Factors Influencing Farmers' Willingness to Participate in Plant Protection Machinery Subsidies

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Abstract In order to have an overview of implementation of the subsidy policy for purchase of plant protection machinery in Fujian Province, based on the questionnaire data on Fujian Province, we use Logit model to conduct empirical analysis of factors influencing farmers' willingness to participate in the subsidy policy for purchase of plant protection machinery. Research results show that there are 69.4% of farmers willing to participate in the subsidy policy for purchase of plant protection machinery; farmers' growing area has a significant impact on the willingness to participate in the subsidy policy for purchase of plant protection machinery, and there is negative correlation; educational level, experience in planting, family farming pure income all have a significant positive impact on the willingness to participate in the subsidy policy.

Key words The subsidy policy for purchase of plant protection machinery, Willingness to participate, Influencing factors, Logit model

In 2002, the Ministry of Agriculture conducted a survey on the nationwide organizations based on the status quo of plant protection machinery and pesticide application techniques. The results show that 80% of the plant protection machines are at the development level of developed countries in the 1950s and 1960s[1]. Currently, the plant protection machinery that most farmers use is still hand-operated pesticide sprayer. The farmers' demand for plant protection machinery is urgent, but the effective purchasing power is short. Central Document No. 1 in 2004 clearly pointed out that we will give some subsidies for farmers to update and purchase applicable agricultural machinery. The subsidy for the purchase of plant protection machinery is an important part. Government gives subsidies for the farmers to purchase state-of-the-art and applicable plant protection machinery, which contributes to the upgrading of the plant protection machinery. At present, there have been many qualitative researches on the domestic subsidies for agricultural machinery, but it lacks quantitative researches. The researches are mainly focused on the effect analysis of subsidies for the purchase of agricultural machinery. Through conducting a survey on farmers' household income, agricultural workers and subsidies for agricultural machinery in Jiangsu Province, coupled with the agricultural machinery service prices, fuel consumption and labor costs, Gu Hejun argues that the subsidies for the purchase of agricultural machinery will stimulate more farmers to purchase agricultural machinery, making the service supply of agricultural machinery increase and prices fall, thereby making agricultural machinery replace labor[2]. Cao Zhiyi conducted a special survey of farmers who enjoyed special subsidies for the purchase of agricultural machinery in 11 provinces such as Hebei, Shandong, Inner Mongolia, Liaoning and Jilin[3]. In terms of the area of arable land and household income, subsidies for the purchase of agricultural machinery have caused significant positive impact on farmers. Wang Jiao conducted a survey of population of farmers, arable land area, agricultural production, sales of agricultural products, agricultural subsidies, non-agricultural employment and agricultural income in Shandong, Henan and Hebei, established PMP model based on this, and believed that the subsidies for agricultural machinery would have a positive impact on food production and farming income[4]. Liu Ning also believes that the implementation of subsidy policy for the purchase of agricultural machinery not only improves food production and income, but also changes the cost structure of food production[5]. In terms of the implementation effect of the subsidy policy, Yang Xiaojing takes the survey data on farmers in Hebei Province as the basis, and uses the variables of regional characteristic variable, farmers' household characteristics and farmers' agricultural production characteristics for analysis by Logit model, drawing the conclusion that the implementation effect of agricultural policy subsidies is vulnerable to farmers' geographical location, farmers' income level and growing area of crop[6]. In addition, Feng Jianying uses Logistic regression for empirical analysis, and finds that the main factors influencing farmers' willingness to purchase agricultural machinery include the level of education, family income, policy and consumers' attitudes[7]. Due to the short period of implementation of agricultural machinery subsidy policy, there are few research reports on agricultural machinery subsidy policy at home, and the researches on the subsidies for the purchase of plant protection machinery are rarely reported. Even if there is research with plant protection machinery as the object, most of the content is focused on the mechanical design and transformation.

Therefore, according to the survey on the implementation of subsidies for the purchase of plant protection machinery in Fujian

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Province, we use Logit model, to analyze the farmers' willingness to apply for the subsidies for the purchase of plant protection machinery and the influencing factors, in order to understand the current farmers' willingness to participate in the policy of subsidies for the purchase of plant protection machinery in Fujian Province and the influencing factors, and provide reference for the implementation and improvement of future policy.

1 A general overview of plant protection machinery subsidies in Fujian Province

The policy of plant protection machinery subsidies was implemented in Fujian Province from 2007, which has covered 76 agricultural counties (cities, districts). According to *Special Implementation Program for Agricultural Machinery Purchase Subsidies in Fujian Province* in the period 2007 – 2010[8] and the internal data of Fujian Agricultural Machinery Administration, it is estimated that as of 2010, the central government invested special funds of a total of 39.381 million yuan in the plant protection machinery in Fujian Province.

In 2007, the total funds input to subsidies for the purchase of plant protection machinery was 22 900 yuan; in 2008, the total funds input to subsidies for the purchase of plant protection machinery was 553 600 yuan, an increase of 530 700 yuan compared with 2007. In 2009, the funds input to subsidies increased by 4.168 5 million yuan compared with 2008, reaching 4.7221 million yuan. Although the annual growth rate is different, there has been an upward trend. In 2010, the sum of input was 34.082 4 million yuan, increasing by 8 times compared with the beginning of the implementation of policies. The share of subsidies for plant protection machinery in Fujian Province in subsidies for agricultural machinery increases from the former 0.08% to 10.47% in 2010, which reflects the determination and efforts of the government to improve plant protection machinery and equipment.

In addition to expanding the funds input to subsidies, Fujian Province also adjusts the annual list of subsidies, so that there are enough types of subsidizing machinery, to meet the practical needs of farmers. The number of manufacturers included in the subsidy list increased from 7 in 2007 to 58 in 2010, and the mechanical types also increased from the former 3 to 7 (Table 1). With the development of science and technology, environment-friendly insecticidal lamps and other physical control machines are also included in the scope of subsidies, enriching the field plant protection methods.

Table 1 Comparison of catalogue of subsidies for plant protection machinery purchase in Fujian Province during the period 2007 – 2010

Year	Catalogue	Number of enterprises
2007	1 power-driven sprayer-duster; 2 power-driven sprayer; 3 boom sprayer	7
2008	1 power-driven sprayer-duster; 2 power-driven sprayer; 3 boom sprayer	7
2009	1 electric sprayer; 2 power-driven sprayer-duster; 3 power-driven sprayer; 4 boom sprayer; 5 air-blast sprayer; 6 insect-killing lamp	15
2010	1 electric sprayer; 2 power-driven sprayer-duster; 3 power-driven sprayer; 4 boom sprayer; 5 air-blast sprayer; 6 insect-killing lamp; 7 pest control bag	58

Data source: *Special Program for Implementation of Agricultural Machinery Purchase Subsidies* during the period 2007 – 2010.

2 Data source and sample description

2.1 Data source Data were derived from the survey in the main agricultural production areas in Fujian Province during the period from July 2010 to September 2010, covering Fuzhou City, Sanming City, Nanping City, Quanzhou City and the Ningde area, a total of 5 prefecture-level cities and 8 villages and towns. 2 villages were selected from each town, and 15 to 20 farmers were randomly interviewed. A total of 250 questionnaires were distributed, and there were 226 valid questionnaires, with the response rate of 90.4%.

The questionnaire mainly includes four parts: (i) The basic information of individual farmers and their families, including the farmers' gender, age, educational level, growing area and family's pure farming income; (ii) The farmers' use of plant protection machinery, including farmers' plant protection mode, choice of plant protection machinery type and other issues; (iii) The willingness of farmers to participate in subsidy channels for the purchase of plant protection machinery, including the level of farmers' awareness of policy; (iv) The survey of farmers' evaluation and expectation of policies from the subsidy standards.

2.2 Statistical characteristics of sample Judging from the gender composition of the surveyed farmers, men account for 78.8% and women account for 21.2%. From the age distribution, the surveyed farmers aged less than 30 years account for 7.52%; the surveyed farmers aged 30 to 45 years account for 35.84%; the surveyed farmers aged 45 to 60 years account for 50%; the surveyed farmers aged more than 60 years account for 6.64%. From the point of view the level of education, the farmers with educational level of primary school and below account for 28.76%; the farmers with educational level of junior high school account for 53.53%; the farmers with educational level of senior high school account for 16.81%; the farmers with educational level of junior college and above only account for 0.88%. Judging from the production characteristics of the farmers, 0.67 hm^2 or less account for 53.26%; 0.67 – 1.33 hm^2 account for 28.26%; 1.33 hm^2 or more account for 18.48%. From the net family income, income less than 10 000 yuan accounts for 15.49%; income between 10 000 yuan and 30 000 yuan accounts for 52.65%; income between 30 000 yuan and 50 000 yuan accounts for 20.35%; income more than 50 000 yuan accounts for 11.5%. All statistics are able to reflect the basic characteristics of farmers in Fujian Province.

3 Study assumptions and theoretical model

3.1 Study assumptions During the analysis, 4 explanatory variables are introduced: farmers' personal characteristics, farmers' family characteristics, production characteristics and policy cognitive characteristics.

(1) Farmers' personal characteristics (X_p), mainly including age, education level and farming experience. Theoretically the higher the educational level, the greater the ability to accept new things and advanced ideas, the greater the willingness to apply for the purchase of new plant protection machinery. In addition, the richer the farming experience, the greater the urgency to improve the efficiency of agricultural production, the greater the willingness to apply for subsidies.

(2) Farmers' family characteristics (X_f), mainly including net income from agriculture and amount of plant protection machinery owned by family. The higher the net income of agricultural production, the greater the tendency to improve the technique of plant protection machinery. For the families having purchased new plant protection machinery, their willingness to purchase plant protection machinery will be reduced, and even if the government gives subsidies, the purchase intention nor will not be very strong.

(3) Production characteristics (X_e), including growing area and labor proportion. The smaller the land scale, the greater the costs of mechanized plant protection operating, the weaker the willingness of farmers to apply for subsidies. Plant protection machinery has a certain role of labor substitution. The lower the proportion of labor force, the higher the demand for the plant protection machinery with high utility, the stronger the willingness of farmers to apply for subsidies to purchase plant protection machinery.

(4) Policy cognitive characteristics (X_c), mainly referring to the awareness level of farmers on the subsidy policy for purchase of plant protection machinery. According to the results of the sample description, the measurement and value assignment of the selected variables are shown in Table 2.

Table 2 Value assignment of independent variable and dependent variable

	Variable	Variable name	Variable definition	Mean
The dependent variable		Willingness to participate	Willing = 1; reluctant = 0	0.68
	Farmers' personal characteristics (X_p)	Educational level	Primary school and below = 1; junior high school = 2; senior high school = 3; above junior college = 4	1.90
		Experience in planting	Actual experience in planting//year	17.19
	Farmers' family characteristics (X_f)	net income from agriculture	Family net income from agriculture//yuan	29077.88
Explanatory variable		Amount of plant protection machinery owned by family	The number of plant protection machinery actually used by family	1.62
	Production characteristics (X_e)	Growing area	The area of crops grown by family//hm^2	0.824
		Labor proportion	The share of labor in household population//%	0.46
	Policy cognitive characteristics (X_c)	Farmers' awareness of policy	Do not know = 1; know = 2	1.72

3.2 Model selection What we care about is farmers' willingness to choose subsidies for the purchase of plant protection machinery, and the dependent variable is a categorical variable, so the linear regression method is not applicable. Logit model is the most commonly used method in the regression analysis for categorical variables, so the binary Logit model is chosen to analyze the factors influencing farmers' willingness to choose subsidies for the purchase of plant protection machinery. The dependent variables in the binary Logit regression model take two values, signified by dummy dependent variable 1 and 0. To test the hypothesis of the willingness of the farmers to be involved in policy and its influencing factors, according to the classification of the previous variables, the willingness of farmers to apply for subsidies for the purchase of plant protection machinery is taken as the dependent variable y, and the functional form is set as follows:

$$y = F(X_p, X_f, X_c, X_e) + \mu \quad (1)$$

where y is the willingness of farmers to participate in the subsidy; willing to apply for = 1; reluctant to apply for = 0. Logit model is established to analyze the willingness to participate in the policy, and the basic form can be seen in expression (2) and (3).

$$p_j = F(\alpha + \sum_{j=1}^{m}\beta_{ij}x_j = 1/\{1 + \exp[-(\alpha + \sum_{j=1}^{m}\beta_{ji}x_j)]\} \quad (2)$$

According to expression (2), we derive the following expression:

$$\ln\frac{p_i}{1-p_i} = \alpha + \sum_{j=1}^{m}\beta_{ji}x_j \quad (3)$$

where p_i represents the probability of farmers involved in policy; j represents the code number of influencing factors; m represents the number of factors that affect this probability; α represents the regression intercept; x_i is independent variable, signifying factor j influencing farmer j.

4 Empirical results of factors influencing farmers' willingness to participate in plant protection machinery subsidies

Prior to analysis, collinearity diagnosing is first conducted on these independent variables. The method of variance expanding factor is a common means to diagnose multicollinearity. The average of va-

riance expanding factors that P independent variables correspond to, is used to test collinearity[9]. When $\overline{VIF}$ is greater than 10, there will be serious collinearity between independent variables. The calculation result in the study $\overline{VIF} = 1.25$, and the value is within the required range ($\overline{VIF} < 10$). There is no serious multicollinearity problem between the independent variables. So it is possible to establish the Logit regression equation.

Using Eviews 6.0 statistical software, the Logit regression processing is conducted on 226 copies of sectional data concerning farmers surveyed. In the process of data processing, ML Logit method is used and after nine iterations, it obtains convergence, to get the model:

$$y = -3.37 + 1.03CUL + 0.06EX + 4.69E - 0.5INC - 0.49LAB + 0.34NUM + 0.08REC - 0.02S$$

where CUL, EX, INC, LAB, NUM, REC, S represent educational level, experience in planting, net family income in agriculture, labor proportion, amount of plant protection machinery owned, policy awareness and growing area, respectively.

In the binary regression model, the goodness of fit is minor, and the expected sign of the regression coefficients and their statistical and (or) the actual significance is primary[10]. Therefore, from the results of running of the model, LR statistic of the model is 51.692 81, and it is used to test the overall significance of the model. The corresponding probability $P = 6.71 \times 10^{-9}$, the probability value is very small, thereby indicating that the model reaches significance level on the whole (Table 3).

Table 3 Regression results of model

Variable	Coefficient	Standard error	z-statistic	*P*	Odds ratio
Constant	-3.368	0.973	-3.460	0.001	-
Educational level	1.027	0.278	3.694	0.0002***	2.794
Experience in planting	0.064	0.018	3.635	0.0003***	1.066
Household income	4.69×10^{-5}	1.11×10^{-5}	4.236	0.0000***	1.000
Labor proportion	-0.490	1.010	-0.486	0.627	0.612
Amount of plant protection machinery owned	0.345	0.238	1.447	0.148	1.411
Policy awareness level	0.076	0.204	0.372	0.710	1.079
Growing area	-0.021	0.011	-1.861	0.062*	0.979
LR statistic (7 df)	51.693	P (LR statistic) $= 6.71 \times 10^{-9}$			
McFadden R^2	0.183				

Note: *** signifies that there is statistical significance at 99% confidence interval; ** signifies that there is statistical significance at 95% confidence interval; * signifies that there is statistical significance at 90% confidence interval.

In operating results, the *P* value is used to judge the significance degree of each factor. Farmers' household income, educational level and experience in planting are significant in 99% confidence interval, and the growing area is of statistical significance in 90% confidence interval. In addition, in the Logit regression model, the regression coefficient can not be understood as a marginal effect on the dependent variable in the ordinary regression. We can only judge from the sign the increase or decrease in variable probability arising from the increase in independent variables[9]. We can adopt odds ratio to interpret the estimated value of the Logit model, namely taking inverse logarithm of the estimated Logit, to derive $p_i/(1-p_i)$ (odds ratio)[10], interpreted as the inverse logarithm of slope coefficient *j*.

4.1 Net income from agriculture has a significant positive impact on the willingness to participate in the subsidy policy Net income from agriculture is the variable with the highest significance in the four significant variables, and the sign of the coefficient is positive, which is consistent with the assumption put forth by us, indicating that the higher the farmers' net income from agriculture, the stronger the willingness to participate in the subsidy policy for purchase of plant protection machinery. The odds ratio further indicates that for each additional one unit in net income from agriculture, the willingness to apply will increase by 2.8 times.

4.2 Educational level has a significant positive impact on the willingness to participate in the subsidy policy The higher the level of education, the stronger the willingness to participate in the subsidy policy for purchase of plant protection machinery. It is consistent with the assumption put forth by us. If the educational level is higher, the farmers are more willing to accept and try to use the new plant protection machinery. In the interview, it is also found that such farmers believe that using the subsidies to buy new machinery, can improve the efficiency of the use of pesticides, and reduce the possibility of pests and diseases.

4.3 Experience in planting has a significant positive impact on the willingness to participate in the subsidy policy The sign of impact coefficient of experience in planting is positive. The richer the experience in planting, the stronger the willingness to participate in the subsidy policy for purchase of plant protection machinery, which is consistent with the assumption put forth by us. The odds ratio further indicates that in the case of other conditions remaining unchanged, for each additional one unit in experience in planting, the willingness to participate in subsidies for the purchase of plant protection machinery will increase by 1.066 times.

4.4 Farmers' growing area has a significant impact on the willingness to participate in the subsidy policy for purchase of plant protection machinery The sign of impact coefficient of

farmers' agricultural growing area is negative, indicating that in the case of other conditions remaining unchanged, the larger the growing area, the weaker the willingness to participate in the subsidy policy for purchase of plant protection machinery, which is contrary with the assumption put forth by us. The possible reason is that large growing households have been basically equipped with one or two types of machinery, which can meet the needs of daily production. For the farmers with a moderate level of growing area, they have a more urgent need for the upgrading of plant protection machinery. The subsidy policy can reduce the cost of the purchase of agricultural machinery, so the willingness to participate in policy is also higher.

5 Main conclusions and recommendations

Plant protection machinery subsidy policy plays a huge role in promoting replacement of plant protection machinery, and farmers' willingness to participate is not only a standard for measuring the effect of this policy , but also an important indicator for observing the ability of farmers to buy.

(1) Farmers are very willing to apply for subsidies for purchase of plant protection machinery, and under the existing policy arrangement, there are 69.4% of farmers willing to apply for the subsidies for purchase of plant protection machinery.

The government should increase the input of subsidy capital and expand farmers' benefiting scope. In addition, since the implementation of policies, government has tightened control on the quality of plant protection machinery included in subsidy list, so that the farmers entertaining wait-and-see attitude show great willingness to participate. There are also some farmers with relatively small acreage wanting to reduce acquisition costs and complete the update of the plant protection machinery by way of subsidies.

(2) Under the current policy, farmers' application will is affected by various factors. In the process of policy implementation, we should not only take full account of Fujian' geographical features and practical needs of the farmers, but also give full consideration to farmers' personal characteristics, household characteristics and production characteristics. Pure family farming income is a key factor affecting willingness to participate, and the demand of the plant protection machinery is constrained by income. Taking the case of Pucheng County, most of the local farmers use manual sprayers, and the prevention effect is poor, so they have a strong need for plant protection machinery, but ability to pay is not enough. On the basis of balance, we should increase support to major grain - producing areas, and improve the subsidy standard for plant protection machinery, to stabilize grain production.

(3) The level of participation is mainly dependent on the publicity of government and related institutions. The policy cognitive factor is not a significant factor that affects farmers' willingness to participate in the subsidy, but the government can play a more important role. The government should not only act as policy advocate, but also act as the builder of a platform, so that the manufacturers of plant protection machinery can communicate with farmers in this platform, and farmers can freely choose the machinery. The government should timely carry out promotion of plant protection machinery in the countryside or the use training of plant protection machinery, to make farmers change the traditional plant protection concepts, and use advanced and applicable plant protection machinery.

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