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Landowners' Participation Behavior on the Payment for Environmental Service (PES)

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1. Introduction

Since private landowners have their rights to determine whether to go afforestation, the government intends to achieve the purposes on ecological conservation of land, soil and water conservation, as well as environmental greening. Because it takes a long time to harvest the forests, such long-term investments make private landowners difficult to raise funds. Therefore, it is common to see that each country in the world agrees on the loan and subsidy schemes for afforestation, and related incentive policies include the free supply of seeds, preferential loans on afforestation, preferential taxes, afforestation subsidies, and so on[1].

Taiwan has introduced many afforestation incentive policies to raise people's intention to go afforestation from 1951 to 2002. Since 1951, in order to reward the afforestation in the ecological conservation land that falls into disuse, the Taiwan Provincial Government has announced the "Detailed Rules and Regulations of Rewarding Afforestation of Ecological Conservation Land in Taiwan Province" to reward the people to invest in the afforestation in ecological conservation land, with the offerings of no payment for rents and the adoption of major/side products without price. At that time, in order to promote local people to go afforestation, the government agreed on "Regulations of Private Forests", "Rules and Regulations of Rewarding Afforestation in Private Forest Land", and so on. In 1974, the government agreed on "Regulations of Revenue and Expenditure, Safekeeping and Manipulation of Afforestation Loan Funds of Taiwan Province". In 1983, in order to foster forest resources and enhance the guidance and assistance of private afforestation, the government agreed on "Regulations of Rewarding Private Afforestation in Taiwan Province", in which the subsidy for afforestation was NT$ 1,200 per hectare.

[1] According to Nagubadi et al. (1996), the related incentive policies for afforestation policy in the U.S. are divided into two categories in general. The first is the direct payment policy, including tax free, direct subsidy and free technical assistance, e.g., Indiana State belongs to this policy; the second is the cost-sharing policy, in which the partial cost is subsidized by the government for landowners to go afforestation. In other words, the cost occurred from afforestation programs include new afforestation land, afforestation and forestry management expenses, in which 50-75% of the expenses were covered by the government. Many forestry policies in the U.S. all belong to this category of policy, including forestry incentive program (FIP), Stewardship incentive program (SIP), agricultural conservation program (ACP) and conservation reserve program (CRP).

In 1991, the government revised "Regulations of Rewarding Private Afforestation in Taiwan Province", and agreed on "Regulations of Rewarding Afforestation in Cropland" to guild and assist the afforestation in marginal cropland and make use of land resources in a reasonable way, in which the subsidy was increased to NT$ 32,000 per hectare, and was revised again in 1994 to NT$ 150,000 at most per hectare. In 1996, Typhoon Herb attacked Taiwan and resulted in severe damage. In order to recover the function of soil and water conservation, the government had carried out the "General Afforestation Campaign" to achieve the objective of greening afforestation and water conservation. Under this program, the afforestation subsidy was increased up to NT$ 530,000 in total per hectare for 20 years. In August 2008, in order to respond to the impact on the trade liberalization of international farm products due to Taiwan's joining WTO, the production of the cropland resources was reduced accordingly. For the released cropland due to the reduction of production, the government has approved the Plain Landscape Afforestation Program (PLAP)[2] since 31 August 2001, and implemented it on 1 January 2002, to guide and assist farmers and Taiwan Sugar Corporation to leave their land fallow in a long-term period and further afforest it. The government provided afforestation subsidies and direct payments, which amounted to NT$ 1,610,000 per hectare for 20 years, and the main objectives were the marginal cropland in ordinary farm areas.

Reward for the afforestation in cropland has become one of the major trends for the forestry policies in the world, which plays an essential role in the development of forestry policies for the time being. As far as Taiwan is concerned, due to the rising ecological consciousness of forest conservation and the rising living standard of the people, human beings' demand for forests is getting more and more. However, under the policy of emphasizing agricultural production previously, most plain areas in Taiwan are used for agricultural production, the forests in plain areas are insufficient, and the cropland acreages planned by Taiwan government are too huge, so that the ecology is threatened. Therefore, if the marginal cropland can be applied for the PLAP, the cropland use will be raised effectively.

Despite the positive comments on the good intention of PLAP, there are still many difficulties during the process of implementation; as shown in Table 1, the total area that implemented the PLAP is 8,829.18 hectares while the area for the afforestation in private cropland is 869.18 hectares (only occupying 9.84% of all), which is against government's original good intention on drafting the policy earlier on. According to the previous work, the possible reasons for the poor implementation of the afforestation in private cropland include insufficient professional afforestation technology, private landowners' low interest in participating in PLAP, insufficient subsidies, and so on.

From the literature, since private landowners normally have less efficiency in land use and do not attain the land production potential, hence the interference of public policies is required. The main goal of the policy tools related to private landowners is to make the personal objective consistent with the objective of maximizing social welfare. As shown in Table 2, many previous results indicated that the subsidy policies and the assistance of

[2] The idea of the afforestation policy in plain areas has been fermenting for a long time, mainly because of insufficient greenery resources of plain areas in Taiwan, entry of WTO, and the bulky croplands that continue to go fallow and reduce production. Hence, the government is actively promoting the afforestation policy in plain areas, which not only attains the fundamental mission for the reduction of fallow area, but also achieves landscaping to increase carbon sequestration and enhance the purpose of enhancing the quality of the environment.

related technologies from the government have positive effects on landowners' decision for afforestation, while there will be negative effects on landowners' decision for afforestation if the government imposes more related regulations on afforestation.

Year	2002	2003	2004	2005	2006	2007	Total
Private Cropland (NIPF)	229.82	132.08	174.83	145.10	124.40	65.17	869.18
Taiwan Sugar Corp. (IPF)	1,361.40	3,940.09	1,150.00	877.00	263.63	367.88	7,960.00
Total	1,591.22	4,072.17	1,324.83	1,022.10	388.03	433.05	8,829.18

Unit: hectare
Note: NIPF denotes nonindustrial private forest, while IPF denotes industrial private forest

Table 1. Afforestation areas for the PLAP in Taiwan (Years from 2002 to 2007).

Government's policy	Effects on decision-making		Related literature
	Effects on afforestation decision	Effects on logging decision	
Knowledge of cost-share programs	positive effect	literature indicated that there was a positive impact, but no concrete conclusion	(Hyberg and Holthausen, 1989) (Royer, 1987) (Zhang and Flick, 2001) (Megalos, 2000) (Hardie and Parks, 1991)
Knowledge of public technical assistance	positive effect	positive effect	(Hyberg and Holthausen, 1989) (Royer, 1987) (Zhang and Flick, 2001) (Hardie and Parks, 1991)
Regulation	negative effect	no related literature	(Zhang and Flick, 2001) (Boyd and Hyde, 1989)

Table 2. Effects of government's related policies on private landowners' afforestation and logging decisions. Source: Cubbage et al. (2003)

Hardie and Parks (1991) indicated that the offerings of cost-sharing programs and public technical assistance give obvious and positive effects on private landowners' decision for afforestation policies. They also conducted an analysis on the cross effects of the public technical assistance and cost-sharing programs, and their result indicated that the cost-sharing programs perform better than the public technical assistance. Cubbage (2003) proposed that the public policy or technical assistance provided by the government would boost landowners' afforestation revenues and the quality of forest management. In addition, a lot of literature analyzes the behavior of participation in afforestation programs, in which the mainly investigated objects are cost-sharing programs. For example, English et al. (1997) found that higher income and lower cost would lead to higher probability of afforestation;

Nagubadi et al. (1996) proposed that older age and larger land area would enhance the probability of participating in afforestation; Stevens et al. (1999) proposed that older age would reduce the probability of participating in afforestation, but higher income would raise it; Megalos (2000) and Lorenzo and Beard (1996) proposed that the people who have larger land area and are not farmers would have higher probability to participate in afforestation. Esseks and Moulton (2000) conducted an examination on private landowners' (NIPF) participation in Forest Stewardship Program (FSP) and Stewardship Incentives Program (SIP), both of which have been implemented since 1990 in the USA and supported by Farm Bill since 2002. Listed as the policies in Forest Land Enhancement Program, these include afforestation, reforestation, forest improvement, forest stewardship plans, agroforestry policy, soil and water quality and wetlands maintenance, and so on. Among them, the subsidy scheme provided by the government has remarkable effects on attracting landowners to participate in afforestation.

In Taiwan, the government has begun carrying on the PLAP since 2002, but the outcome is under expectation. Therefore, the Taiwanese government needs to desperately study the following important issues: What are the key factors that influence private landowners to participate in the PLAP? What are the factors that affect private landowners' afforestation behavior? Are these factors the same as those listed in other literature? In light of the above, the primary purpose of this paper is to analyze the decision behavior of private landowners' participation in the PLAP in Taiwan, and analyze the factors that influence private cropland owners' participation in afforestation. In addition, we compare the similarities and dissimilarities between Taiwanese private landowners' decision and the decision factors listed in the literature. The empirical result of this paper expects to provide as a reference to those policy institutors of forest department in Taiwan for related policy institution.

This paper is organized as follows. The theoretical model of landowners' decision on afforestation is given in section 2, the empirical model and the analysis on our empirical result are given in section 3, whereas Conclusions and suggestions are given in section 4.

2. Theoretical model of landowners' decision

2.1 Theoretical model of landowners' decision on afforestation

As for the landowners' behavior on land use, Rahm and Huffman (1984) were the first to propose a general equilibrium model based on farmers' pursuing the utility maximization. Let $t = 1$ (resp., $t = 0$) represent that the private landowner does (resp., does not) participate in the PLAP. The utility function of private landowner i is defined as $U(H_{ti}, M_{ti})$, in which H_{ti} represents the landowner characteristics factor, including age, education, income and occupation; M_{ti} represents the management characteristics factor, including information source, attitude, current land use, etc. The utility function $U(H_{ti}, M_{ti})$ is expressed as follows:

$$U_{ti} = \alpha_t F_{ti}(H_{ti}, M_{ti}) + e_{ti}, \quad \text{for } t = 1, 0 \text{ and } i = 1, 2, \ldots, n \tag{1}$$

The above equation is not limited as a linear function, in which U_{ti} is a random function. Therefore, if $U_{1i} > U_{0i}$, then landowner i will participate in the PLAP ($t = 1$); otherwise, landowner i will not participate in the PLAP ($t = 0$). Let y_i^* (i.e., $U_{1i} - U_{0i}$) be an unobservable afforestation tendency variable. Therefore, the observable variable for afforestation decision (y_i) can be expressed as follows:

$$y_i = \begin{cases} 1, \text{ if } y_i^* > 0; \\ 0, \text{ otherwise.} \end{cases} \quad (2)$$

in which y_i = 1 represents that landowner i chooses to participate in the PLAP while y_i = 0 represents no. Therefore, the probability P_i of landowner i's participation in PLAP is given as follows:

$$\begin{aligned} P_i &= P_r(y_i = 1) = P_r(U_{1i} > U_{0i}) \\ &= P_r[\alpha_1 F_{1i}(H_{1i}, M_{1i}) + e_{1i} > \alpha_0 F_{0i}(H_{0i}, M_{0i}) + e_{0i}] \\ &= P_r[e_{1i} - e_{0i} > F_{ti}(H_{ti}, M_{ti})(\alpha_0 - \alpha_1)] \\ &= P_r[\mu_i > F_{ti}(H_{ti}, M_{ti})\beta] \\ &= F(X_i^{'}\beta) \end{aligned} \quad (3)$$

in which P_i is the probability of landowner i 's participation in PLAP; $\mu_i = e_{1i} - e_{0i}$ is a random disturbance term; $\beta = \alpha_0 - \alpha_1$ is a predicate parameter vector, X_i' is an explanatory variable vector; $F(X_i', \beta)$ is a cumulative distribution function. If there is no function form of $F(X_i', \beta)$ in the above equation, then it is not allowed to predict it directly. The form of $F(X_i', \beta)$ is determined according to the distribution of $\mu_t = e_{1t} - e_{0t}$. If μ_t is a normal distribution, then F is a cumulative normal distribution; if μ_t is a uniform distribution, then F is a triangular distribution. The landowners of private cropland depend upon the above decision model to determine whether to participate in the PLAP. Since the dependent variables include participation and nonparticipation, the Probit model and Logit model can be applied to the analysis on this type of problems.

2.2 Binary choice model

A so-called binary choice model[3] is to suppose that a representative individual needs to choose one out of two items. The regression model of normal linear probability mode is stated as follows:'"

$$\begin{aligned} Y_i &= \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_j X_{ji} + \varepsilon_i \\ Y_i &= \begin{cases} 1, & \text{if "Yes";} \\ 0, & \text{if "No".} \end{cases} \end{aligned} \quad (4)$$

in which Y_i is a binary choice variable, X_{ji} is an independent variable, and ε_i is a deviation item. Since Y_i represents only two numbers, i.e., 1 and 0. Therefore, we can let P_i = Prob(Y_i = 1) and 1 – P_i = Prob(Y_i = 0) to explain the distribution of Y probability, whose expected value is:

$$E(Y_i) = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_j X_{ji} = P_i \quad (5)$$

To transform Equation (4) as an estimate equation, we obtain:

[3] Binary choice issue is a issue with two possibilities, such as whether to pass the admission exam, whether to come down with disease, whether to participate in afforestation program and so on. All these belong to Binary or Dichotomous, while the Probit model and Logit model can be used to analyze this kind of binary choice issues.

$$Y_i = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_j X_{ji} \tag{6}$$

That is, the linear probability model in Equation (6) takes the estimated value of *Y* as its probability, and therefore, if the estimated value *Y* exceeds the range of [0, 1], then there will be a problem on estimation. In order to solve this problem, we may re-estimate the parameters *a* and *β* under the limitation of $0 \le Y_i \le 1$, and determine minimum square parameter estimated value according to the limitation of inequality, but this is a nonlinear way to estimate the value. In the linear probability model, there exist some variances which cannot be explained through the model. In order to solve this problem, the previous research used a conversion probability from 0 to 1, i.e. to use a cumulative probability function to convert the variable. The probability distribution is listed as follows:

$$P_i = F(\alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_j X_{ji}) = F(Z_i) \tag{7}$$

It will lead to a probability model with restricted conditions if the above equation is applied to the variable conversion. There will be a variety of probability models if we apply different cumulative probability functions for variable conversion. A probability model via the normal cumulative random function for variable conversion is the Probit model, while the probability model via the variable conversion of the cumulative logarithmic probability is the Logit model. The results of these two models are roughly the same, but the differences of explanatory variables will be affected drastically if some explanatory variables are too large numbers and have huge variances. But the Logit model can make up for this drawback. In this paper, we apply the Logit model to conducting analysis, since the numbers of explanatory variables varies a lot in comparison to the numbers of dependent variables.
A probability model via the variable conversion of the cumulative logarithmic probability function is the Logit model, which is shown as follows:

$$\begin{aligned} &P_i = F(Z_i) = \frac{1}{1+e^{-Z_i}}, \\ &\log(\frac{P_i}{1-P_i}) = Z_i, Z_i = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_j X_{ji} \end{aligned} \tag{8}$$

in which P_i represents the probability of landowner number *i* for the participation of afforestation; *a* is the intercept; β_j is the coefficient of independent X_{ji}. From Equation (8), it is estimated that once the independent variable is changed by one unit, the value of dependent variable is changed to:

$$\frac{\partial P}{\partial X} = \frac{\partial F(Z_i)}{\partial X} = f(Z_i)\beta_j X_{ji} \tag{9}$$

This paper will conduct an empirical analysis on the above theoretical model.

3. Empirical model and empirical result analysis

3.1 Variable selection and data source

3.1.1 Variable selection

From the literature, there exist many results regarding the analysis on nonindustrial private forest landowners' behavior on afforestation (e.g., Royer, 1987; Alig et al. 1990; Hardie and

Parks 1991; Nagubadi et al., 1996; Zhang and Flick, 2001; Sills and Abt, 2003). This paper considers the possible factors proposed by Sills and Abt (2003) which might affect private landowners' behavior on afforestation–including landowner characteristics (*OC*), cropland characteristics (*CC*), and forestry programs (*FP*). The landowner characteristics include gender, household income, occupation, age, number of family members, etc.; the cropland characteristics include cropland price, cropland rental, distance away from downtown, area, amount of cropland area, etc.; the forestry programs include afforestation subsidy amount, duration of subsidy, rules on adjoining and adjacent areas, etc.

Hence, this paper bases upon the above variables to establish the following regression model to examine the choice of landowners' decision on afforestation:

$$PP = f\,(OC, CC, FP) \tag{10}$$

In other words,

$$PP = \alpha + \Sigma\, \beta_i \cdot OC_i + \Sigma\, \gamma_j \cdot CC_j + \Sigma\, \delta_k \cdot FP_k + \varepsilon$$

in which *PP* represents whether to participate in the PLAP (*PP* is 1 if participation, while *PP* is 0 if no); *OC* represents private landowners characteristics; *CC* represents the cropland characteristics owned by private landowners; *FP* represents forestry programs[4]; OC_i, CC_j, and FP_k represent each characteristic of *OC*, *CC*, and *FP*, respectively, and β_i, γ_j and δ_k are their corresponding weights in the formula.

3.1.2 Data source

From Table 1, in spite of the limitation of the afforestation area, Pintung County reported the most significant result in terms of afforestation area among the 16 cities and counties that implemented the PLAP in Taiwan, and there were private landowners in Pintung County participating in the PLAP from 2002 to 2005, which was the only region that participated in PLAP for the four years consecutively. Therefore, this paper has conducted a survey in Pintung County during August to November 2004, to analyze farmers' participation and nonparticipation in PLAP.

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[4] According to a study on landowner's effective theory (Binkley, 1981), the empirical research of landowners' forestry management pointed that the landowners' characteristics including landowners' income, occupation (agriculture and non-agriculture), residence type (local residents or external residents), education level and age based on the research (Cubbage, 2003) said that, the most important about landowner characteristics was "income"; it showed that the higher the income, then the higher participation on the afforestation policy. According to Alig et al. (1990), the impact on logging decision is far more than the impact on afforestation among the landowner characteristics. This probability implies that the landowner characteristics will have a more direct impact on the market (logging revenues). Also, according to the efficiency model for the decision-making behavior of the private landowners (Binkley, 1981; Dennis, 1989), "career factor" is normally a more indirect factor and according to Romm et al. (1987), for those local landowners who live here for a long time have higher probability in participating the afforestation program while those temporary residents have longer probability in participating the afforestation program. Moreover, Romm et al. (1987) also found that older elderly tends to reduce investment behavior, while Zhang & Flick (2001) pointed that the age does not have significant relevance to the choice of afforestation. As far as cropland characteristics are concerned, cropland area has significant relevance to the participation probability. Likewise, the higher percentage the forest land is, the higher participation probability it is. The residents who live here for a long time also reported higher probability in participating in the afforestation program.

The respondents of the survey included the farmers that do or do not participate in the PLAP. There are 33 villages and towns in total at Pintung County, deducted from those mountain aboriginal towns with less or none normal agriculture areas (eight towns/villages in total) and Luoqiu Village. Hence, we considered the 24 remaining villages/towns. Then we conducted a random sampling out of these 24 villages/towns, and selected out 11 villages/towns, including Pintung City, Lin-lo, Qui-zu, Kao-shu, Wang-luan, Ne-pu, Hsin-bei, Fang-liao, Hsin-yuan, Ken-ding, and Ling-beng Villages/Towns.

For these 11 villages/towns, the sampling number of each village/town was determined according to the size of its normal agricultural area, such that the sampling data falls into the cropland in the normal agricultural area. What we chose included 38 samples from Pintung City, 15 samples from Lin-lo, 21 samples from Qui-zu, 115 samples from Kao-shu, 74 samples from Wang-luan, 57 samples from Ne-pu, 43 samples from Hsin-bei, 71 samples from Fang-liao, 16 samples from Hsin-yuan, 15 samples from Ken-ding, and 16 samples from Lin-beng. There were 481 samples in total and 304 effective samples. Since there were not many farmers participating in the PLAP, thus we applied census to investigating the farmers who have participated in the PLAP. There were 39 samples in total.

3.1.3 Variable description

As mentioned above, according to the previous literature, Sills and Abt (2003) pointed that the possible factors of affecting the behavior of private landowners' participation in afforestation includes landowner characteristics–gender, annual household income, occupation, age, number of family members, cropland characteristics–cropland price, cropland rental, distance from the downtown, cropland area, number of cropland parcels, forestry programs–afforestation subsidy, duration of afforestation, rules on adjoining and adjacent areas, etc. This paper uses the survey data of the farmers in Pintung County to conduct the estimation on the decision behavior of the participation in afforestation.

Based upon Equation (10), the definition of variables in the model is listed in Table 3. According to this equation, the explanatory variables of afforestation programs can be divided into three types: landowner characteristics (*OC*), cropland characteristics (*CC*) and forestry programs (*FP*). The landowner characteristics include six variables – gender, age, education level, occupation, household income, and number of family members. Cropland characteristics include six variables – total cropland area, cropland, cropland price, distance from Township Office, distance from county government, and number of cropland parcels. Finally, the forestry program variables include three variables as follows – whether landowners' cropland area meets the regulation of adjoining and adjacent areas, whether landowners agree that the subsidy for PLAP is reasonable, and whether landowners agree that the duration for the subsidy of PLAP is reasonable (e.g., the participation in the PLAP might make the future cropland use lack for flexibility; the participation in the PLAP might reduce the opportunity for the change of land use; not clear about the value of afforestation after 20 years).

3.2 Analysis of whether landowners participate in PLAP

From Table 4, the reason for the landowners' non-participation in the PLAP is that they are not aware of the PLAP, representing up to 60%; those who are aware of the PLAP and choose not to participate in the PLAP still occupies 68.9%, among which "landowners' croplands fail to meet the requirement of afforestation policy's adjoining and adjacent areas, and it is not easy for a joint application with other people" occupies 25%, followed by "the participating in the PLAP might lead to inflexibility of land use" occupying 20.0%, and "the participation in the PLAP might reduce the opportunity for the change of land use", which occupies 18.9%. Other reasons such as "higher revenues if used in other purposes", or "participation in the PLAP will lose flexibility of land use in future" occupies less proportion. Other related parameters that determine whether to participate in afforestation program are shown in Table 4.

Variable type	Variable name	Variable description	Prediction direction
The decision dependent variable (*PP*)	whether to participate in PLAP	yes=1, no=0	
Landowner characteristics (*OC*)	sex (SEX)	male=1, female=0	+
	age (AGE)	age of landowner (year)	+
	education level (EDU)	junior high school=1, above senior high school/vocation school=0	?
	occupation (OCC)	agriculture=1, non-agriculture=0	+
	annual household income (INC)	landowner's INC (NT$ 10,000/year)	+
	number of family members (POP)	number of landowner's family members (person)	?
Cropland characteristics (*CC*)	cropland area (ALAND)	total operation areas of the cropland	+
	cropland rental (RLAND)	landowners' cropland rental (NT$ 10,000/hectare/year)	–
	cropland price (PLAND)	landowners' cropland price (NT$ 10,000/hectare)	–
	distance from the county government (LOCA1)	the distance of landowners' cropland from county government (km)	+
	distance from the township office (LOCA2)	the distance of landowners' cropland from ownership office (km)	+
	number of cropland parcels (NLAND)	landowners' number of cropland parcels	–
Forestry programs (*FP*)	regulation of rewarding afforestation (REG)	landowners' cropland area that meets the regulation of adjoining and adjacent areas = 1, if not=0	+
	duration of afforestation (YSUB)	those who agree that the duration for the subsidy of PLAP is reasonable=1, if not=0 if not	+
	afforestation subsidies (ASUB)	those who agree that the subsidy for PLAP is reasonable=1, if not=0	+

Table 3. Instructions for the parameters used in the model

<table>
<tr><td rowspan="2">Unaware of the PLAP (60%)</td><td>Participating in the PLAP after being aware of it (31.1%)</td><td rowspan="3">Reasons for not participating in the PLAP after being aware of it:
Landowners' cropland fails to meet the regulation on land area (25.0%)
Low afforestatoin subsidies (11.2%)
Lose flexibility of land use for 20 years (20.0%)
Reduce the opportunity for the change of land use(18.9%)
Unfamiliar with afforestation tasks (11.8%)
Unfamiliar with the value of afforestation after 20 years (13.1%)</td></tr>
<tr><td>Not participating in the PLAP after being aware of it (68.9%)</td></tr>
<tr><td colspan="2">Choose not to participate in the PLAP after being aware of it (40%)</td></tr>
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Table 4. Analysis on the landowners who do not participate in PLAP

3.3 Mean and significance of independent variables in afforestation decision-making

The mean and standard deviation of independent variables are listed in Table 5. Generally speaking, no matter whether to participate in PLAP, the male is the majority as always; there is no remarkable difference of ages of the landowners who participate in PLAP or not. This result is consistent with the results from Ervin and Ervin (1982), Korsching et al. (1983),

Independent variable	(participants) n = 39		(nonparticipants) n = 304		F-statistics
	Mean	(S.D.)	Mean	(S.D.)	
SEX	0.87	0.34	0.80	0.40	1.07
AGE	56.67	10.87	55.77	12.82	0.18
EDU	0.28	0.46	0.57	0.50	11.78***
OCC	0.31	0.47	0.53	0.50	6.91***
INC	55.05	45.15	51.88	46.51	0.16
POP	4.18	1.94	4.69	2.50	1.53
ALAND	3.65	4.70	1.16	1.76	41.30***
RLAND	5.18	3.99	5.18	7.85	0.10
PLAND	592.19	416.41	566.71	690.90	0.05
LOCA1	27.86	19.15	24.88	13.87	1.45
LOCA2	4.35	1.24	4.44	6.50	0.01
NLAND	1.18	0.60	2.51	1.76	22.01***
REG	1.00	0.00	0.51	0.50	32.27***
YSUB	1.00	0.00	0.78	0.42	11.17***
ASUB	1.00	0.00	0.49	0.50	40.87***

Note: a sample size of 343 in total, in which there are 39 participants and 304 nonparticipants. (*), (**) and (***) represent a significance level of 10%, 5% and 1%, respectively

Table 5. Mean and standard deviation of independent variables in the model

McNamara et al. (1991) and Nagubadi (1995), which proposed that older landowners tend to participate in afforestation programs. Moreover, according to the survey conducted by this paper, the education level of those who participate in PLAP is apparently less than that of the landowners who do not participate, which is different from the results from Boyd (1984), Hammentt (1992) and Nagubadi et al. (1996), which proposed that the landowners with higher education level tend to participate in afforestation programs. As for annual household income, those who have participated in PLAP reported a higher income than those who do not participate in PLAP.

The occupation type for those who do not participate in PLAP tends to be agriculture industry. Those who do not participate in PLAP reported more family members but yet obvious. On the other hand, participants reported larger cropland areas than the landowners who do not participate in PLAP. Such a conclusion is consistent with the results from Napier et al. (1984), Korsching et al. (1983), McNamara et al. (1991) and Nagubadi et al. (1996). As for the cropland rental and cropland price, there is no major difference between participants and nonparticipants while nonparticipants reported higher rental and land cost. The croplands owned by nonparticipants reported far distance from county government and township office. The cropland owned by participants reported more complete cropland while the cropland owned by nonparticipants is more fragmentary. As for the forestry program variables, it is obvious that participants recognize the contemporary policy design more while nonparticipants who fail to meet the rules of adjoining and adjacent areas are less agreeable with the subsidies and duration of PLAP, in which most of the respondents wish that the subsidies can be increased and the rewarding period can be shortened.

3.4 Logit model analysis of decision-making behavior for afforestation

3.4.1 Empirical result analysis of decision-making behavior for afforestation

According to the different estimate results produced by inducing different variables, since there are too many virtual variables in the model, thus we substitute the logarithmic values of AGE, INC, RLAND, PLAND, LOCA1, LOCA2, etc. to the model, in order to obtain more precise estimates. Based on this, we conduct the Logit analysis, and the analysis result is given in Table 6.

From Table 6, we observe that age, education level, as well as annual household income among the landowner characteristics reported remarkable influence on the decision-making of whether to participate in PLAP, under a 10% confidence level. The older a private landowner is, the higher the probability of her/his participation in the PLAP is. For each unit increase on age, a 3.5% participation probability will be increased accordingly. This positive relationship is consistent with the conclusion of Nagubadi et al. (1996), but is contrary to the result of Stevens et al. (1999).

Second, the present study also revealed that the higher the education level of a landowner is, the lower the probability of her/his participation in the PLAP is, with a significance level of up to a = 10%. Our result indicated that when the education level increases from under junior high school to over senior high school level, the probability of landowners' participation in the PLAP will be decreased by 6.4%.

Third, the higher the annual household income of a landowner is, the lower the probability of her/his participation in the PLAP is, with a significance level of a = 10%. When the annual household income is increased by one unit, the participation probability will be increased by 6.9%. This positive relationship is consistent with the conclusion of English et al. (1997). Moreover, Megalos (2000) and Lorenzo and Beard (1996) proposed that non-farmers had reported a higher participation probability. The direction of occupation variables shown in this paper is consistent with the conclusion of the above literature results, but yet at a not much significance level. This has proved the results of Binkley (1981) and Dennis (1989), which found that the occupation was a more indirect factor in the decision utility model of landowners' participation behavior. Generally speaking, landowner characteristics remarkably affect the probability of landowners' participation in the PLAP.

As far as the cropland characteristics is concerned, cropland area, cropland price and number of cropland parcels reported the most significant influence among the factors that affect landowners' participation in the PLAP. The larger the cropland area is, the higher the probability of landowners' participation in the PLAP is. When cropland area is increased by one unit, the participation probability will be increased by 3.3% accordingly. This positive relationship is consistent with the conclusions of Megalos (2000) and Lorenzo and Beard (1996). Besides, from Table 6, the higher the cropland price is, the lower the probability of landowners' participation in the PLAP is. This meets the expectation of the opportunity cost theory.

Our results also indicated that when cropland price is increased by one unit, the participation probability will be decreased by 55.5%. It is evident that the cropland price shows significance on the marginal effect of participation decisions. We also observe from Table 6 that the more the number of cropland parcels is the lower the participation probability is. Hence, whether the cropland is fragmentary will affect the participation probability significantly. This is associated with the regulation that requires 2-hectare adjoining area or over 5-hectare adjacent area. Our results also indicated that when the number of cropland parcels is increased by one unit, the participation probability will be decreased by 74.7% accordingly. It is evident that the fragmentary level reported a significant relationship with the participation probability. Our analyses also showed an insignificant relationship with the distance of cropland from the township office or county government.

The forestry program factors include whether the subsidy, subsidy duration and rewarding policy are reasonable. This paper indicated that these three variables reported a positive relationship with the participation probability though the statistics yet achieve a significance level, i.e., the more the landowners agree on the subsidies, duration and rewarding policy, the higher the participation probability is. This meets the theoretical expectation.

In overall, cropland characteristics reported the most significant impact on the participation probability among the three types of factors, in which the cropland area, cropland price and number of cropland parcels are the utmost important in particular. Besides, many cropland factors achieve over 1% significance level. The empirical result of this paper indicated that apart from the distance of cropland from county government and number of family members are under expectation, the remaining meets the expectation in Table 3 as well. Among the landowner characteristics, age (+), education level (−), and annual household income (+) have achieved a significance level, while gender (+) and occupation (+) have yet achieved a significance level, which are consistent with previous literature results and the expectation. On the other hand, among the cropland characteristics, cropland area (+), cropland price (−), and number of cropland parcels (−) have achieved a significance level, and the factors that fail to achieve a significance level include level-cropland rental (−) and the distance of cropland from villages/ towns (−), which have met the expected direction of the existing theory. Among the forestry programs, the amount of subsidies (+), subsidy duration (+), and rules of adjoining and adjoining areas have yet achieved a significance level while the signs are consistent with the expected direction.

3.4.2 Goodness of fit analysis of afforestation decision model

As far as the goodness of fit in the Logit model is concerned, we analyze the difference level (Hosmer and Lemeshow, 1989) between the designed regression model and the full saturated model[5], under the measurement of log likelihood function[6]. The observed value can be completely estimated by the full saturated model. Based on the likelihood function, we usually introduce -2 multiplied by log of maximum likelihood value between the designed regression model and the full saturated model, to compare the estimated value with observed value. If the value is set larger, then it implies that this regression model has better goodness of fit, and vice versa. The value calculated by this paper is 93.715, which represents a goodness of fit.

Secondly, Hosmer and Lemeshow (1989) proposed a method that examines the goodness of fit of Logit model, called *Hosmer and Lemeshow index*, which is appropriate for the Logit regression with null hypothesis (H_0). The χ^2 value examined by Hosmer-Lemeshow test in this paper is 1.074, whose significance level is 0.998 that is not high, and yet achieves a significance level under 5% of significance level. Hence, we cannot reject H_0. That is, the model and data derived is appropriate, which show that the model established by this paper has well goodness of fit.

As for the precision of predication, based the log likelihood model, this paper introduces an index similar to R^2 index, such as likelihood ratio index (LRI) (Hosmer and Lemeshow 1989), which depicts the percentage for the variance of dependent variable explained by independent variables within the model. Nagelkerke (1991) revised the definition of R^2 proposed by Cox and Snell (1989), which enabled a better prediction power of the index. When R^2 gets close to 1, it implies that this model has a more precise prediction power. Nagelkerke's R^2 value in this paper achieves 0.695, which represents a good prediction power and the regression of this model performs well, with up to 69.5%.

In addition, through the omnibus test of model coefficients, it helps determine whether this regression model is helpful to the predication of the PLAP. The null hypothesis (H_0) in this test is "the Logit regression derived does not help the prediction". The χ^2 value in the omnibus test of model coefficients in this paper is 148.774, with 0.000 significance level, which shows that the model in this paper performs well and achieves a significance level under 5% significance level. It means that the model is helpful to predicting the participation in the PLAP. Moreover, as far as the Logit model established by this paper is concerned, as shown in Table 7, it reported a probability of 98.0% in precisely predicting the nonparticipation in the PLAP and a probability of 71.8% in precisely predicting the participating in the PLAP, with 95% probability for prediction in overall. It represents a good prediction result.

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[5] Hair et al. (1998) have suggested to conduct goodness of fit test on Logistic regression model, with the numerous methods above introduced in the meantime, which is more objective to make a consolidated judgment.

[6] Likelihood function means the probability for obtaining the observation result under a certain parameter estimate requirement.

Variable	Coefficients	S.D.	Wald value	*P*-value	Movement value of probability
INTERCEPT	-21.38	31.16	0.16	0.693	-
OC					
SEX	0.77	0.77	1.01	0.316	0.035
ln_AGE	2.23	1.36	2.70	0.100*	0.080
EDU	-1.23	0.69	3.15	0.076*	-0.064
OCC	0.50	0.58	0.75	0.387	0.017
ln_INC	0.58	0.31	3.58	0.058*	0.069
POP	-0.14	0.15	0.95	0.330	-0.063
CC					
ALAND	0.402	0.15	7.36	0.007***	0.033
ln_RLAND	-0.31	0.60	0.28	0.600	-0.056
ln_PLAND	-1.00	0.38	6.97	0.008***	-0.555
ln_LOCA1	0.37	0.39	0.90	0.343	0.051
ln_LOCA2	-0.09	0.49	0.04	0.852	-0.010
NLAND	-1.70	0.47	13.29	0.000***	-0.747
PF					
REG	9.28	42.52	0.05	0.827	0.079
YSUB	9.38	56.13	0.03	0.867	0.080
ASUB	9.66	42.34	0.05	0.820	0.079
-2 Loglikelihood	93.715				
Good/bad of overall model	Cox-Snell R square＝0.354, Nagelkerke R square＝0.695				
Overall model test	Omnibus test of model coefficient, Chi-square＝148.774 with 0.000 significance level***				
Goodness of fit test	Hosmer-Leme show test, Chi-square＝1.074 with 0.998 significance level				

Note: a sample size of 343 in total, there are 39 participants (PP = 1) and 304 nonparticipants; (*), (**) and (***) represent a significance level of 10%, 5% and 1% for α, respectively. The "movement value of probability" on the right column is the movement value of probability for the change of unit quantity of independent variables

Table 6. The analysis of Logit model

Prediction groups / Real groups	*PP*＝0	*PP*＝1	Total
PP＝0	296	6	302
PP＝1	11	28	39
precision rate(%)	98.0 %	71.8%	95.0 %

Table 7. Statistics for precise values predicted by the Logit model

4. Conclusions and suggestions

The afforestation policy in the plain areas (PLAP) was certified by Taiwan government on 31 August 2001 and has been implementing from 1 January 2002 to 31 December 2007. Despite the positive comments on the good intention of afforestation policy, still, there are many difficulties during the process of implementation, such as insufficient technology for afforestation, private landowners' low interest in the participation in the PLAP, insufficient subsidies, etc., which are all potential threats that hinder the PLAP from moving forward in future. This paper selects Pingtung County as a region for sampling and targets those private landowners with or without intention to participate the PLAP. Then the Logit model for empirical analysis is used in order to analyze the factors that determine whether to join the PLAP respectively in terms of those farmer samples that do or do not participate in the afforestation scheme, and to understand the effect of PLAP on the personal decision of afforestation. This paper indicates that the possible factors that might determine private landowners' participation in PLAP include landowner characteristics, cropland characteristics and forestry programs.

The possible reasons for landowners who do not participate in the PLAP include: not aware of the PLAP with up to 60%, while those who are aware of the PLAP and choose not to participate occupies 68.9%, and among the other possible reasons, "landowners' cropland fails to meet the requirement of afforestation policy's adjoining and adjacent areas, and it is not easy for a joint application with other people" occupies 25.0%, followed by "landowners' participation in the PLAP might lead to inflexibility of land use" occupying 20.0%, and "landowners' participation in the PLAP might reduce the chance for the change of land use", which occupies 18.9%. In addition, according to the empirical analysis of this paper, age, education level and annual household income reported the most significant influence among the factors that determine landowners' participation in PLAP. The older the private landowner is, the higher probability she/he has in participating in the PLAP. The higher the education level of a landowner is, the lower participation probability is. The higher the annual household income of a landowner is, the lower participation probability is. Among the cropland characteristics, cropland area, cropland price and number of cropland parcels reported the most significant influence on participating in the afforestation program. The larger the cropland area is, the higher participation probability is. The higher the cropland price is, the lower participation probability is. The more the number of cropland area is, the lower the participation probability is, which meets the theoretical expectation in this paper.

The total afforestation area implemented in the plain areas between 2002 and 2005 is 8,010.32 hectares (Taiwan Sugar Corporation and private cropland), which comprised only 8.51% of total afforestation area in the plain areas and had a diminishing tendency from year to year. In order to increase the incentives to the private cropland that participates in the PLAP, it is necessary for the government to conduct propaganda and establish related incentive schemes; especially, the first-tier city governments and township office units should be more active on guidance and promotion. According to the survey result in this paper, the reason why the landowners do not participate in the PLAP is their unawareness of the PLAP, which represents up to 60%. The government needs to reinforce the outreach and promotion mechanism. The reasons for the farmers who are aware of the PLAP but choose not to participate include too lengthy contract duration (20 years), uncertainty of cropland value and purpose of wood use, in addition to their primary cropland areas failing to meet the regulation, which occupies 50%. Only 10% is recognized a low subsidy amount. It is evident that the government should make an explanation in detail in terms of 20-year subsidy duration, cropland value, wood use after 20 years so as to solve farmers' confusion to effectively enhance the incentives that attract farmers to participate in the PLAP.

According to the empirical result in this paper, age, education level, and annual household income factors reported a significant influence among the landowner characteristics. The older the private landowner is, the higher probability she/he has in participating in the PLAP. For every year increase on age, a 3.5% probability will be increased accordingly. The higher the education level of a landowner is, the lower participation probability is. When the education level of a landowner is increased from under junior high school to over senior high school level, the participation probability for PLAP will be decreased by 6.4%. The higher the annual household income is, the lower participation probability is. When annual household income is increased by one unit, the participation probability will be increased by 6.9%. Therefore, the government should actively encourage the landowners with three overlapping characteristics of non-farmer occupation, higher education level (junior high school above) and older landowners to establish promotion mechanism and assist with moral persuasion to encourage these landowners to participate in the PLAP.

Moreover, according to the empirical result in this paper, those landowners with larger cropland area, less number of cropland parcels and lower cropland price have higher probability in participating in the PLAP, in which the number of cropland parcels reported the most significant influence. This paper also indicated that when the number of cropland parcels is increased by one unit, the participation probability will be decreased by 74.7% accordingly. When the cropland area is increased by one unit, the participation probability will be increased by 3.3% accordingly. When cropland price is increased by one unit, the participation probability will be decreased by 55.5%. Therefore, the government should conduct promotion to the cropland that meets these characteristics to encourage the farmers to participate in PLAP.

Moreover, it helps understand the situation of goodness of fit of the model established by this paper through many statistics indices, such as Nagelkerke's R^2 value is 0.695 which implies that the regression capability of the model is good. Hosmer-Lemeshow test and χ^2 value of omnibus test also revealed that the Logit model in this paper may provide fine goodness of fit. The Logit model established by this paper has a probability of 98.0% in predicting nonparticipants, and a probability of 71.8% in predicting the participants, with 95% probability for prediction in overall. The empirical result of this paper expects to help implement the PLAP in Taiwan.

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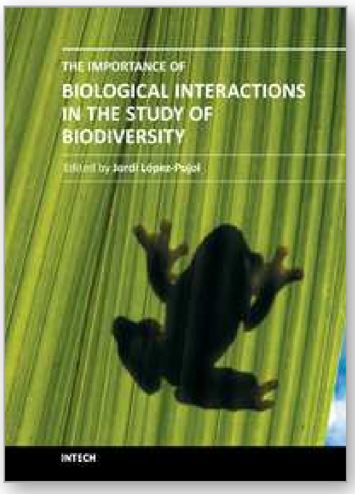

The Importance of Biological Interactions in the Study of Biodiversity
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The term biodiversity defines not only all the variety of life in the Earth but also their complex interactions. Under the current scenario of biodiversity loss, and in order to preserve it, it is essential to achieve a deep understanding on all the aspects related to the biological interactions, including their functioning and significance. This volume contains several contributions (nineteen in total) that illustrate the state of the art of the academic research in the field of biological interactions in its widest sense; that is, not only the interactions between living organisms are considered, but also those between living organisms and abiotic elements of the environment as well as those between living organisms and the humans.