Does Participation in Low-Carbon Agriculture Influence Farmers' Willingness to Grow Eco-Agricultural Crops?

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Abstract. Low-carbon agriculture has aroused wide concern around the world. Many countries are exploring how to reduce carbon emissions in agriculture. While farmers play a vital role in agriculture planting and eco-agricultural crops create less carbon emission, so are farmers willing to participate in the cultivation of eco-agricultural crops in the context of low-carbon agriculture? This paper seeks to find whether farmers who participate in low-carbon agriculture are more willing to plant eco-agricultural crops (taking mushrooms for an example) in China. Logistic regression model was applied to find their relationships. The results show that farmers’ participation in low-carbon agriculture has remarkable effects on their willingness to plant mushroom or other eco-agricultural crops, except for farmers’ characteristics and the status of household production operation. According to this research, farmers are more likely to plant mushrooms when they recycle crop straw, agricultural plastic films and other agricultural wastes. And planting mushrooms have a positive effect on family’s agricultural incomes both in low-income and high-income households. Recognition of benefits of low-carbon agriculture is a primary issue. Likewise, changing rural population structure as well as integrating rural resource factors is an effective measure to encourage farmers to plant mushrooms or other eco-agricultural crops. Subsidies and specialized cooperative organization’s guidance should also be taken into consideration, which is good to arouse farmers’ enthusiasm in planting eco-agricultural crops.

1. Introduction

As the global warming becomes more and more severe, the NO.1 Central Document issued by Chinese government in 2015 has promoted the development of eco-agriculture. It has been pointed out that treatment for agricultural non-point source pollution should be strengthened, and in-depth testing soil for formulated fertilization needs to be carried out. According to the document, bio-organic fertilizer, low toxicity and low residue pesticides should be promoted vigorously. The government also supports to develop regional demonstrations of resource utilization of straw and excrement of livestock, as well as recovering residue of agricultural plastic films. Accordingly, there should be some related fiscal taxation policy to encourage all the above behaviors. Besides, as showed in the document, new achievements should be made in improving farmers’ income and provide strong support for the sustainable and healthy development of economy and society. In the process of strengthening the ecological management of agriculture and promoting the synchronous development
of new industrialization, informalization urbanization and agricultural modernization, the development of eco-agricultural crops, likewise mushroom, undoubtedly plays a positive role in the management of prominent problems in agricultural environment, agricultural sustainable development plan, prosperity of rural areas and increase of farmers' income. With the popularity of mushroom's nutritive value, economic value and ecological value, our country's mushroom industry has changed from original supplementary rural economic form to a region, an area or a country's pillar industry, and it is playing a decisive role in the international market. The total export volume of mushroom in the whole country reached 514,800 ton in 2014, earning foreign exchange of $2.833 billion. Compared with total export volume of mushroom in 2013, it respectively increased by 0.48% and 5.14%. Mushroom industry has become the featured industry that could mobilize the structural adjustment of our country's agriculture and increasing farmers' income.

Sustainable development of modern agriculture has emerged as one of the biggest challenges of the world in the 21st century, like many other countries, China has formulated plans and policies to stimulate environment-friendly agriculture, that is, ecological agriculture and low-carbon agriculture. Mushroom industry, as the sunrise industry, meets the basic requirements for the development of our country's modern ecological agriculture. Its economic benefits and ecological effects are both good. It is not only the important way for farmers to increase income, but also a significant project of our country's recycling agriculture. Farmers' willingness to plant mushroom are affected by many factors, which is not only confined by the householder's characteristics and characteristics of household operation, but also is influenced by farmer's participation in low-carbon agriculture. Therefore, study on the production subjects of mushroom, namely, study on farmers' behavior, especially the study on farmers' planting willingness is of great significance both theoretically and practically. It plays a positive role in promoting the healthy development of our country's mushroom industrial system and stimulating the overall development of ecological agriculture.

2. Literature review

The characteristic of Chinese farmers is household management, which determines that households are the main body of agricultural production, the basic organization and decision making units. From the point of view of the research content, the study of household activities covers the farmland management behavior, farmland circulation behavior, water-saving irrigation behavior, fertilizer behavior, and planting behavior including the willingness to grow crops. From the point of view of research methods, there are mainly Logistic model, Probit model, Tobit model and Hechman two-stage model.

In the book Psychological analysis of economic behavior, economic factors, psychological factors and environmental factors are taken together to explore people's economic behaviors and psychological activity. The study on peasant household's behavior has already become the focus that countries all over the world study gradually and many scholars have proposed different theories and distinct standpoints on it at home and abroad. Popkin (1979)[1] proposed the hypothesis that farmers are rational individuals and pursuit maximum welfare of the family. Farmers maximize their profit provided that the possibility of ruin is negligible when representing farmers' production decisions (Boussard et al., 1967)[2]. Starting from farmers operational behavior analysis, from the age of transition and market economic structure, the farmers operational behavior and performance under the household contract management system were studied and it was found that farmers should re-select their operational behavior according to resource allocative efficiency principle (Yu, 2011)[3]. While the farming scale was introduced into the analysis of household's behavior, with discussion on the influencing factors of household production and management behavior, the household's farming scale was noted to be an important variable affecting the household's choice (Barnum et al., 1980)[4]. Besides, transactions costs, specialization degree, industrial concentration degree, input resources and some other factors may directly affect the peasant household decision-making of production and management behavior (Key et al., 2000 and Vukina, 2003)[5,6].

Farmers' willingness to grow different crops or trees depends on many factors, and if governments
or other organizations want farmers change their decision to grow other crops, these factors need to be considered. An increase in the productivity of staple crops seems to have been an important factor permitting farmers to plant trees. Another factor related to resource endowment that induced farmers to grow trees is the response to declining soil productivity as a result of erosion (Filius, 1996)[7]. Some scholars raise questions about farmer's willingness to grow bioenergy crops or produce alternative cellulosic feedstocks. In other words, farmers and landholders may not be willing to grow bioenergy crops. Due to this concern, previous research about bioenergy production by evaluating farmer's and landholder's willingness to produce different varieties of biofuel feedstocks (Caldas et al., 2014)[8]. Based on the survey data and using Binary Logistic Regression Model, the factors that influence the farmers' willingness to plant energy trees as well as their behavior mechanisms was explored. It has been shown that the education level of the household head, land scale, the family income, and farming expectations have significant effects (Heng et al., 2014)[9]. Factors influencing farmers' willingness to participate in these policy subsidies was examined to show that 69.4% of the farmers expressed their willingness to participate in the policy subsidy, and influencing factors of planting size, education years, planting experience and income were significant (Linping et al., 2011)[10]. Through the use of reconnaissance surveys, household surveys and focus group discussions, the effects of land and tree tenures and household characteristics on farmers' willingness to plant and domesticate indigenous fruit trees was assessed in Malawi and Zambia (German et al., 2009)[11]. Others tried to explore a broad range of factors in determining farmers' willingness to grow one kind of crops or trees in order to make a contribution to environmentally friendly agriculture, specifically, Cellulosic Biofuel Feedstocks, Jatropha carcass as a biofuel source in traditional agroecosystems, and other sequestering carbon through afforestation (Shaikh et al., 2007, Lynes et al., 2011 and Vera Castillo et al., 2014)[12-14].

Despite the constant progress in the study on farmers' behavior, the research subjects mainly focus on staple crops. It is advisable to study farmers' planting decision-making mechanism on one of special eco-agricultural crops like mushroom. Researches on the mushroom in the past mainly focused on the production capacity, industrial development, yield and consumption, most of which were conducted at the macro level of mushroom industry. However, little attention was paid to the relation and influencing mechanism between mushroom farmers' behaviors with their participation in low-carbon agriculture from the micro level. This paper adopts the household questionnaire method to collect farmers' relevant data, and through the establishment of Logistic regression based on farmers’ willingness to grow mushrooms, farmers' participation in low-carbon agriculture and other household characteristics. On one hand, the empirical study helps to know the planting situation of our country's mushroom products. On the other hand, it also conducts an in-depth analysis of the influencing factors of farmers' planting mushroom and provides a theoretical foundation for the sound development of our country's mushroom industry and low-carbon agriculture.

3. Method and Data

3.1. Assumption

Based on the previous studies and literature review and combing the field research and industrial characteristics of mushroom plantation, this paper believes that major factors that affect farmers' willingness to plant mushroom include farmer's characteristics, status of household operation and farmer's participation in low-carbon agriculture.

Farmer's characteristics consist of farmer's gender, age, education degree, years of farming, whether doing part-time job and whether having participated in agricultural technical training or not.

Status of household operation covers the total size of farmland, labor force, average per capita income, distance from the market to the house, substitutes or other commercial crops' planting situation and whether participating in farmers' specialized cooperative organization or not.

Besides, farmer's participation in low-carbon agriculture includes the application amount of pesticide, application quantity of chemical fertilizer, recycling utilization of crop straw, handling of
livestock excrement and agricultural films and whether to carry out centralized processing of waste or not. These all will affect mushroom industry's acceptability to farmers. Application of pesticide and chemical fertilizer is one of the important sources of carbon emission in agriculture. However, our country's agricultural industry still depends heavily on pesticide and chemical fertilizer. Excessive use of pesticide and fertilizer means more carbon emission. Under the premise of guaranteeing the food production, reducing the use of high carbon emission production factors like pesticide and chemical fertilizer as little as possible or proper use of them could help control the carbon emission in agriculture; Crops straw and livestock excrement are another important sources of agricultural carbon emission. Changing straws and excrement into fertilizer and turning straw into feed, energy, ground material and industrial raw materials mean participation in recycling utilization. Directly abandoning them like burning, burying or discarding them will result in environmental pollution and is not good to the development of low-carbon agriculture; similarly, burning or discarding waste agricultural films or other wastes may create the environment pollution, but participation in recycling utilization benefits the development of low-carbon agriculture.

3.2. Model

The dependent variable in our research is farmer’s willingness to grow some crops, which is a categorical binary variable, namely to be willing or not willing. Accordingly, the econometric model is established with discrete dependent variable. There are many kinds of models to solve the non-linear variables problem, among which the Binary Logistic Model is the most widely used in practice.

Suppose there are \( n \) observation samples, and \( y_i^* \) is on half of the given event's occurrence, then there may be a linear relationship between dependent variable \( y_i^* \) and independent variable \( x_i(i = 1, 2, \ldots, n) \), which can be expressed as Equation (1):

\[
y_i^* = X_i' \beta + \varepsilon_i
\]

(1)

Obviously, \( y_i \) is observed response variable. If \( y_i = 1 \), it means that it's certain to happen. If \( y_i = 0 \) that means the event can't happen.

\[
y_i = 1, \text{ where } y_i^* > 0.
\]

\[
y_i = 0, \text{ where } y_i^* \leq 0.
\]

Assume stochastic error term \( \varepsilon_i \) follows a distribution which \( F \) is the cumulative distribution function, and \( f \) is the probability density function. Then,

\[
p_i = P(y_i = 1) = P(y_i > 1) = P(X_i' \beta + \varepsilon_i > 0) \]

\[
= P(\varepsilon_i > -X_i' \beta) = \int_{-X_i' \beta}^{\infty} f(t)dt
\]

\[
= \int_{-\infty}^{X_i' \beta} f(t)dt = F(X_i' \beta)
\]

\[
1 - p_i = P(y_i = 0) = 1 - F(X_i' \beta)
\]

As the observed items are generally independent of each other, their joint distribution can be expressed as the product of the marginal distributions, showed as Equation (2):

\[
L = \prod_{y_i = 1} p_i \prod_{y_i = 0} (1 - p_i) \]

\[
= \prod_{y_i = 1} F(X_i' \beta) \prod_{y_i = 0} (1 - F(X_i' \beta)) \]

(2)

According to the Logistic distribution, the likelihood function can be expressed as Equation (3) and Equation (4):
Where $Z$ is the linear combination of independent variables $X_i (i = 1, 2, \cdots, n)$, $b_0$ is intercept parameter, and $b_i (i = 1, 2, \cdots, n)$ are regression coefficients to be estimated. In the process of statistical analysis, if the probability of farmer’s willingness to grow the target crop is $P(Y=1)$, the probability of farmer’s unwillingness to grow the crop is $1-P(Y=1)$. And the Binary Logistic Model should be Equation (5):

$$
Logit(P) = \ln\left(\frac{P}{1-P}\right) = b_0 + \sum_{i=1}^{n} b_i X_i
$$

$$
P = \frac{\exp(Z)}{1 + \exp(Z)}
$$

$$
Z = b_0 + \sum_{i=1}^{n} b_i X_i = b_0 + b_1 X_1 + b_2 X_2 + \cdots + b_n X_n + \varepsilon_i
$$

In this research, we take mushroom for example. In other words, dependent variable $Y$ is farmer’s willingness to plant the this kind of eco-agricultural crop. When $Y$ equals 1, it means the farmer is willing to grow mushroom. However, when $Y$ equals 0, it means the farmer is unwilling to grow mushroom. According to the above research assumptions, our model has eighteen independent variables including farmer’s gender($X_1$), age($X_2$), education degree($X_3$), years of farming($X_4$), whether doing part-time job($X_5$), whether having participated in agricultural technical training($X_6$), the total size of farmland($X_7$), labor force($X_8$), average income per-capita($X_9$), distance from the market to the house($X_{10}$), substitutes or other commercial crops’ planting situation($X_{11}$), whether participating in farmers' specialized cooperative organization($X_{12}$), application amount of pesticide($X_{13}$), application quantity of chemical fertilizer($X_{14}$), recycling utilization of crop straw($X_{15}$), handling of livestock excrement($X_{16}$) and agricultural films($X_{17}$) and whether to carry out centralized processing of waste($X_{18}$).

3.3. Survey design and data collection

The data used for this paper originates from a field survey conducted by Hubei Rural Development Research Center from Hubei province, China. A random sample of 8-15 households were selected from each village for the survey. This was followed by random sampling of 3 villages households from each district. The survey collected valuable information on several factors including farmers’ characteristics, status of household operation, participation in low-carbon agriculture with 24 indicators in all. Finally, a random cross-section sample of 403 valid household questionnaires were used to analyze the problem (the data were cleaned by excluding invalid questionnaires based on missing data or nonsensical responses). It should be noted that all members of the investigation team are from rural areas, being familiar with rural living habits, agricultural production conditions and farmers behaviors, and most of the members have rural survey experience before. Further, in order to overcome the bias as far as possible to ensure the accuracy of the survey data, before the interview, the investigation team prepared a gift to reduce the deviation of non-respond, and all the investigation members had been trained to reduce the deviation of investigators. Table 1 presents the mean value and standard error of selected variables in the surveyed 403 households.

| Variable                | Code | Assignment                                      | Mean value | std    |
|-------------------------|------|-------------------------------------------------|------------|--------|
| Gender                  | $X_1$| female=0, male=1                                | 0.911      | 0.724  |
| Age                     | $X_2$| Farmer’s physical age (unit: years)              | 51.920     | 12.304 |
| Farmer’s characteristics | Education | illiterate or semi-illiterate=1, primary school=2, middle school=3, high school or college school=4, college degree and above=5 | 2.721   | 0.995  |
| Farming years           | $X_4$| under 10 years=1, 10~20 years=2, 20~30 years=3, 30+ years=4 | 3.001 | 1.365  |
4. Results and Discussion

4.1. Regression Results

In the regression model, the explanatory variables are selected as comprehensively as possible. The correlation or collinearity among explanatory variables will perhaps have an impact on the significance of influence coefficient. Before setting up the model, we have calculated the Inflation Factor's VIF value and found that there do not exist strong multi-collinearity or correlation among variables in altitude. If we ignore the insignificant collinearity or correlation among part of the variables, we could reserve all the explanatory variables in the preset model. Stata.12 is used to further estimate the fitting condition of the model, and the model fits well. Regression results are showed in Table 2.

| Variable | Coef. | S.E.  | Z     | P>|Z| |
|----------|-------|-------|-------|-----|
| Gender   | 1.8808| 0.9778| 1.63  | 0.103|
| Age      | -0.1665**| 0.0621| -2.46 | 0.014|
| Education| 0.1774 | 0.3118| 0.57  | 0.569|
| Farming years| -0.1391**| 0.0536| 2.59  | 0.010|
| Part-time job| -0.9223| 0.4778| -1.53 | 0.125|
| Training | 0.1402 | 0.7034| 0.20  | 0.842|
| Farmland | 1.4145**| 0.5471| 2.59  | 0.010|
| Labor force| -0.2124| 0.2010| -1.06 | 0.290|
| Income   | -0.0492| 0.0667| -0.74 | 0.461|
| Market   | -0.0828| 0.5016| -0.17 | 0.869|
| Substitutes| -0.4296***| 0.1182| -3.64 | 0.000|
| Cooperation| -1.8191***| 0.3906| -4.66 | 0.000|
| Pesticide| -0.2902| 0.2864| -1.01 | 0.311|
| Fertilizer| 0.7763 | 0.5946| 1.38  | 0.168|
| Straw    | -0.8987*| 0.4728| -1.90 | 0.057|
| Excrement| -1.7579| 1.0857| -1.62 | 0.105|
| Plastic films| 2.1981***| 0.5154| 4.26  | 0.000|
| Waste    | 0.2260 | 0.3759| 0.60  | 0.548|
| Constant | 4.3219 | 2.6364| 1.64  | 0.101|
| -2 Log likelihood | 149.0329 | |
| Pseudo R2 | 0.4743 | |

Notes: ***, ** and * denote that the variables are statistically significant at the 1%, 5% and 10% levels, respectively.
4.1.1. Farmer’s Characteristics

Results show that in the six variables of farmer's characteristics, only age and farming years pass the significance test. Farming years have significant positive correlation with the willingness to plant mushroom, but farmer's age has significant negative correlation with farmer's willingness to plant mushroom, which suggests that age and farming years will both have significant influences on farmers' willingness to plant mushroom. The more years farmers engage in farming, the more willingness to plant mushroom, because farmers who engage in farming for many years tend to be more familiar with crops income and they will choose to grow some new commercial crops. However, when farmers get older and older, they are reluctant to plant mushroom, as they are more conservative about the choice of agricultural production. At the same time, their acceptability is not so good as young farmers.

Some variables in the model have the expected signs. Two variables were founded to be significant in farmers’ willingness to plant mushroom. The age of household head and farming years are hypothesized to negatively decrease in planting mushroom. As expected, age of household head takes a negative sign, all suggesting that older people are reluctant to planting mushroom. This is because they are more conservative and not willing to accept new technology. There are some uncertainties to their willingness in planting a new product.

This survey finds no significant variation in planting mushroom across gender, education degree or technical training, and part-time job do not pass the significance test, namely, there is no enough evidence that could prove these variables have influences on farmers' willingness to plant mushroom, which is inconsistent with the previous assumption. There are 3 possible reasons for this phenomenon. Firstly, farmers' education degree is low on the whole. The mean value is 2.7211 which is showed in Table 1. This suggests that rural population’s education is in a low level in our country. Rural population just have primary school education, and some even are illiteracy or know very few words. Secondly, except for formal school education, few farmers participate in agricultural specialized technical training, where it is of great benefit to their production, either. The mean value of whether having participated in agricultural technical training is only 0.1030, which suggests that almost 90% of the farmers have not been exposed to modern agricultural technical training, and technical training should be accepted to improve their quality. At last, farmers who do part-time job have little effect on farmers' willingness to plant mushroom, which indicates that this variable does not affect households' planting choice of mushroom.

4.1.2 Status of Household Operation

The total size of farmland, substitutes or other commercial crops' planting situation and participation in farmer's specialized cooperative organization have significant influences on farmer's willingness to plant mushroom. The regression coefficient of the size of farmland is positive, suggesting the more farmland the household has, the more inclined they are to plant mushroom, which is contrary to our assumption. Mushroom planting is delicate work and requires much labor, but we cannot ignore its' occupation of land. Households with limited farmland do not have the condition to plant mushroom even though they have strong planting willingness. Substitutes or other commercial crops' planting situation and farmers' participation in specialized cooperative organization have significant negative correlation with the willingness to plant mushroom. Form the index evaluation, it can be seen that the more income other commercial crops bring to the household, the more reluctant they are to plant mushroom. It can be seen from the survey data that the planting of cotton, rape and peanut will replace the planting of mushroom to a certain degree. They all belong to commercial crops and few of them are provided for themselves to eat, while most of them are sold for economic income. Farmer's participation in specialized cooperative organization has significant positive effects with the planting of mushroom, which proves the assumption mentioned above. Participation in farmer's specialized cooperative organization, especially some mushroom cooperatives, have greatly mobilized farmer's enthusiasm about the mushroom production.

Variable of labor force, average income per capita and distance from the market to the house
present no significant correlation with the planting willingness. Combing the variable of whether doing part-time or not, it suggests that labor force in the family and family economic factors do not have influences on the willingness to plant mushroom. Theoretically, distance from the market to the house will to some extent increase the production and selling cost of mushroom planting, thus discouraging farmers to plant mushroom. As a matter of fact, village-to-village in our country's rural area has been realized, and transportation expense is no longer a large terrifying spending as in the past. From Table 1, it can be seen that the average distance from the distance to the house is only 2.2901 miles, and the range of driving, whether it is time cost or economic cost, is a very small factor for current rural residents whose modern life quality has been improved greatly. So this variable does not has significant effects on farmer's willingness to plant mushroom.

4.1.3. Participation in Low-carbon Agriculture
Interestingly, the recycling utilization of crop straw and handling of agricultural plastic films have significant positive correlation with farmer's willingness to plant mushroom, which suggests that farmers who choose recycling utilization of crop straw and agricultural films tend to be more willing to plant mushroom. It is not difficult to understand. Crop straw like rice and corn could be used as the ground material for planting mushroom and the mushroom industry is an important project of recycling agriculture advocated by our country as the modern agriculture. When farmers are willing to recycle the straw, their recognition of recycling agriculture is higher than others, as a result, they are more willing to participate in the planting of mushroom. Agricultural plastic film is a recycling material for households. The thin plastic film used in raising rice seedlings and growing corn seedlings could be recycled as the internal veil or tubing film, which not only saves the cost, but also reduces pollution and helps to control agricultural carbon emission.

Variables of the application amount of pesticide and chemical fertilizer, handling of livestock excrement and participation in the centralized processing of waste do not pass the significance test. It can be regarded as specific performance of farmer's participation in low-carbon agriculture to choose the application amount of pesticide and chemical fertilizer, and make livestock excrement or waste in centralized processing. In the meanwhile, they are also the important sources of agricultural carbon emission. However, from this research's test results, it can be seen that there is no enough evidence to prove they have significant relation with farmer's willingness to plant mushroom. In the survey, it finds that farmer's application of pesticide and chemical fertilizer basically follows the operation instructions, and they do not apply more or less deliberately. These people make up about two thirds of the total sample, but there are some farmers who tend to apply more in the agricultural production process and farmers who apply more pesticide account for 31%. 37% of the farmers apply more chemical fertilizer. There are very few farmers who reduce the application amount and they make up less than 7% of the total sample. There almost does not exist abandonment or deserting of livestock excrement. From Table 1, it can be seen that the mean value of this variable is 0.9801, and its standard deviation is 0.1397, which suggests that most of the farmers choose to recycle the livestock excrement. Thus this explanatory variable does not present influences on farmer's willingness to plant mushroom. Whether participating in centralized processing of waste or not is the daily habit people have developed, and it may affects the family's awareness of the environmental protection and cognition of low-carbon agriculture, but it has no direct relation with farmer's willingness to plant mushroom.

4.2. Robust Test
In order to test the reliability of our empirical model and the robustness of regression results, the data being removed out the extreme value has been tested again according to robust control theory. The test results are shown in table 3.

| Variable   | Coefficient | S.E.  | Z    | P > | Z |  |
|------------|-------------|-------|------|-----|---|---|
| Gender     | 1.8808      | 0.8948| 1.65 | 0.101 |   |   |
The robust test results show that the our empirical model and the regression findings are reliable and strong. Compared with the original regression results in table.2, after eliminating some extreme value data, from the robust test results, we can see that there is no significance difference of most variables covering farmer's gender, age, education degree, years of farming, whether having participated in agricultural technical training or not, the total size of farmland, labor force, average income per-capita, distance from the market to the house, substitutes or other commercial crops' planting situation, whether participating in farmers' specialized cooperative organization, the application amount of pesticide, application quantity of chemical fertilizer, recycling utilization of crop straw, handling of agricultural films and whether to carry out centralized processing of waste or not. There are only two variables including whether doing part-time job and handling of livestock excrement whose significance level changes when running the robust regression. They are of non-significant in the original regression results in table.2, while show significant and negative impacts on farmer's willingness to plant mushroom or other eco-agricultural crops in the robust test in table 3.

5. The Influence of Planting Mushroom on Income

5.1. The Influence Factors of Household's Income

| Variable          | I Q(25)      | II Q(50)      | III Q(75)     |
|-------------------|--------------|---------------|---------------|
| Mushroom (var2)   | 0.2470***    | 0.0099**      | 0.0180**      |
| Gender (var3)     | 0.1251       | -0.0116*      | -0.0096       |
| Age (var4)        | -0.0201**    | 0.0147        | -0.0047       |
| Education (var5)  | -0.0918      | 0.0677        | -0.0047       |
| Farming years (var6) | -0.0046*     | 0.0134        | -0.0154       |
| Part-time job (var7) | -0.0547***   | -0.1464**     | -0.1021**     |
| Training (var8)   | 0.0205       | 0.0190        | -0.0044       |
| Farmland (var9)   | -0.6167      | 0.1920        | 0.2147*       |
| Labor force (var10) | 0.2374*      | 0.0757        | 0.2041*       |
| Expenditure (var11) | -0.0099      | 0.0125        | 0.0097        |
| Market (var12)    | 3.0460***    | 3.8671***     | 4.5432***     |
| Substitutes (var13) | -0.0261      | -0.0384       | -0.0254       |
| Cooperation (var14) | 0.02473      | 0.0165        | 0.0289        |
| Pesticide (var15) | -0.0463      | 0.1381        | -0.0970       |

Notes: *** and ** denote that the variables are statistically significant at the 1% and 5% levels, respectively.
The ultimate aim for farmers of planting mushroom is to boost their revenue streams. In order to conduct detailed explorations of the influence of planting mushroom on the household's income, the Quantile regression model was applied to test the decision effects. In this model, the household's total income was taken as dependent variable $Y$, while there are 19 independent variables including 17 same variables with the fist model in part 4. Besides, household's expenditure and whether to plant mushroom which is the key independent variable. The test results are shown in table 4.

Results show that all the three values of Link test have passed the significant test at 5% level, which demonstrates that the holistic model has statistically significance.\(^{(16)}\) Besides, the values of Pseudo R-square are above 0.3, that means the original model is convincing to a certain extent. According to the regression results, the concerned independent variable(var2), which is whether to plant mushroom, presents prominently affecting household's income at different income level. That can be described as that the farmers who plant more mushroom will bring in more revenue for his family. Further, this situation is more evident in low-income families than the high-income ones. Complementary, the less of the farmer's age(var4) and farming years(var6) leads the more income, but only when the families are in low-income level. Several variables, say doing part-time job(var7), labor force(var10), distance from the market to the house(var12), handling of livestock excrement(var18), have remarkable effects on household's income both in the low-income and high-income families.

![Figure 1. Simultaneous-quantile regression coefficient change](image-url)
5.2. Simultaneous-quantile Regression Test

In order to ensure the reliability of this model and the robustness of regression results, the Simultaneous-quantile regression was used to test the robustness and the preciseness of the region model. Figure 1 illustrates the marginal contribution and variation tendency of the key independent variable on different quantiles.

In Figure 1, the abscissa represents quantile change and ordinate represents the Quantile regression coefficient of variables. Solid and dashed lines represent Quantile regression coefficient and OLS regression coefficient, while the shaded portion means confidence bands. As we can see, the several significant variables in table 4 have an image fluctuating obviously, such as var2, var4, var7, var10, var12 and var18 respectively indicating whether to plant mushroom, farmer's age, household's labor force, distance from market to the house, substitutes or other commercial crops' planting situation. It indicates that these variables' estimated coefficients on different quantile points vary significantly. Conversely, the other thirteen variables without significantly impacting the household's income at the 5% level by Quantile regression test show the changes are comparatively stable from the images. It demonstrates the variations of those variables' estimated coefficients on different quantile points are not obvious. It follows that Quantile regression is certainly consistent with conclusions above.

6. Conclusions and Policy implication

6.1. Conclusions

Based on the analysis on farmers' production behaviors, the influencing factors were identified to be the following three aspects: farmer's characteristics, status of household operation and farmer's participation in low-carbon agriculture. Applying Stata 12 software and 403 samples, this paper established a Logistic regression to explore the effects of participation in low-carbon agriculture on farmers' willingness to grow eco-agricultural crops and other influencing factors. The results show that:

(i) In six variables of farmers' characteristics, age and farming years both have significant influences on farmers' willingness to plant mushroom. The more years farmers engage in farming, the more willingness they are to plant mushroom, but when farmers get older, especially rural population aging has become increasingly serious, there are not many households expressing willingness to plant mushroom or other eco-agricultural crops. Relatively, The status of household production operation largely determines the farmer's decisions on crop choice. Specifically, the total size of farmland, other commercial crops' planting situation and participation in farmer's specialized cooperative organization are all the important factors leading to mushroom production reducing.

(ii) Farmers' participation in low-carbon agriculture has remarkable effects on their willingness to plant mushroom or other eco-agricultural crops. The main performance is that the higher degree of farmers involvement in recycling utilization of crop straw, agricultural plastic films, and other agricultural waste, the more willingness to plant mushroom. It suggests that actively advocate participation behaviors in low-carbon agriculture will help scale up the mushroom production.

(iii) When we pay attention to the difference of income between households with mushroom and households without mushroom, it is confirmed that whether to plant mushroom prominently influences household's income. To plant mushroom will bring in revenue for one's family. And, this consequence is also applicable to various income level households.

6.2. Policy implication

Combing the empirical study results and research findings above, in order to realize the popularization of low-carbon agriculture and the promotion of planting mushroom and other eco-agricultural crops, we would like to propose policies as follows:

Firstly, make efforts to improve the rural population structure. The development of rural economy is restricted by the rural labor structure, which first results in different degrees of discontinuing farming and letting go out of cultivation exist in various areas. Abandoned farmland not only exists in
mountainous area with inconvenient traffic, but also exists in low hill area and plains with convenient traffic. Abandoned farmland tends to be more and more in mountainous areas. Probing into the causes, apart from the decline of agricultural income and untimely flow of farmland, the lack of young rural labor is an important factor.

Secondly, integrate rural resource factors properly and actively guide the healthy development of farmers' specialized cooperative organization. The NO.1 Central Document in 2009 asked resource factors to be pushed toward rural areas, which is the requirement aimed at the continuous loss of rural resource factors, also the objective necessity for quickening up the new rural construction and helps to improve the application and popularization efficiency of agricultural science and technology. Besides, developing farmer's specialized cooperatives is the inevitable requirement for developing modern agriculture, and it has significant effects on stimulating farmers' planting enthusiasm and initiative. The government could issue some policies and regulations related to the development of specialized cooperatives, guarantee the healthy development of mushroom cooperative and improve the current development situation of farmer's specialized cooperative organizations in our country in which only ten percent of farmers participate.

Thirdly, strengthen the publicity and giving government subsidies to enhance farmer's recognition of participation in low-carbon agriculture, aiming at improving farmer's enthusiasm about planting mushroom or other eco-agricultural crops. Advocation of the recycling of crop straw, agricultural films and productive waste in agriculture should be especially increased. It also should be known to all that burning, burying or deserting crops straw or agricultural films are forbidden. At the same time, measures like giving out government subsidies could be taken in the initial stage to guide farmers to participate in the development of low-carbon agriculture. Additionally, logistics platform and market mechanism could be established gradually for the recycling of agricultural waste and the marketization of agricultural waste could be realized to indirectly encourage farmers to participate in mushroom production.

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