016). Traditional methods have been updated, and innovative eco-friendly technology is rigorously studied, introduced, and reviewed to reduce farm's emissions from non-spike sources and to enhance its influence and China's improve environmental stand while sustaining or increased crop production (Wang et al. 2007; XIANG and ZHOU 2007; El Bilali and Allahyari 2018). Global studies have shown that to alleviate rural non-point source pollution and improve the quality of products. Several eco-friendly technologies have been applied in horticultural production, such as soil testing and formula fertilization, organic fertilizer instead of chemical fertilizer, green prevention and control technology, soil improvement technology, etc. Moreover, the reviled a smooth shift's recent progression emphasizes scientific testing by research facilities to participative field trials (COE 2002).

It has great significance for farmers to adopt environment-friendly technology to improve products' quality, protect the ecological environment, and effectively integrate into the high-value industrial chain. The continuous adjustment of the agricultural and industrial structure has forced more farmers to turn their limited land resources to planting high-yield and high-value products (Razzaghi Borkhani and Mohammadi 2019). From the effect, the application of the technologies reduces the rural non-point source pollution. It improves the quality of products conducive to obtaining the food quality and safety certification, to lay a foundation for products to enter the high-end postpartum consumption market (Scialabba 2012). Though the strategies of reducing the non-point cause of agricultural emissions are entirely satisfactory within demonstration zones and experimental stages, whether the effectiveness of those innovative tactics and the promotions as well the adoption intentions are not sufficiently explored yet (Lee 2005; Bukchin and Kerret 2020; Pan et al. 2021). Thus the areas where small farms can practically use this advanced technology would have to assess appropriately. Therefore, based on apple farmers' actual situation in Shandong, from the capital endowment and ecological cognition, this paper analyzes the impact mechanism of environment-friendly technology adoption.

Scholars mainly focus on influencing factors and adopting decision-making by using environment-friendly technologies (Baidu-Forson, 1999; Chuchird et al., 2017; Barnes et al., 2018). Due to the difference in endowment, the heterogeneity of their technology adoption behavior is apparent, and the age factor is usually included in the estimation model first. For example, Wang et al. (2016) provided a brief assessment on the adoption behavior of soil testing, and formula fertilization technology for grain crop farmers shows that the older the age, the lower the possibility of technology adoption, which is in line with the previous studies on IPM of vegetable farmers. However, Zhou et al. (2008) also argued that experienced farmers might have a higher willingness to adopt Water‐Saving and labor-saving technologies. Seemingly, Ma et al. (2015) addressed that farmers with higher education tend to have a deeper understanding of how to use chemical products scientifically and rationally to reduce the impacts of excessive use and have a higher adoption rate of environment-friendly technologies.

Moreover, the promotions and guidance from suppliers also have a significant impact on practical usage of chemical products and technology adoption behavior of farmers (Ngowi et al. 2007), while the planting years, scale, number of laborers, and whether to join cooperatives also have an impact on the adoption behavior of environment-friendly technologies (McDonald and Glynn 1994; Kaine and Bewsell 2008). Interestingly, farmers' new technology adoption decision-making is different from the adoption intention, which is a rational choice after comparing the expected cost and benefit. Farmers show a low awareness of green prevention and control technologies such as biological pesticides and have a skeptical attitude towards the effect (Ma and Abdulai 2019) and show a profound paradox in the application willingness and behavior (Warren 2002; Goldberger and Lehrer 2016). Whether farmers adopt environment-friendly technologies depends on the potential performance that can be significantly improved after technology adoption, such as market share, yield level, and cost-benefit comparison (Lordan et al., 2019). However, the government's subsidies to farmers who adopt environment-friendly technologies have the best effect on improving the adoption level of environment-friendly technologies and controlling rural non-point source pollution (Issa et al. 2010).

The existing studies mainly focus on single technology adoption, and most of them centered within the crop farmers' context. In contrast, a minimal number of publications have been traced that can quantify adoption behavior towards environmental-friendly technologies among apple or other orchards-based products. Moreover, the research on the adoption behavior and degree of farmer's environment-friendly technology around capital endowment, ecological cognition, and ecological compensation policy is relatively rare, quantifying the article's strength and prime novelty. For fulfilling the research mentioned above the gap, these articles used the survey of 471 apple farmers from 9 counties (cities, districts) of Shandong Province, and adopted the Heckman sampling model to provide an in-depth assessment of the adoption behavior and measured the degree of adoption of environmentally friendly technologies by orchard farmers from the perspective of capital endowment and ecological cognition. Hence, the article's findings will help formulate and implement relevant agricultural policies as we have provided a theoretical basis for adopting environment-friendly technologies for orchards, especially apple farmers. This article is helpful to further researches to understand the mechanism of the adoption of environmentally friendly technologies.

The article has designed as follows: section 1 comprised the introduction and theoretical baseline. Section 2 described a brief overview of the data sources and theoretical outline. Section 3 outlined the Variables and research approaches, whereas section 4 denotes the results and analytical framework. Section 5 comprised the discussion and section 6 explored the conclusions of the study and policy recommendations.

1. **Methodology**
   1. **Data sources**

The empirical data are collected through the field survey among the apple orchard farmers listed in the "National Research Center for Apple Engineering and Technology (NRCAET), Shandong Agricultural University," situated in prime apple production counties of Shandong province from December 2018 to January 2019. The surveyed regions were covered by nine major apple production counties (Penglai, Laiyang, Qixia, Haiyang, Longkou, Zhaoyuan, Zibo, and Linyi). Whereas we randomly selected 5-6 apple-growing townships from each county, each township selects a core apple-growing village. Finally, we randomly selected 10 to 15 apple growers from each selected village with sufficient communication skills to answer the questionnaire. A total of 500 questionnaires were distributed, and 471 valid questionnaires were collected, with an effective rate of 94.20%. Shandong is one of China's largest apple-growing areas, and it is one of the largest exporter provinces in china, having strong market competitiveness within South Asia and Europe. However, due to the excessive application of fertilizers and pesticides, the local agricultural and environmental pollution problems are very prominent, so it is pertinent to study environmentally friendly technologies by apple growers. The nine counties surveyed in this article are also the core clusters of apple growers in Shandong. Thus the data of the growers in these nine counties are representative.

* 1. **Demographic profile of the respondent**

The respondents are primarily middle-aged farmers, whereas 57.96% are over 50 years old, and 79.9% had junior high school education. Moreover, the planting scale is not big enough; 74.31% of them are less than 1.4 acres. The degree of specialization is high, 87.69% of apple production income accounts for more than 60% of the total income, and 80.3% joined the agricultural cooperatives. On the whole, the sample farmers are representative. The results show that the adoption rate of soil improvement technology is relatively high, reaching 87.26%. Among those, Penglai City, Qixia City, Yiyuan County, and Mengyin County are covered around 90% because they are situated within the pilot areas to replace chemical fertilizer with organic fertilizer. The adoption rate of reducing application and efficiency increasing technology has been found moderate, about 54.26%. It could be happed due to the positive subsidy policy introduced by China. The results showed that the adoption level of reducing application and efficiency increasing technology in the above four pilot counties is higher than average.

In contrast, the adoption level of green prevention and control technology (biological control, physical trapping) is relatively low, only 18.47%, which may be happened for relatively high cost and slow effect of this technology, and the low recognition of the effect of this technology. Besides, 52.02% of the fruit farmers adopted two environmentally friendly technologies (soil improvement technology, reduction, and efficiency technology, green prevention, and control technology), 23.99% of the fruit farmers adopted three environmentally friendly technologies (soil improvement technology, reduced application efficiency technology, green prevention, and control technology). It can be seen that, on the whole, the subjective willingness of fruit farmers to adopt environmentally friendly technology is more optimistic. However, the willingness and acceptance rate of green prevention and control technology in environmentally friendly technology is relatively low.

* 1. **Theoretical basis and research hypothesis**

**The direct impact of capital endowment and ecological cognition on farmer's adoption of environment-friendly technology**

Environment-friendly technology can improve land productivity, reduce rural non-point source pollution, promote quality and efficiency, and transform and upgrade (Wang et al. 2016). The environment-friendly technologies in this paper mainly refer to the technologies of reducing and increasing efficiency of chemical fertilizer (soil testing and formula fertilization, water, and fertilizer integration technology), green prevention and control technology (artificial release of natural enemies, physical trapping), soil improvement technology (using organic fertilizer to replace chemical fertilizer, garden grass). Farmers need to invest an amount of human and material resources in adopting environment-friendly technology. When farmers make decisions, they are usually constrained by their capital endowment. Therefore, the capital endowment has a significant impact on the farmer's behavior choice and decision-making. Due to the limitation of capital endowment, farmers may show lower adoption behavior when making adoption decisions. On the other hand, according to the planned behavior theory, farmers' decisions will also be affected by subjective cognition. In production, farmers will have some knowledge of the surrounding ecological environment, which will encourage farmers to make different decisions to adapt to the ecological environment changes (Deng Zhenghua et al. 2013).

Moreover, farmers' cognition of changes positively impacts their living environment and eventually shaped the adoption behavior of environment-friendly technologies (Liu Zheng and Zhou Jing 2018). Also, farmers' awareness of environmental risk positively impacts their adoption of Environment-friendly behavior (Chen Li and Xie Jiazhi 2013). Therefore, capital endowment and ecological cognition will affect farmers' adoption of environment-friendly technologies **(see Figure 1)**. Based on the above analysis, the author puts forward the following assumptions:

Hypothesis 1: capital endowment has a positive impact on the farmer's adoption of environment-friendly technology.

Hypothesis 2: ecological cognition has a positive impact on the farmer's adoption of environment-friendly technologies.

**Impact of ecological compensation policy on farmer's adoption of environment-friendly technology**

As a rational decision-maker, whether farmers finally decide to adopt new technologies is usually rational after comparing the expected costs and benefits. If the government can provide certain policy subsidies to farmers, it will help them eliminate their endowments' restrictions and urge farmers to adopt environment-friendly technologies (Zhang Yu et al. 2015a; Huang Xiaohui et al. 2019) actively. Also, ecological compensation policy improves farmers' awareness of environmental protection policies, thus promoting their enthusiasm to adopt environment-friendly technologies because farmers will adjust their production behavior according to agricultural subsidy policies (Huang et al. 2020).

Hypothesis 3: ecological compensation policy has a regulatory effect on farmers' Capital endowment and ecological cognition.

**Figure 1** Theoretical model for the adoption of environment-friendly technology by farmers

1. **Variables and research approaches**
   1. **Variables**
      1. **Dependent variable**

The dependent variables are "willingness to adopt" and "adoption" of environment-friendly technologies. The measurement of "willingness to adopt" uses the binary valuation method. If the farmers adopt any two or more of the above three technologies, it means that the willingness to adopt environment-friendly technologies is relatively positive, and the value is 1. on the contrary, it means that it is not active enough to adopt environment-friendly technology, and the value is 0. For measuring the "adoption" of environment-friendly technology, the values are 1-3 according to the number of types adopted by farmers for reducing application efficiency technology, green prevention and control technology, and soil improvement technology. The farmers' willingness to adopt environment-friendly technologies indicates their enthusiasm for the ecological management of orchards, and the degree of adoption of environment-friendly technologies indicates the efficiency of technology adoption.

* + 1. **Core explanatory variables**

Capital endowment and ecological cognition. For drawing on domestic and international scholars' relevant research, this paper selects age, education, the labor force, and duration as a capital endowment. It selects planting scale, quality of agricultural pieces of machinery, income, and specialization as a material capital endowment. Meanwhile, the respondents' cognition on the harm of excessive fertilization, the cognition of soil environmental protection policy, and the cognition of environment-friendly technology to improve the ecological environment was selected to represent the ecological cognition.

* + 1. **Moderator**

This paper selects the impact of ecological compensation policy as the moderating variable. The attitude and willingness of farmers to adopt environment-friendly technology will affect the ecological compensation policy and its implementation after technology adoption. We can learn from the relevant research results of Zhang Yu et al. (2015a) and Huang Xiaohui et al. (2019). The influence of compensation policy is represented by the degree of understanding, the satisfaction with ecological compensation policy, and the benefit to ecological compensation policy. The definition and descriptive statistics of variables are shown in Table 1.

* 1. **Research Approaches**

Theoretically, in terms of adopting environment-friendly technology, in most cases, farmers will face a dilemmatic situation of whether they are willing to adopt it or not (Hall et al. 2009). Previous studies mainly involved the issue of willingness to adapt (Feng and Xu 2015; Channa et al. 2019; Memon et al. 2020), but not enough attention was paid to the degree of the farmer's adoption intentions. From the perspective of subjective adoption intention, the first issue is whether the farmers are willing to adopt environment-friendly technologies, and if the farmers' subjective willingness is not favorable, they will not fully adopt the three environment-friendly technologies. While the Heckman two-stage model can control the selectivity deviation caused by unobservable factors (Zongo et al. 2016; Wang et al. 2017), it can deal with effect evaluation based on binary selection. Therefore, this paper uses Heckman sampling to solve effect evaluation based on binary selection, as suggested by Lambrecht et al. (2014). The sample selection model is used to deal with the above problems, which is as follows:



Equation (1) represents the selection equation, and equation (2) represents the resulting equation. Where i represents the No. of the grower,  represents the willingness to adopt environmentally friendly technologies,  represents the degree of adoption of technologies, which are the dependent variable; and are the independent variables of the two equations,  is latent variables that cannot be observed, b indicates that several technologies were adopted, and the selection mechanism is as follows: only when>0,  can be observed. Meanwhile, and are the parameter to be estimated and are residual, consistent with the normal distribution.

The conditional expectation of farmers' adoption of environment-friendly technology is as follows:

in (3), where (·) is the inverse mills ratio function. While is the coefficient of correlation of and, where when= 0, it means that will not be affected by, when ≠ 0, will be affected by . Therefore, there is an ample selection bias,  denotes the standard deviation.

**Table 1 Variable definition and descriptive statistics**

1. **Results and analysis**
   1. **Impact analysis of farmer's willingness to adopt environment-friendly technologies**

The estimated results in Table 2 show that the ownership of agricultural machinery, the cognition of environment-friendly technology to improve the ecological environment, and the understanding of farmers' ecological compensation policy has passed the positive significance test of 10%. It shows that the more the agricultural machinery owned by farmers in the Capital endowment, the higher the enthusiasm of adopting environment-friendly technology. In ecological cognition, the higher the awareness of environment-friendly technology to improve the ecological environment, the easier it is to adopt environment-friendly technology to improve the ecological environment of the orchard. As for the impact of ecological compensation policy, farmers are more likely to adopt environment-friendly technology to improve the ecological environment. Farmers' understanding of ecological compensation policies has a significant positive effect on their willingness to adopt environment-friendly technologies. Farmers need to pay a specific cost to adopt environmentally-friendly technologies. If they cannot get the compensation, farmers' enthusiasm to adopt environment-friendly technologies will be affected. Therefore, understanding and mastering the ecological compensation policies can promote them to adopt environment-friendly technologies.

* 1. **Analysis of the impact of the adoption of environment-friendly technologies**

From the adoption degree perspective, the planting scale, family income level, and a specialization degree in Capital endowment have significant positive effects on farmers' adoption of environment-friendly technologies. For adopters, the larger the planting scale is, the higher the utilization efficiency of adopting environment-friendly technologies will be, and the adoption cost will be relatively reduced. The family income level is that farmers adopt environment-friendly technologies. The higher the level of income and specialization, the higher the farmers' enthusiasm to adopt environment-friendly technology, and the greater the degree of adoption. Hypothesis 1 holds, but hypothesis 2 has not been verified. Besides, the understanding degree of ecological compensation policy also has a significant positive effect on the adoption degree of farmers' environment-friendly technology, which indicates that acceptable ecological compensation policy can not only enhance the willingness of farmers to adopt environment-friendly technology but also help to improve the degree of farmers' adoption of environment-friendly technology. From the perspective of the interaction between ecological compensation policy and farmers' Capital endowment and ecological cognition, the interaction coefficient of farmers understanding of ecological compensation and planting scale, family income level and specialization degree, soil environmental protection policy cognition, and environmental improvement effect cognition all have a positive impact on the adoption of environment-friendly technology at the level of 10%. The results show that the ecological compensation policy has a certain moderating effect on farmers' Capital endowment and ecological cognition.

**Table 2 Model regression results**

Note: \*, \* \*, and \* \* \* represent significant at 10%, 5% and 1% confidence levels, respectively.

1. **Discussion**

To further verify the robustness of the estimation results, this paper measures the ecological compensation policy variables calculates the average value of the impact of ecological compensation policy on farmers by calculating the degree of understanding, satisfaction, and benefits of ecological compensation policy, which are parallel with Zhang Yu et al. (2015a) and Huang Xiaohui et al. (2019). Then, the average values are used as the grouping standard, and the groups below the average value and higher than the average value are divided into a group. The Heckman model was then used to quantify the influence of Capital endowment and ecological cognition on the willingness and degree of adoption of environment-friendly technology in the two groups. The ecological compensation policy's regulatory effect was investigated by examining the significant changes of different variable coefficients in the two groups (Zhang Yu et al. 2015b; Huang et al. 2020). The specific analysis results are shown in Table 3.

From the perspective of capital endowment, the group estimation results show that the influence coefficient of planting scale, family income level, and specialization degree on farmer's adoption of environment-friendly technology has passed the significance test of 5%, and the regression results are consistent with the estimation results as shown in Table 2. Further, the coefficients of the ecological compensation policy are affected by the more extensive the scale of planting area, the higher the level of family income and the degree of specialization of farmers, the higher the enthusiasm of farmers to adopt environment-friendly technology, and the more comfortable to benefit from the ecological compensation policy, which is supported by Liu et al. (2008) and Ke-guo (2007).

From the perspective of ecological cognition, the improved cognition effect of environment-friendly technology has a significant impact on farmers' adoption of environment-friendly technology at the level of 10%, and the coefficient level of the high group is affected by the ecological compensation policy is greater than that of the low group. I further verify that the ecological compensation policy has a certain regulatory effect on farmers' ecological cognition. Thus the findings are verified by the study of Home et al. (2014). However, it is worth noting that farmers' ecological cognition has no significant impact on adopting environment-friendly technologies. Which shows that, although the ecological compensation policy is conducive to help the majority of farmers to improve their awareness regarding improving the ecological environment and only if the majority of farmers can acquire benefit from the process of technology adoption then they will be attracted more towards the positive impact on the improvement of environment-friendly technology adoption in the future. This assumption is also supported by Dezdar (2017). Therefore, the government should continue to strengthen the ecological compensation policy and provide full support to enhance the awareness building activities such as training facilities, boost the demonstration process, and massive circulation of the advantages of new and improved eco-friendly technologies.

**Table 3 Ｒegression results of the robustness test**

Note: \*, \* \*, and \* \* \* represent significant at 10%, 5% and 1% confidence levels.

1. **Conclusion**

Based on the survey data of 471 apple farmers in 9 counties (cities and districts) of Shandong Province, this paper empirically analyzes the impact of Capital endowment and ecological cognition on farmers' adoption of environment-friendly technology. It verifies the regulatory effect of ecological compensation policy on Capital endowment and ecological cognition. The results showed that: (1) Overall, farmers had a positive attitude towards adopting environment-friendly technologies. However, there were significant differences in adopting the three kinds of environment-friendly technologies, as soil improvement technology was triggered the highest adoption level of 87.26%, the middle rate of application reduction and efficiency enhancement technology was 54.26%, and the lowest was 18.47%. Whereas 52.02% of farmers adopted two kinds of environment-friendly technologies, 23.99% of farmers adopted three environment-friendly technologies. (2) From the perspective of capital endowment, the planting scale, family income level, and specialization degree have significant positive effects on adopting environment-friendly technology. (3) The understanding of ecological compensation policy has a significant positive impact on farmers' adoption of environment-friendly technology. The ecological compensation policy has a certain regulatory effect on farmers' Capital endowment and ecological cognition.

This paper draws the following policy recommendations: first, improve the training content of science and technology to the countryside, and give play to the leading role of technical training. In the process of science and technology training in rural areas, agricultural technology departments should not only guide farmers who have not adopted environment-friendly technologies to adopt environment-friendly technologies actively but also encourage and drive farmers who meet the environmental conditions to adopt a variety of environment-friendly technologies according to local conditions, significantly to strengthen the adoption level and promotion of green prevention and control technology. Second, it is necessary to strengthen the publicity and education of rural non-point source pollution hazards in rural communities, to improve the cognitive level of the majority of farmers on green development. It is necessary to popularize the publicity and education of rural non-point source pollution hazards, improve the cognition level of the majority of farmers on the ecological value generated by environment-friendly technology, make the farmers fully realize the important role of adopting environment-friendly technology in improving the ecological environment of the orchard, improving land fertility and improving fruit quality, and promote farmers to adopt environment-friendly technology. Third, it is necessary to increase ecological compensation further and give full play to the supporting role of agricultural subsidy policy for green development. In particular, it should be published by the Ministry of agriculture and rural affairs in 2017 based on the pilot counties of fruit vegetable tea subsidy. We will gradually expand the scope of organic fertilizer instead of chemical fertilizer subsidy, provide financial support for the majority of farmers to adopt environment-friendly technologies and improve the ecological environment through government subsidies, help farmers to reduce the constraints of ecological awareness and capital endowment in adopting environment-friendly technologies, and increase the comparative income of farmers in adopting environment-friendly technologies The enthusiasm of the majority of farmers to adopt environment-friendly technology will be fundamentally improved.

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**Table 1 Variable definition and descriptive statistics**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variables | Meaning & assignment | AVG | Standard deviation | Minimum | Maximum |
| **Dependent variable** |  |  |  |  |  |
| Y1: The Willingness | Adopting (two or more) positive = 1; otherwise= 0 | 0.51 | 0.49 | 0 | 1 |
| Y2: Adaptation | Adoptation | 2.06 | 0.78 | 0 | 3 |
| **Capital endowment** |  |  |  |  |  |
| X1Sex | F=0；M=1 | 0.37 | 0.48 | 0 | 1 |
| X2 Age | By 2017 | 51.03 | 9.48 | 25 | 85 |
| X3 Education | Years of Education | 7.64 | 5.22 | 0 | 11 |
| X4: Duration | Duration | 27.63 | 5.07 | 4 | 58 |
| X5: Scale | AVG of the area in 2017 | 4.13 | 0.48 | 1 | 12 |
| X6: Labors | Labours in family | 3 | 1.49 | 0 | 12 |
| X7: Machinery | Machinery | 0.48 | 0.65 | 0 | 4 |
| X8: Family income | income in 2017 | 10. 52 | 0.95 | 7.60 | 13.30 |
| X9: Specialization | Proportion to total income in 2017 | 68.47 | 7.89 | 60 | 86 |
| **Ecologic cognition** |  |  |  |  |  |
| X10: Awareness of The Hazards of Over Chemicals Use | Don't know = 1; have heard of = 2; know something = 3; know very well = 4 | 1.83 | 1.02 | 1 | 3 |
| X11: Awareness of Soil Environmental Protection Policy | Don't know = 1; have heard of = 2; know something = 3; know very well = 4 | 2.53 | 0.70 | 1 | 3 |
|  |  |  |  |
| X12 Awareness on Effect of Environment-Friendly Technology | No = 1; little effect = 2; large action = 3; great effect = 4 " | 2.28 | 0.50 | 1 | 4 |
| **The impact of environmental policy** |  |  |  |  |  |
| X13 Understanding of Ecological Policy | 1 = totally do not understand, 2 = do not understand, 3 = general, 4 = understand, 5 = fully understand " | 3.38 | 0.87 | 2 | 5 |
| X14: Satisfaction with Ecological Policy | 1 = very dissatisfied 2 = not very satisfied 3 = general 4 = satisfied 5 = very satisfied " | 3.18 | 2.04 | 1 | 5 |
| X15: Benefit | 1 = significant decrease, 2 = slight decrease, 3 = constant ,4 = slight increase, 5 = obvious increase. | 3.42 | 0.98 | 1 | 5 |

**Table 2 Model regression results**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Willingness to adopt | | Degree | |
| Coefficient | Standard error | Coefficient | Standard error |
| x1 Sex | -0.214 | 0.150 | -0.082 | 0.075 |
| x2 Age | -0.006 | 0.008 | -0.002 | 0.004 |
| x3 Education | 0.036 | 0.021 | 0.003 | 0.009 |
| x4 Duration | 0.005 | 0.012 | 0.034 | 0.005 |
| x5 Scale | -0.012 | 0.046 | 0.002\* | 0.020 |
| x6 Laors | -0.076 | 0.047 | 0.011 | 0.026 |
| x7 Machinery | 0.138\* | 0.080 | 0.019 | 0.040 |
| lnx8 Family income | 0.011 | 0.078 | 0.059\* | 0.035 |
| x9 Specialization | -0.005 | 0.010 | 0.011\*\*\* | 0.004 |
| x10: Awareness of excessive use | -0.011 | 0.072 | -0.036 | 0.031 |
| x11: Awareness of soil protection policy | 0.140 | 0.103 | 0.215 | 0.052 |
| x12: Awareness on improving effect | 0.113\* | 0.146 | 0.019 | 0.069 |
| x13: Awareness of ecological compensation | 0.111\* | 0.082 | 0.053\* | 0.040 |
| x14: Satisfaction with ecological compensation | -0.072 | 0.080 | -0.057 | 0.038 |
| x15: Satisfaction with ecological compensation | 0.083 | 0.076 | 0.015 | 0.037 |
| x13: Awareness of ecological compensation \* x5 Scale | — | — | 0.029\* | 0.020 |
| x13: Awareness of ecological compensation \* x8 Family income | — | — | 0.042\* | 0.155 |
| x13: Awareness of ecological compensation \* x9 Specialization | — | — | 0.011\* | 0.017 |
| x13: Awareness of ecological compensation \* Awareness of soil protection policy  x13: Awareness of ecological compensation \* x12: Awareness on improving effect | —  — | —  — | 0.277\*  0.302\* | 0.151  0.166 |
| The constant | 1.295 | 1.306 | 1.694\*\*\* | 0.575 |
| Log-likelihood | -440.6671 |  |  |  |
| Wald chi2(15) |  | 22.41 |  |  |

**Table 3 Ｒegression results of the robustness test**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | High group on ecological compensation | | Low group on ecological compensation | |
| Willingness to adopt | Degree | Willingness to adopt | Degree |
| Coefficient | Coefficient | Coefficient | Coefficient |
| X5: Scale | 0.008\* | 0.035\*\* | -0.002 | 0.032\* |
|  | (0.016) | (0. 208) | (0.074) | (0.020) |
| X7: Machinery | 0.137\*\* | 0.012 | 0.116 | 0.052 |
|  | (0.210) | (0.056) | (0.144) | (0.056) |
| lnX8: Family income | 0.028 | 0.042\*\* | -0.160 | -0.013 |
|  | (0.100) | (0.247) | (0.133) | (0.055) |
| X9: Specialization | 0.009 | 0.008\*\* | -0.016 | 0.004\*\* |
|  | (0.013) | (0.206) | (0.017) | (0.007) |
| X12: Cognition of improving environmental effect | 0.078\*\* | 0.087\* | -0.030 | 0. 017 |
|  | (0.019) | (0.012) | (0.252) | (0. 016) |
| The constant | -0.361 | 2.124\*\* | 6.272\*\* | 0.236 |
|  | (1.767) | (0.876) | (2.518) | (1.082) |
| Log likelihood | -266.0604 |  | -177.2996 |  |
| Wald chi2(15) |  | 24.46 |  | 27.46 |

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**Figure 1 Theoretical model for the adoption of environment-friendly technology by farmers**