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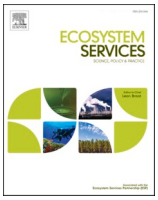

Full Length Article

Assessing the ecosystem services provided by conventional and organic farmlands: A better outcome for organic farmlands?

Ching-Hua Hsieh [a], Hsing-Wei Lin [b], Wan-Yu Liu [c,d,*]

[a] Department of Forestry, National Chung Hsing University, Taichung 402, Taiwan
[b] Department of Agricultural Economics, National Taiwan University, Taipei 106, Taiwan
[c] Department of Forestry, National Chung Hsing University, Taichung 402, Taiwan
[d] Innovation and Development Center of Sustainable Agriculture, National Chung Hsing University, Taichung 402, Taiwan

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ABSTRACT

To assess and compare the value of conventional and organic farmland ecosystem services, this study firstly used the analytic network process to measure the weights of these services to the value. Then, the contingent valuation method was employed to investigate the public's perception of farmland ecosystems as well as the amount that they would be willing to pay for ecosystem services offered by different types of farmland use. The results of the study revealed that, among seven common farmland use types, farmland cultivated using organic farming methods was perceived to be the most valuable. The estimated results of the regression model revealed that the amount that participants would be willing to pay for farmland ecosystem services was related to their average monthly income and their perception of farmland ecosystem services. This study offered the following recommendations: if the Taiwanese government wishes to increase the value of Taiwan's farmland ecosystem services, it should introduce farmland afforestation incentives, organic farming incentives, and farmland-friendly incentives to encourage farmers to transform abandoned farmland or farmland cultivated using conventional farming methods into farmland cultivated using organic or environmentally friendly farming methods. Moreover, the government should increase subsidies granted for production environment maintenance to induce farmers to allow farmland to lie fallow. Additionally, the government can guide and promote agricultural experience activities such as 1-day trips to villages and farmland ecosystems to educate the public about farmland ecosystem services and to enable them to develop a positive understanding of farmland ecosystem services.

1. Introduction

Through direct and indirect management of ecosystems, individuals can optimize ecosystem services and thereby support human survival, livelihoods, and economic growth (Millennium Ecosystem Assessment, 2005). However, as individuals benefit and obtain resources from ecosystems, their activities also change ecosystems, so that ecosystem degradation may lead to a decline in the quality of human life. Farmland ecosystems occupy-one third of the world's lands (Garbach et al., 2014). Farmland ecosystems are generally managed in a centralized manner to increase resource productivity (e.g., food, fibers, and energy), and individuals rely on ecosystems to regulate and provide support services (e.g., carbon sequestration, pollination, pest control, and fertile soil), which enable them to use these ecosystems as agricultural production sites (Millennium Ecosystem Assessment, 2005; Zhang et al., 2007).

When the value of farmland ecosystems is assessed by conventional agricultural performance assement methods, which only considers the production in the farmland value chain and observable aspects of farmland ecosystems in the agricultural market (e.g., tangible inventories, flow, results, and influences), these methods neglect a lot of critical and economically unobservable aspects, such as intangible inventories, flow, results, economic impact, and the ecosystem services with external and public good-related characteristics being neglected. In addition, these methods conventionally neglect the services from economic assessment models of ecosystems and calculation of gross domestic product (GDP), which are generally crucial driving factors determining the success of many sustainable development goals (Food and Agriculture Organization of the United Nations, 2018; The

* Corresponding author.
E-mail address: wyliu@nchu.edu.tw (W.-Y. Liu).

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Economics of Ecosystems and Biodiversity [TEEB], 2018).

Most governments worldwide use environment-related agricultural policies and management measures to support the supply for market and nonmarket value of agricultural services, and to formulate favorable agricultural and environmental standards to manage natural resources sustainably, maintain biodiversity and animal welfare, stimulate the diversification of the agricultural industry and its production quality, adjust markets, and strengthen rural vitality, in order to meet the agricultural needs of current society and promote farmland ecosystem services (Casini et al., 2012; Rolf et al., 2018; Blanco et al., 2020; Cao et al., 2021). Ecological subsidies are commonly used to mitigate agricultural environmental degradation and facilitate agricultural environmental versatility. Additionally, ecological subsidies are often employed by countries in agriculture-related decision-making because many countries believe that these subsidies are effective in solving external problems related to nonmarket goods (Endres et al., 2015; Heres et al., 2015; Bai et al., 2018). Related studies on monitoring farmland ecosystem services and valuating these services are the basis for planning and implementing payment measures related to farmland ecosystem services.

However, is the value of farmland ecosystem services the same between farmlands cultivated using different farming methods? For example, is the value of ecosystem services rendered through cultivated farmland greater than that of ecosystem services rendered through fallow farmland? Is the value of ecosystem services rendered through farmland cultivated using organic farming methods greater than that of ecosystem services rendered through farmland cultivated using conventional farming methods? If so, how much is the difference? Additionally, because subsidies granted to farmers vary based on the type of farmland that they cultivate, assessment of the different farmland use types will assist relevant agencies in planning and implementing agricultural subsidy policies and measures. Most previous empirical studies on farmland value assessment have had a single-subject focus for assessment and analyses. For example, Tseng and Lee (2005), Chen et al. (2006), and Hsieh et al. (2020) primarily assessed and analyzed paddy fields; furthermore, Lin and Chen (2010) and Hsu et al. (2014) mainly assessed and analyzed farmland. The items that are used in this study to assess value are different from those used in previous studies, with the exception of a study conducted by Hsu et al. (2014). Tseng and Lee (2005) used food safety and landscape value as their assessment items. Lin and Chen (2010) used consumers' willingness to pay for life and cultural functions of farmland. Chen et al. (2006), Vieira da Silva et al. (2014), and Krause et al. (2017) aimed to estimate diversity value for farmlands. By contrast, this study targeted farmland ecosystem services for assessment, thereby addressing the dearth of literature in this field.

Previous studies indicated that the contingent valuation method (CVM) is a stated preference technique, which analyzes participants' value preference for environmental goods or services through questionnaires. The CVM mainly consists of designing related questions, establishing an institutional context, and investigating how much participants are willing to pay their personal income for making a tradeoff to improve the environment positively, and the maximum amount that participants are willing to pay to avoid negative environmental changes, so as to guide the economic preferences of the participants. The willingness to pay (WTP) expressed by the participants can be regarded as the potential value of environmental goods or services. The CVM is a common method for assessing nonmarket value, and this is the reason why this study adopts the CVM to evaluate the ecosystem services that are provided by farmlands using conventional and organic farming methods.

This study evaluated farmland ecosystem services in Taiwan through relevant data collected by using the CVM and a questionnaire survey to realize participants' knowledge of farmland ecosystems and the value that they attach to the farmland ecosystem services provided by (a) paddy fields cultivated using conventional farming methods; (b) dry farmland cultivated using conventional farming methods; (c) farmland for specialty crops cultivated using conventional farming methods; (d) paddy fields cultivated using organic farming methods; (e) dry farmland cultivated using organic farming methods; (f) farmland for specialty crops cultivated using organic farming methods; (g) fallow farmland; and (h) abandoned farmland. Subsequently, the effects of the participants' knowledge and the amount that they were willing to pay for the different farmland ecosystem services were analyzed. Finally, the analytic network process was used to estimate the weighted value composed of different ecosystem services (e.g., storing water resources, purifying water, mitigating flooding, conserving soil quality, facilitating nutrient cycles, perpetuating phytoremediation, driving biodiversity, inducing pollination and seed dissemination, controlling pests, purifying air, engendering carbon sequestration and reducing carbon, and regulating microclimates) provided by different farmland use types.

2. Materials and methods

In this study, an opinion poll was conducted among participants aged 20–65 ($n = 1088$) recruited from 19 counties and cities in Taiwan between July and August of 2020, to gain insight into the economic value that they ascribed to farmland ecosystem services. Because farmland ecosystem services possess externality and characteristics of public goods, and the value of farmland ecosystems in Taiwan belongs to large-scale assessment, the value of ecosystem services in Taiwan cannot be not valuated solely by farmer or non-farmer groups. Similarly, no single group can directly and completely valuate Taiwan's farmland ecosystems or the number of related subsidies that should be granted by the government. Thus, to obtain an overview of the Taiwanese public's views on farmland ecosystem services, participants working in different fields were surveyed. The sex, age, and number of participants to be surveyed for each region were determined by referencing the latest household registration data collected by the Department of Household Registration at the Ministry of the Interior, Taiwan (Department of Household Registration, Ministry of the Interior, Taiwan, 2022).

The number of participants selected as the study sample was based on an optimal sample size. That is, with a confidence level of 95 % and an estimated sampling error of ± 0.3 %, the optimal sample size was determined to be 1,068 or more, based on the following equation:

$$n = \frac{1.96^2 \times \hat{p} \times (1 - \hat{p})}{e^2} \tag{1}$$

where n is the optimal sample size; $\hat{p}$ is the ratio of any attribute of participants (e.g., sex, age, and education level), assuming a $\hat{p}$ value of 0.5 under unknown conditions to maximize the sample size; and e is the sampling error, which cannot not exceed the tolerable limit when estimating population ratios on the basis of sample ratios.

The method of random stratified quota sampling was adopted in this study, and the population of Taiwan (separated by sex, age group, and city or county of residence) was used as a reference for determining the number of participants to be recruited for the ratios of sex, age group, and place of residence. The valid sample size for each demographic characteristic was based on an overall valid sample size of 1,088 (with an optimal sample size of 1,068 or more). To determine whether the actual samples mirrored the intended population structure, this study performed a goodness-of-fit test, presented as follows:

$$X^2 = \sum \frac{(O_i - E_i)^2}{E_i}, df = n - 1 \tag{2}$$

where O represents the number of actual samples collected; E represents the number of samples to be assigned to each stratum (category); and df represents the degree of freedom. The results of the test revealed that the samples collected in this study were valid and representative.

The questionnaires conducted in this study were designed to assess the economic value of farmland ecosystem services in Taiwan. The questionnaire content was divided into four sections: "questionnaire-

related information," "participant's knowledge of farmland ecosystem services," "participant's assessment of the value of farmland ecosystems," and "participant's demographic information." "Questionnaire-related information" included descriptions of farmland (i.e., paddy fields, dry farmland, and farmland for specialty crops) that was organically farmed, conventionally farmed, fallow, and abandoned. To ensure that the participants understood the type of farmland being investigated and could, therefore, more accurately assess the amount that they would be willing to pay for the farmland ecosystem services, this study adopted the visualization method, which is a common support method used in the CVM and choice experiments. Visual stimuli (e.g., ecosystem service illustrations, ecosystem environment photos, and landscape changes under different management strategies) were used to provide participants with background information. Landscape photos were provided as pictorial support for the four farmland types (McDougall et al., 2020). "Participant's knowledge of farmland ecosystem services" evaluated participants' understanding of farmland ecosystem services, the importance that they attached to such services, the attention that they paid to such services, and their attitudes toward such services. "Participant's assessment of the value of farmland ecosystems" asked participants to report the amount that they would be willing to pay for the farmland ecosystem services which were offered by the four farmland types. "Participant's demographic information" was used to collect participants' demographic information.

There are four pictures in the questionnaire, and each picture is accompanied with a description. Organic farming (Fig. 1): Organic farming is sustainability-oriented and based on the principles of ecological balance and nutrient cycles. Organic farming does not involve chemical fertilizers, pesticides, genetically modified organisms, or products derived from genetically modified organisms. Organic farming can effectively reduce environmental pollution and damage to the environment, protect water and soil resources, and provide consumers with safe, healthy agricultural products (Liu, 2020).

Conventional farming (Fig. 2): Conventional farming is food production-oriented. During cultivation seasons, chemical fertilizers and pesticides are used to prevent damage caused by pests and diseases. Conventional farming generates substantial agricultural products and economic profits, and effectively increases food self-sufficiency rate. However, long-term use of conventional farming methods may cause soil fertility and biodiversity to decline, bacteria and pests to develop a resistance to pesticides, soil and water resources to become polluted and damaged, or other adverse environmental events (Huang et al., 2018).

Fallow farmland (Fig. 3): The objective of fallow farmland use is to maintain soil fertility. Crop rotation is practiced to effectively utilize the farmland during "transitional" phases. During such phases, green manure and landscape crops (such as soybeans, brown hemp, Indian sesbania, and sunflowers) may be grown to facilitate plowing and water storage. Fallowing beautifies rural landscapes, improves farmland fertility, stabilizes farmland production, and maintains farmland ecosystems (Liu, 2020).

Abandoned farmland (Fig. 4): Abandoned farmland is farmland that does not grow crops and is not managed. Some abandoned farmland has been idle for many years and contains problems such as waste accumulation (left by humans), loss of soil fertility, neglected rural roads, and dilapidated irrigation facilities (Liu, 2020).

3. Results

In this study, factors affecting the economic value of farmland ecosystem services in Taiwan were analyzed. Explanatory variables were defined, and statistical data were compiled based on the amount that participants would be willing to pay for farmland ecosystem services and the effects of participants' demographic information on their knowledge of farmland ecosystem services. The results are displayed in Table 1.

Generally, the estimation equations for willingness to pay (WTP) are presented in the following form of linear functions:

$$\begin{aligned} V_{ti} = {} & \beta_0 + \beta_1 Gen_i + \beta_2 Age\_Con_i + \beta_3 Edu\_Con_i + \beta_4 Marr_i + \beta_5 A\_M_i \\ & + \beta_6 A\_S_i + \beta_7 A\_E_i + \beta_8 Inc\_Con_i + \beta_9 Farm_i + \beta_{10} Group_i \\ & + \beta_{11} Visit\_Con_i + \beta_{12} S1\_R_i + \beta_{13} S1\_C_i + \beta_{14} Und_i + \beta_{15} Att_i + \beta_{16} Imp_i \\ & + \beta_{17} Sat_i + \beta_{18} Con_i + \beta_{19} Ant_i + \beta_{20} Gro_i + \beta_{21} Rec_i + \beta_{22} Har_i + \varepsilon_i \end{aligned} \quad (3)$$

where t denotes the farmland type; i denotes the i^{th} participant; β_0 is a constant; β_1, β_2, β_3,…, β_{19} are coefficients of the explanatory variables; and ε_i denotes random errors; "V_t" is a dependent and continuous variable which denotes the price that the participant would be willing to pay for the ecosystem services provided by the t^{th} farmland type. The farmland types included all farmland types as a whole; paddy fields, dry farmland, and farmland for specialty crops cultivated using organic farming methods and conventional farming methods; fallow farmland; and abandoned farmland. The independent variables, namely "age" (*Age_Con*; measured in years), "education level" (*Edu_Con*; measured in years), "average monthly income" (*Inc_Con*; measured in NT$1); and number of times visiting or coming into contact with farmland (*Visit_Con*; measured in number of times per year), are displayed as continuous variables.

Eq. (3) contains the following participant demographic information–related explanatory variables: sex (*Gen*), age (*Age_Con*), education level (*Edu_Con*), marital status (*Marr*), living in central Taiwan (*A_M*), living in southern Taiwan (*A_S*), living in eastern Taiwan (*A_E*), average monthly income (*Inc_Con*), owning farmland or having farming activity–related experiences (or not) (*Farm*), having or not having participated

Fig. 1. Farmland cultivated using organic farming methods.

Fig. 2. Farmland cultivated using conventional farming methods.

Fig. 3. Fallow farmland.

Fig. 4. Abandoned farmland.

in environmental protection–related activities or groups (*Group*), and the average number of times visiting or coming into contact with farmland per year (*Visit_Con*).

For Eq. (3), participants' knowledge of farmland ecosystem services were divided into the following: believing farmland ecosystem–related regulation and maintenance services were the most important (*S1_R*), believing that farmland ecosystem–related cultural services were the most important (*S1_C*), understanding of farmland ecosystems (*Und*), attention given to farmland ecosystems (*Att*), importance attached to farmland ecosystems (*Imp*), satisfaction with farmland ecosystems (*Sat*), confidence in maintaining farmland ecosystems (*Con*), beliefs toward anthropocentrism (*Ant*), beliefs toward limiting growth (*Gro*), reflections on development (*Rec*), and beliefs toward harmonization and noninterference with nature (*Har*).

Table 1
Variables defined in the regression model.

Category	Variable notation	Variable definition (unit)	Mean	Standard deviation
Value of farmland ecosystem services	V_t	Amount (NT$/year) that the participant is willing to pay for farmland ecosystem services, $t = 1$ (all farmland types).	758.73	695.34
		Amount (NT$/year) that the participant is willing to pay for farmland ecosystem services, $t = 2$ (sustainable paddy fields).	711.12	684.56
		Amount (NT$/year) that the participant is willing to pay for farmland ecosystem services, $t = 3$ (sustainable dry farmland).	646.25	650.37
		Amount (NT$/year) that the participant is willing to pay for farmland ecosystem services, $t = 4$ (sustainable farmland for specialty crops)	556.94	602.89
		Amount (NT$/year) that the participant is willing to pay for farmland ecosystem services, $t = 5$ (conventional paddy fields).	493.89	584.06
		Amount (NT$/year) that the participant is willing to pay for farmland ecosystem services, $t = 6$ (conventional dry farmland).	443.93	551.55
		Amount (NT$/year) that the participant is willing to pay for farmland ecosystem services, $t = 7$ (conventional farmland for specialty crops).	409.47	540.88
		Amount (NT$/year) that the participant is willing to pay for farmland ecosystem services, $t = 8$ (fallow farmland).	611.51	633.22
		Amount (NT$/year) that the participant is willing to pay for farmland ecosystem services, $t = 9$ (abandoned farmland).	348.69	518.54
Demographic information	*Gen*	Dummy variable, where "1″ and "0" denote "male" and "female," respectively.	0.50	0.50
	Age_Con	Age.	42.43	11.24
	Edu_Con	Educational level (measured in years).	16.09	2.04
	Marr	Dummy variable, where "1″ and "0" denote "married" and "single," respectively.	0.50	0.50
	A_M	Dummy variable, where "1″ denotes "living in central Taiwan," and "0" denotes otherwise.	0.25	0.44
	A_S	Dummy variable, where "1″ denotes "living in southern Taiwan," and "0" denotes otherwise.	0.28	0.45
	A_E	Dummy variable, where "1″ denotes "living in eastern Taiwan," and "0" denotes otherwise.	0.02	0.13
	Inc_Con	Average monthly income (unit: NT$10,000).	4.60	2.60
	Farm	Dummy variable, where "1″ denotes "owning farmland or having farming activity–related experience," and "0" denotes otherwise.	0.23	0.42
	Group	Dummy variable, where "1″ denotes "having participated in environmental protection–related activities or groups," and "0" denotes otherwise.	0.13	0.34
	Visit_Con	Average number of times having visited or come into contact with farmland per year.	20.77	56.82
Knowledge of farmland ecosystem services	*S1_R*	Dummy variable, where "1″ denotes "believing that regulatory and maintenance services are the most important services," and "0" denotes otherwise.	0.36	0.48
	S1_C	Dummy variable, where "1″ denotes 1 "believing that cultural services are the most important services," and "0" denotes otherwise.	0.06	0.23
	Und	Participant's understanding of farmland ecosystems, where "1," "2," "3," "4," and "5" denote "no understanding at all," "little understanding," "some understanding," "good understanding," and "great understanding," respectively.	3.24	0.85
	Att	Attention given to farmland ecosystems, where "1," "2," "3," "4," and "5" denote "never paying attention," "rarely paying attention," "sometimes paying attention," "often paying attention," and "usually paying attention," respectively.	3.56	0.94
	Imp	Importance attached to farmland ecosystems, where "1," "2," "3," "4," and "5" denote "very unimportant," "unimportant," "somehow important," "important," and "extremely important," respectively.	4.56	0.60
	Sat	Satisfaction with farmland ecosystems, where "1," "2," "3," "4," and "5" denote "extremely dissatisfied," "dissatisfied," "somewhat satisfied," "satisfied," and	3.06	0.81

(*continued on next page*)

Table 1 (*continued*)

Category	Variable notation	Variable definition (unit)	Mean	Standard deviation
		"extremely satisfied," respectively.		
	Con	Confidence in maintaining farmland ecosystems, where "1," "2," "3," "4," and "5" denote "extremely unconfident," "unconfident," "somewhat confident," "confident," and "extremely confident," respectively	2.97	0.93
	Ant	Beliefs toward anthropocentrism, where "1," "2," "3," "4," and "5" denote "strongly disagree," "disagree," "somewhat agree," "agree," and "strongly agree," respectively.	2.80	1.15
	Gro	Beliefs toward limiting growth, where "1," "2," "3," "4," and "5" denote "strongly disagree," "disagree," "somewhat agree," "agree," and "strongly agree," respectively.	4.41	0.68
	Rec	Reflections on development, where "1," "2," "3," "4," and "5" denote "strongly disagree," "disagree," "somewhat agree," "agree," and "strongly agree," respectively.	4.50	0.62
	Har	Beliefs on harmonization and noninterference with nature, where "1," "2," "3," "4," and "5" denote "strongly disagree," "disagree," "somewhat agree," "agree," and "strongly agree," respectively.	4.59	0.61

Source: compiled in this study.

However, the participants in this study demonstrated protesting response behavior that caused the survey result analyses to exhibit selection bias (Cho et al., 2008). Accordingly, this study employed the Tobit model, which is used to analyze censor dependent variables, before entering the survey results of both the protest responses and nonprotest responses for analyses. This model prevented creating sampling bias because of elimination of the protest samples (Wu et al., 2004). A WTP estimation model was derived using the Tobit model, which can be written as Eqs. (4) and (5).

$$V_{ti}^{*} = \beta_0 + \beta_1 Gen_i + \beta_2 Age\_Con_i + \beta_3 Edu\_Con_i + \beta_4 Marr_i + \beta_5 A\_M_i + \beta_6 A\_S_i + \beta_7 A\_E_i + \beta_8 Inc\_Con_i + \beta_9 Farm_i + \beta_{10} Group_i + \beta_{11} Visit\_Con_i + \beta_{12} S1\_R_i + \beta_{13} S1\_C_i + \beta_{14} Und_i + \beta_{15} Att_i + \beta_{16} Imp_i + \beta_{17} Sat_i + \beta_{18} Con_i + \beta_{19} Ant_i + \beta_{20} Gro_i + \beta_{21} Rec_i + \beta_{22} Har_i + \varepsilon_i \quad (4)$$

$$V_{it} = \begin{cases} V_{ti}^{*}, & \text{if} V_{ti}^{*} > 0; \\ 0, & \text{if} V_{ti}^{*} \le 0. \end{cases} \quad (5)$$

Assume that the amount that Participant *i* would be willing to pay for farmland ecosystem services is V_{ti}^{*}; and the amount that Participant *i* answered to be willing to pay for farmland ecosystem services is V_{it}. If V_{ti}^{*} is>0, then V_{it} would be equal to V_{ti}^{*}; and the participant's actual value preferences can be determined. However, if V_{ti}^{*} is less than or equal to 0, this signifies that the amount that the participant would be willing to pay is NT$0 or less. When this occurs, the amount that the participant would actually be willing to pay is NT$0. When V_{ti}^{*} is less than zero, it indicates that the participant believes that they should be compensated for biodiversity conservation efforts.

4. Analysis of empirical results

4.1. Descriptive statistical analyses

(1) Sample Structure Analyses

The results of the statistical analysis obtained using participants' demographic information are presented in Table 2. The number of participants selected for ratios of sex, age group, and area of residence was determined according to the data from the latest census performed by the Ministry of the Interior, Taiwan (Department of Household Registration, Ministry of the Interior, Taiwan, 2022). Concerning the other variables, the results of the analysis are as follows: of the participants, 68.4 % were college or university graduates; 50.4 % were married; most (34.1 %) had an average monthly income of NT$20,001–NT $39,999; and approximately 75.2 % had an average monthly income of NT$60,000 or less.

Approximately 76.9 % of participants did not own farmland and had no farming activity–related experiences; 87.1 % had not participated in environmental protection–related activities or groups; and most (24.4 %) had never visited and had not come into contact with farmland. Furthermore, some had visited farmland 1–2 times in the past 3 years (20.0 %); and the number of participants (8.3 %) who visited farmland at least once a week was the lowest. On average, the participants visited farmland approximately 21 times a year.

(2) Perceptions of Farmland Ecosystem Services and the Value of These Services

The descriptive statistics of the participants' perceptions of farmland ecosystem services are presented in Table 3. Regarding the relative importance that participants attached to the different types of farmland ecosystem services, 58.6 % believed that farmland ecosystem–related supply services were the most important; 52.8 % felt that farmland ecosystem–related regulation and maintenance services were the second most important; and 80.0 % maintained that farmland ecosystem–related cultural services were the third most important. Among the three main farmland ecosystem service types, the participants assigned importance of 41.7 %, 37.3 %, and 21.0 % for farmland ecosystem–related supply services, regulation and maintenance services, and cultural services, respectively.

A total of 51.3 % of the participants had some understanding of the value of farmland ecosystem services; 45.1 % often paid attention to farmland ecosystem service–related issues; 61.2 % believed that that farmland ecosystem services were extremely important for current and future generations; 55.7 % were somewhat satisfied with the functions and services currently provided by farmland ecosystems; and 46.5 % were somewhat confident in the new subsidy measures implemented by government agencies for farmland ecosystem services.

The four simplified items pertaining to the participants' beliefs regarding the environment (i.e., anthropocentrism, limiting growth, reflections on development, and harmonization and noninterference with nature) are as follows: for "anthropocentrism," 29.3 % of participants disagreed with humans being born with the right to use and manage all natural things; for "limiting growth," 49.9 % of participants strongly agreed that natural ecological balance is extremely vulnerable

Table 2
Descriptive statistics of participants' demographic information.

Variable	Notation	Item	Frequency	Percentage (%)
Sex	*Gen*	Female	548	50.4
		Male	540	49.6
Age	*Age*	20–29	212	19.5
		30–39	242	22.2
		40–49	256	23.5
		50–59	311	28.6
		60–65	67	6.2
Education level	*Edu*	Elementary school or below	4	0.4
		Junior high school	6	0.6
		Senior or vocational high school	118	10.8
		College or university	744	68.4
		Graduate school or above	216	19.9
Marital status	*Marr*	Single	540	49.6
		Married	548	50.4
Place of residence	*Area*	Northern Taiwan	492	45.2
		Central Taiwan	276	25.4
		Southern Taiwan	300	27.6
		Eastern Taiwan	20	1.8
Average monthly income	*Inc*	No monthly income	28	2.6
		NT$20,000 or less	129	11.9
		NT $20,001–NT $39,999	371	34.1
		NT $40,000–NT $59,999	289	26.6
		NT $60,000–NT $79,999	155	14.2
		NT $80,000–NT $99,999	52	4.8
		NT$100,000 or above	64	5.9
Owning farmland or having farming activity–related experience	*Farm*	No	837	76.9
		Yes	251	23.1
Having participated in environmental protection–related activities groups	*Group*	No	948	87.1
		Yes	140	12.9
Average number of times visiting or coming into contact with farmland	*Visit*	Once a week or more	90	8.3
		1–3 times a month	107	9.8
		1–2 times every 3 months	121	11.1
		Once every 6 months	145	13.3
		Once a year	142	13.1
		1–2 times every 3 years	218	20.0
		Never visited or came into contact with farmland	265	24.4

Source: compiled in this study.

Table 3
Descriptive statistics on participants' perceptions of farmland ecosystem services.

Variable	Notation	Item	frequency	Percentage (%)
Importance attached to farmland ecosystem–related supply services	*Pro*	Most important	638	58.6
		Second most important	358	32.9
		Third most important	92	8.5
Importance attached to farmland ecosystem–related regulation and maintenance services	*Reg*	Most important	387	35.6
		Second most important	575	52.8
		Third most important	126	11.6
Importance attached to ecosystem–related cultural services	*Cul*	Most important	63	5.8
		Second most important	155	14.2
		Third most important	870	80.0
Understanding of farmland ecosystems	*Und*	No understanding at all	22	2.0
		Little understanding	143	13.1
		Some understanding	558	51.3
		Good understanding	281	25.8
		Great understanding	84	7.7
Attention given to farmland ecosystems	*Att*	Never paying attention	15	1.4
		Rarely paying attention	153	14.1
		Sometimes paying attention	276	25.4
		Often paying attention	491	45.1
		Usually paying attention	153	14.1
Importance attached to farmland ecosystems	*Imp*	Very unimportant	1	0.1
		Unimportant	4	0.4
		Somehow important	44	4.0
		Important	373	34.3
		Extremely important	666	61.2
Satisfaction with farmland ecosystems	*Sat*	Extremely dissatisfied	25	2.3
		Dissatisfied	197	18.1
		Somewhat satisfied	606	55.7
		Satisfied	205	18.8
		Extremely satisfied	55	5.1
Confidence in maintaining farmland ecosystems	*Con*	Extremely unconfident	73	6.7
		Unconfident	221	20.3
		Somewhat confident	506	46.5
		Confident	242	22.2
		Extremely confident	46	4.2
Belief in anthropocentrism	*Ant*	Strongly disagree	148	13.6
		Disagree	319	29.3
		Somewhat agree	313	28.8
		Agree	221	20.3
		Strongly agree	87	8.0
Belief in limiting growth	*Gro*	Strongly disagree	3	0.3
		Disagree	7	0.6

(*continued on next page*)

Table 3 (*continued*)

Variable	Notation	Item	frequency	Percentage (%)
		Somewhat agree	78	7.2
		Agree	457	42.0
		Strongly agree	543	49.9
Reflections on development	*Rec*	Strongly disagree	1	0.1
		Disagree	3	0.3
		Somewhat agree	57	5.2
		Agree	416	38.2
		Strongly agree	611	56.2
Beliefs on harmonization and noninterference with nature	*Har*	Strongly disagree	1	0.1
		Disagree	6	0.6
		Somewhat agree	46	4.2
		Agree	335	30.8
		Strongly agree	700	64.3

Source: compiled by this study.

and can be easily destroyed; for "reflections on development," 56.2 % of participants strongly agreed that humans are abusing environmental resources; and for "harmonization and noninterference with nature," 64.3 % of participants strongly agreed that humans should harmoniously coexist with nature and not exploit nature at will.

4.2. Analysis of the amount that participants would be willing to pay for farmland ecosystem services and Protest-Response participants

Regarding the amount that participants would be willing to pay for different farmland ecosystem services, some participants wrote NT$0. However, their writing zero (instead of the actual amount that they would be willing to pay) may have been caused by external influencing factors. Therefore, the questionnaire included seven questions regarding their "reasons for being willing to pay only NT$0" for all farmland types to determine whether participants were demonstrating protesting response behavior. If they were, they were placed into a protest-response group.

The analysis of the value that protest-response and nonprotest-response participants assigned to farmland ecosystems is presented in Table 4. Accordingly, the participant sample comprised protest- and nonprotest-response participants totaling 1,088 participants (100 %). Among the nonprotest-response participants, the number and percentage who would actually be willing to pay more than NT$0 and who thought they would be willing to pay more than NT$0 for the different farmland types cultivated through different farming methods are listed as follows: (a) paddy fields cultivated using organic farming methods (1,025; 94.2 %); (b) dry farmland cultivated using organic farming methods (1,026; 94.3 %); and (c) farmland for specialty crops cultivated using organic farming methods (1,000; 91.9 %). These numbers and percentages were all greater than those obtained for farmland cultivated using conventional farming methods, which were as follows: (a) paddy fields cultivated using conventional farming methods (904; 83.1 %); dry farmland cultivated using conventional farming methods (909; 83.5 %); and farmland for specialty crops cultivated using conventional farming methods (883; 81.2 %). The numbers and percentages obtained for fallow farmland (1,011; 92.9 %) were similar to those of farmland cultivated using organic farming methods. With respect to abandoned farmland, it had the lowest number and percentage (790; 72.6 %).

Among the nonprotest-response participants, the number and percentage of participants who would actually be willing to pay NT$0 and thought that they would be willing to pay NT$0 for the different farmland types cultivated through different farming methods are listed as follows: (a) paddy fields cultivated using organic farming methods (4; 0.4 %); (b) dry farmland cultivated using organic farming methods (7; 0.6 %); and (c) farmland for specialty crops cultivated using organic farming methods (8; 0.7 %). These numbers and percentages were all considerably less than those obtained for farmland cultivated using conventional farming methods, which were as follows: (a) paddy fields cultivated using conventional farming methods (98; 9.0 %); dry farmland cultivated using conventional farming methods (93; 8.5 %); and farmland for specialty crops cultivated using conventional farming methods (101; 9.3 %). The numbers and percentages obtained for fallow

Table 4
Value protest-response and nonprotest-response participants assigned to farmland ecosystems.

Farmland type		Overall sample	Nonprotest-response participants				Protest-response participants				
			WTP > 0		WTP = 0	Total		WTP ≥ / ≤ 0			
		Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Organic farming methods	Paddy fields	1,088	100.0	1,025	94.2	4	0.4	1,029	94.6	59	5.4
	Dry farmland	1,088	100.0	1,026	94.3	7	0.6	1,033	94.9	55	5.1
	Farmland for specialty crops*	1,088	100.0	1,000	91.9	8	0.7	1,008	92.6	80	7.4
Conventional farming methods	Paddy fields	1,088	100.0	904	83.1	98	9.0	1,002	92.1	86	7.9
	Dry farmland	1,088	100.0	909	83.5	93	8.5	1,002	92.0	86	7.9
	Farmland for specialty crops*	1,088	100.0	883	81.2	101	9.3	984	90.5	104	9.6
Fallow farmland		1,088	100.0	1,011	92.9	15	1.4	1,026	94.3	62	5.7
Abandoned farmland		1,088	100.0	790	72.6	154	14.2	944	86.8	144	13.2

Note: Among nonprotest-response participants, the participants who indicated "WTP > 0" were those who were willing to pay more than NT$0 for farmland ecosystem services; the participants who indicated "WTP = 0" were those who were unwilling to pay for farmland ecosystem services and who selected one of the following reasons as the reason for why they were unwilling to pay for such services: "farmland ecosystem–related subsidies are unnecessary" or "there are more critical issues to address than giving farmland ecosystem–related subsidies." The total number of nonprotest-response participants was the sum of the two aforementioned participant groups. Among protest-response participants, the participants who indicated WTP ≥ or ≤ 0 were those who would be unwilling to pay for farmland ecosystem services and who selected one of the following as the reason for their unwillingness to pay for farmland ecosystem services: "the government should not be using the taxes that I pay for farmland ecosystem–related subsidies," "I have taken real action to protect farmland ecosystems," "the subsidies will provide little assistance toward ensuring improved farmland ecosystems," "the government or farmers will not use the farmland ecosystem–related subsidies properly," or "other.".
Note*: "farmland for specialty crops" was farmland used to grow specialty crops.
Source: compiled in this study.

farmland (15; 1.4 %) were slightly higher than those of farmland cultivated using organic farming methods. Abandoned farmland had the highest number and percentage (154; 14.2 %). For protest-response participants, the number and percentage of participants who would actually be willing to pay less than NT$0, NT$0, or more than NT$0 and who thought they would be willing to pay less than NT$0, NT$0, or more than NT$0 for different farmland cultivated through different farming methods are listed as follows: (a) paddy fields cultivated using organic farming methods (59; 5.4 %); (b) dry farmland cultivated using organic farming methods (55; 5.1 %); and (c) farmland for specialty crops cultivated using organic farming methods (80; 7.4 %). These numbers and percentages were all less than those obtained for farmland cultivated using conventional farming methods, which were as follows: (a) paddy fields cultivated using conventional farming methods (86; 7.9 %); dry farmland cultivated using conventional farming methods (86; 7.9 %); and farmland for specialty crops cultivated using conventional farming methods (62; 5.7 %). The numbers and percentages obtained for fallow farmland (62; 5.7 %) were slightly higher than those of farmland cultivated using organic farming methods. Abandoned farmland had the highest number and percentage (144; 13.2 %).

In this study, structural analyses were constructed on the seven reasons why nonprotest-response participants selected "WTP = 0" and why protest-response participants selected WTP $\geq$ or $\leq$ 0 (Table 5). Among participants who would be unwilling to pay for the ecosystem services offered by paddy fields, dry farmland, and farmland for specialty crops cultivated using organic farming methods, the most common reason was "the government should not be using the taxes that I pay for farmland ecosystem–related subsidies" for all three farmland types (at 42.9 %, 37.1 %, and 30.7 %, respectively). Other common reasons were "the government or farmers will not use the farmland ecosystem–related subsidies properly" (at 25.4 %, 29.0 %, and 25.0 % for paddy fields, dry farmland, and farmland for specialty crops, respectively) and "the subsidies will provide little assistance toward ensuring improved farmland ecosystems" (at 19.0 %, 17.7 %, and 20.5 % for paddy fields, dry farmland, and farmland for specialty crops, respectively). These results indicate that most participants who would be unwilling to pay for ecosystem services offered by farmland cultivated using organic farming methods demonstrated protesting response behavior. Among participants who would be unwilling to pay for ecosystem services offered by paddy fields, dry farmland, and farmland for specialty crops cultivated using conventional farming methods, the most common reason was "farmland ecosystem–related subsidies are unnecessary" (at 38.6 %, 39.7 %, and 38.0 %, respectively). Other common reasons were "there are more critical issues to address than giving farmland ecosystem–related subsidies" (at 14.7 %, 12.3 %, and 11.2 %, respectively), "the government should not be using the taxes that I pay for farmland ecosystem–related subsidies" (at 14.1 %, 19.6 %, and 20.5 %, respectively), and "the government or farmers will not use the farmland ecosystem–related subsidies properly" (at 15.8 %, 16.2 %, and 12.2 %, respectively). These results revealed that most participants who would be unwilling to pay for ecosystem services offered by farmland cultivated using conventional farming methods felt that farmland ecosystem–related subsidies need not be granted to farmland cultivated using such methods. Among participants who would be unwilling to pay for ecosystem services offered by fallow fields, the most common reasons were "the government should not be using the taxes that I pay for farmland ecosystem–related subsidies" (42.9 %), "the government or farmers will not use the farmland ecosystem–related subsidies properly" (27.3 %), and "farmland ecosystem–related subsidies are unnecessary" (16.9 %). Among participants who would be

Table 5
Reasons why protest- and nonprotest-response participants reported unwillingness to pay for farmland ecosystem services.

Reason for unwillingness to pay for farmland ecosystem services	Organic farming methods			Conventional farming methods			Fallow farmland	Abandoned farmland
	Paddy fields	Dry farmland	Farmland for specialty crops	Paddy fields	Dry farmland	Farmland for specialty crops		
Farmland ecosystem–related subsidies are unnecessary	2	3	7	71	71	78	13	133
	(3.2 %)	(4.8 %)	(8.0 %)	(38.6 %)	(39.7 %)	(38.0 %)	(16.9 %)	(44.6 %)
There are more critical issues to address than giving farmland ecosystem–related subsidies	2	4	1	27	22	23	2	21
	(3.2 %)	(6.5 %)	(1.1 %)	(14.7 %)	(12.3 %)	(11.2 %)	(2.6 %)	(7.0 %)
Nonprotest-related reasons	4	7	8	98	93	101	15	154
	(6.4 %)	(11.3 %)	(9.1 %)	(53.3 %)	(52.0 %)	(49.2 %)	(19.5 %)	(51.7 %)
The government should not be using the taxes that I pay for farmland ecosystem–related subsidies	27	23	27	26	35	42	33	51
	(42.9 %)	(37.1 %)	(30.7 %)	(14.1 %)	(19.6 %)	(20.5 %)	(42.9 %)	(17.1 %)
I have taken real action to protect farmland ecosystems	4	2	5	7	3	4	2	5
	(6.3 %)	(3.2 %)	(5.7 %)	(3.8 %)	(1.7 %)	(2.0 %)	(2.6 %)	(1.7 %)
The subsidies will provide little assistance toward ensuring improved farmland ecosystems	12	11	18	21	17	24	5	49
	(19.0 %)	(17.7 %)	(20.5 %)	(11.4 %)	(9.5 %)	(11.7 %)	(6.5 %)	(16.4 %)
The government or farmers will not use the farmland ecosystem–related subsidies properly	16	18	22	29	29	25	21	33
	(25.4 %)	(29.0 %)	(25.0 %)	(15.8 %)	(16.2 %)	(12.2 %)	(27.3 %)	(11.1 %)
Other	0	1	8	3	2	9	1	6
	(0.0 %)	(1.6 %)	(9.1 %)	(1.6 %)	(1.1 %)	(4.4 %)	(1.3 %)	(2.0 %)
Protest-related reasons	59	55	80	86	86	104	62	144
	(93.6 %)	(88.6 %)	(91.0 %)	(46.7 %)	(48.1 %)	(50.8 %)	(80.6 %)	(48.3 %)
Total (100.0 %)	63	62	88	184	179	205	77	298

Note: Participants who selected "farmland ecosystem–related subsidies are unnecessary" or "there are more critical issues to address than giving farmland ecosystem–related subsidies" as their reasons for unwillingness to pay for farmland ecosystem services were considered to not have protesting behavior, whereas those who selected "the government should not be using the taxes that I pay for farmland ecosystem–related subsidies," "I have taken real action to protect farmland ecosystems," "the subsidies will provide little assistance toward ensuring improved farmland ecosystems," "the government or farmers will not use the farmland ecosystem–related subsidies properly," or "other" were considered to have protesting behavior.
Source: compiled in this study.

unwilling to pay for ecosystem services offered by abandoned farmland, the most common reasons were "farmland ecosystem–related subsidies are unnecessary" (44.6 %), "the government should not be using the taxes that I pay for farmland ecosystem–related subsidies" (17.1 %), and "the subsidies will provide little assistance toward ensuring improvements in farmland ecosystems" (16.4 %).

In this study, the demographic information of the participants was compiled, and descriptive analyses were performed for nonprotest-response participants and for the two participant groups (i.e., the protest- and nonprotest-response participants) as a whole (Table 6). This study considered the following eight farmland types: paddy fields, dry farmland, and farmland for specialty crops cultivated using organic farming methods; paddy fields, dry farmland, and farmland for specialty crops cultivated using conventional farming methods; fallow farmland; and abandoned farmland. Subsequently, the average amount that participants would be willing to pay for the farming ecosystem services offered by the farmland types was collected. The amount that the nonprotest-response participants would be willing to pay for all farmland types was higher than that the two groups combined would be willing to pay. Among the different farmland types, participants reported being willing to pay more for ecosystem services offered by paddy fields, dry farmland, and farmland for specialty crops cultivated using organic farming methods and by fallow farmland (i.e., they were willing to pay the most for sustainable paddy field ecosystem services). The nonprotest-response participants would be willing to pay an average of NT$751.9 for farmland ecosystem services, whereas the two groups combined would be willing to pay an average of NT$711.1. The participants reported being willing to pay less for ecosystem services offered by paddy fields, dry farmland, and farmland for specialty crops cultivated using conventional farming methods and by abandoned farmland. Finally, the participants reported being willing to pay the least for ecosystem services offered by abandoned farmland, with the nonprotest-response participants reportedly being willing to pay NT $401.9 and the two groups combined being willing to pay NT$348.7. Annual disposable income in Taiwan appears to be NT$369,742; and the best case for paddy fields that participants would be willing to pay (when protest responses removed) would be NT$751.9 (only accounting for 0.20 % of their disposable income).

Table 6
Average amount that participants would be willing to pay for farmland ecosystem services (NT$/person/year).

Item			Average amount that participants would be willing to pay
Sustainable farming	Paddy fields	Overall	711.1
		Protest responses removed	751.9
	Dry farmland	Overall	646.3
		Protest responses removed	680.7
	Farmland for specialty crops*	Overall	556.9
		Protest responses removed	601.1
Conventional farming	Paddy fields	Overall	493.9
		Protest responses removed	536.3
	Dry farmland	Overall	443.9
		Protest responses removed	482
	Farmland for specialty crops*	Overall	409.5
		Protest responses removed	452.7
Fallow farmland		Overall	611.5
		Protest responses removed	648.5
Abandoned farmland		Overall	348.7
		Protest responses removed	401.9

Note: "Overall" includes both protest- and nonprotest-response participants, whereas "protest response removed" includes only nonprotest responses.
Note: * represents that "farmland for specialty crops" was farmland used to grow specialty crops.
Source: compiled in this study.

4.3. Analysis of the amount that participants would be willing to pay for farmland ecosystem services and related influential factors

The contingent valuation method (CVM) was adopted to investigate the amount that the Taiwanese public would be willing to pay for ecosystem services offered by various farmland types. However, several participants in this study demonstrated protesting response behavior, which caused analyses of the survey results to exhibit selection bias (Cho et al., 2008). Accordingly, the Tobit model is used to analyze censor dependent variables, and was employed before the survey results of both the protest and nonprotest-response samples were used for analysis. Such an approach prevented the protest samples from potentially creating sampling bias (Wu et al., 2004). The Tobit model was used to analyze the factors influencing participants' WTP for the farmland ecosystem services offered by eight farmland types (i.e., sustainable paddy fields, sustainable dry farmland, sustainable farmland for specialty crops, conventional paddy fields, conventional dry farmland, conventional farmland for specialty crops, fallow farmland, and abandoned farmland) as well as all farmland types as a whole. Subsequently, the coefficients of all variables were obtained and the empirical results, displayed in Table 7, were recorded.

When all farmland types were considered as a whole, WTP for ecosystem services was significantly different between participants from different independent variable groups. The independent variables were "average monthly income" (*Inc_Con*), "attention given to farmland ecosystems" (*Att*), "importance attached to farmland ecosystems" (*Imp*), "satisfaction with farmland ecosystems" (*Sat*), "confidence in maintaining farmland ecosystems" (*Con*), and "belief in limiting growth" (*Gro*). For "average monthly income," participants with a higher average monthly income reported being willing to pay more for farmland ecosystem services than those with lower; and the difference between the two groups was significant. For "attention given to farmland ecosystems," participants who paid more attention to farmland ecosystem service–related issues reported being willing to pay more for farmland ecosystem services than those who paid less; and the difference between the groups was significant. For "the importance attached to farmland ecosystems," participants who considered farmland ecosystem services and their value to be crucial to the environment and for current and future generations reported being willing to pay more for farmland ecosystem services than those who did not; and the difference between the groups was significant. For "satisfaction with farmland ecosystems," participants who were less satisfied with the functions and services currently provided by farmland ecosystems reported being willing to pay more for farmland ecosystem services than those who were more satisfied; and the difference between the groups was significant. For "confidence in maintaining farmland ecosystems," participants who were more confident in the effectiveness of new subsidy measures implemented by government agencies for farmland ecosystem services reported being willing to pay more for farmland ecosystem services than those who were not; and the difference between the groups was significant. Finally, for "belief in limiting growth," participants who agreed more that natural ecological balance was extremely vulnerable, and could be easily destroyed reported being willing to pay more for farmland ecosystem services than those who did not; and the difference

Table 7
Analysis performed using the Tobit model for factors influencing the value participants assigned to farmland ecosystem services.

Variable	Farmland as a whole	Organic farming method			Conventional farming method			Fallow farmland	Abandoned farmland
		Paddy fields	Dry farmland	Farmland for specialty crops	Paddy fields	Dry farmland	Farmland for specialty crops		
Gen	−66.77	−29.55	−11.63	−4.95	11.83	−0.02	8.51	−22.99	−1.69
Age_Con	0.71	0.95	0.07	−0.49	−4.25	−3.26	−3.38	−0.39	−2.67
Edu_Con	−5.08	−0.35	−4.28	−9.86	−7.91	−15.77	−16.24	−7.64	−4.70
Marr	3.10	4.06	40.42	−3.83	74.01	49.01	12.69	44.80	38.32
A_M	59.71	4.65	−8.06	18.01	4.44	18.27	62.11	15.45	0.50
A_S	68.70	73.24	96.02*	81.42	99.32*	109.93*	89.44*	62.00	62.46
A_E	203.01	285.76	297.16*	375.41**	246.69	315.73*	328.98*	121.44	68.92
Inc_Con	57.76***	51.52***	49.25***	39.78***	32.66***	31.41***	32.52***	46.94***	27.31**
Farm	21.02	50.24	67.98	48.80	59.55	33.72	32.50	47.25	91.30
Group	44.55	2.74	28.47	41.73	−42.86	3.61	−7.05	38.03	42.79
Visit_Con	0.27	0.32	0.31	0.50	0.58	0.44	0.74*	0.26	0.48
S1_R	20.19	21.59	6.74	10.85	−31.31	−17.28	3.11	−14.76	13.07
S1_C	−28.88	29.60	27.26	73.94	25.88	71.45	113.89	−8.31	63.24
Und	−48.37	−43.16	−66.20*	−68.46*	−83.17**	−62.95*	−73.64**	−68.81*	−78.13*
Att	56.88*	45.19	41.88	7.44	29.67	23.21	14.34	53.42*	30.34
Imp	112.43**	111.41**	88.39*	96.78*	77.85	49.54	73.24	96.76*	64.43
Sat	−76.17*	−71.57*	−57.94	−34.30	−4.11	−1.53	28.70	−56.97	−32.35
Con	81.23**	103.40***	106.85***	110.33***	120.61***	118.47***	113.15***	121.92***	164.26***
Ant	−23.93	−26.86	−12.45	12.36	54.40**	58.22**	75.82***	−32.49	46.51*
Gro	80.20*	78.18*	35.27	42.74	65.09	69.04*	52.45	50.67	22.24
Rec	−43.98	−37.50	−39.43	−27.90	−108.48*	−72.17	−87.51*	−12.63	−5.07
Har	81.83	59.27	82.53	48.43	11.07	14.79	16.99	29.90	−5.90
logSigma	6.54***	6.53***	6.48***	6.43***	6.47***	6.40***	6.39***	6.47***	6.44***
log-likelihood:	−8,263.18	−8211.89	−8165.35	−7934.78	−7292.10	−7264.41	−7067.52	−8044.54	−6441.84
Wald-statis	107.9***	100.4***	97.7***	79.1***	99.7***	106.3***	129.7***	98.4***	99.3***
scale	692.3	687.1	652.8	621.9	643.9	603.2	597.5	642.4	627.8

Source: compiled in this study.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

between the groups was significant.

Regarding paddy fields cultivated using organic farming methods, WTP for ecosystem services was significantly different between participants from different independent variable groups. These independent variables were "average monthly income" (*Inc_Con*), "importance attached to farmland ecosystems" (*Imp*), "satisfaction with farmland ecosystems" (*Sat*), "confidence in maintaining farmland ecosystems" (*Con*), and "belief in limiting growth" (*Gro*). For "average monthly income," participants with a higher average monthly income reported being willing to pay more for sustainable paddy field ecosystem services than those with lower; and the difference between the groups was significant. For "importance attached to farmland ecosystems," participants who considered farmland ecosystem services and their value to be crucial to the environment and for the current and future generations reported being willing to pay more for sustainable paddy field ecosystem services than those who did not; and the difference between the groups was significant. For "satisfaction with farmland ecosystems," participants who were less satisfied with the functions and services currently provided by farmland ecosystems reported being willing to pay more for sustainable paddy field ecosystem services than those who were more satisfied; and the difference between the groups was significant. For "confidence in maintaining farmland ecosystems," participants who were more confident in the effectiveness of new subsidy measures implemented by government agencies for farmland ecosystem services reported being willing to pay more for sustainable paddy field ecosystem services than those who were less; and the difference between the groups was significant. Finally, for "beliefs on limiting growth," participants who agreed more that natural ecological balance was extremely vulnerable and could be easily destroyed reported being willing to pay more for sustainable paddy field ecosystem services than those who agreed less; and the difference between the groups was significant.

With respect to dryland cultivated using organic farming methods, WTP for ecosystem services was significantly different between participants from different independent variable groups. These independent variables were "living in southern Taiwan" (*A_S*), "living in eastern Taiwan" (*A_E*), "average monthly income" (*Inc_Con*), "importance attached to farmland ecosystems" (*Imp*), and "confidence in maintaining farmland ecosystems" (*Con*). For "living in southern Taiwan," participants who lived in southern Taiwan reported being willing to pay relatively more for sustainable dry farmland ecosystem services than their counterpart did; and the difference between the groups was significant. For "living in eastern Taiwan," participants who lived in eastern Taiwan reported being willing to pay relatively more for sustainable dry farmland ecosystem services than their counterpart did; and the difference between the groups was significant. For "average monthly income," participants with a higher average monthly income reported being willing to pay more for sustainable dry farmland ecosystem services than those with lower did; and the difference between the groups was significant. For "importance attached to farmland ecosystems," participants who considered farmland ecosystem services and their value to be crucial to the environment and for the current and future generations reported being willing to pay more for sustainable dry farmland ecosystem services than those who did not did; and the difference between the groups was significant. For "confidence in maintaining farmland ecosystems," participants who were more confident in the effectiveness of new subsidy measures implemented by government agencies for farmland ecosystem services reported being willing to pay more for sustainable dry farmland ecosystem services than those who were less did; and the difference between the groups was significant.

Regarding farmland for specialty crops cultivated using organic farming methods, WTP for ecosystem services were significantly different between participants from different independent variable groups. These independent variables were "living in eastern Taiwan" (*A_E*), "average monthly income" (*Inc_Con*), "importance attached to farmland ecosystems" (*Imp*), and "confidence in maintaining farmland ecosystems" (*Con*). For "living in eastern Taiwan," participants who lived in eastern Taiwan reported being willing to pay more for sustainable special crop farmland ecosystem services than their counterpart did; and the difference between the groups was significant. For "average monthly income," participants with a higher average monthly income reported being willing to pay more for sustainable special crop farmland ecosystem services than those with lower did; and the difference between the groups was significant. For "importance attached to farmland ecosystems," participants who considered farmland ecosystem services and their value to be crucial to the environment and for the current and future generations reported being willing to pay more for sustainable special crop farmland ecosystem services than those who did not did; and the difference between the groups was significant. For "confidence in maintaining farmland ecosystems," participants who were more confident in the effectiveness of new subsidy measures implemented by government agencies for farmland ecosystem services reported being willing to pay more for sustainable special crop farmland ecosystem services than those who were less did; and the difference between the groups was significant.

Concerning paddy fields cultivated using conventional farming methods, WTP for ecosystem services was significantly different between participants from different independent variable groups. These independent variables were "living in southern Taiwan" (*A_S*), "average monthly income" (*Inc_Con*), "confidence in maintaining farmland ecosystems" (*Con*), "beliefs on anthropocentrism" (*Ant*), and "reflections on development" (*Rec*). For "living in southern Taiwan," participants who lived in southern Taiwan reported being willing to pay more for conventional paddy field ecosystem services than their counterpart did; and the difference between the groups was significant. For "average monthly income," participants with a higher average monthly income reported being willing to pay more for conventional paddy field ecosystem services than those with lower did; and the difference between the groups was significant. For "confidence in maintaining farmland ecosystems," participants who were more confident in the effectiveness of new subsidy measures implemented by government agencies for farmland ecosystem services reported being willing to pay more for conventional paddy field ecosystem services than those who were less did; and the difference between the groups was significant. For "beliefs on anthropocentrism," participants who agreed more that humans were born with the right to use and manage all things in nature reported being willing to pay more for conventional paddy field ecosystem services than those who agreed less did; and the difference between the groups was significant. Finally, for "reflections on development," participants who agreed more that humans were abusing environmental resources" reported being willing to pay less for conventional paddy field ecosystem services than those who agreed less did; and the difference between the groups was significant.

Regarding dry farmlands cultivated using conventional farming methods, WTP for ecosystem services was significantly different between participants from different independent variable groups. These independent variables were "living in southern Taiwan" (*A_S*), "living in eastern Taiwan" (*A_E*), "average monthly income" (*Inc_Con*), "confidence in maintaining farmland ecosystems" (*Con*), "beliefs on anthropocentrism" (*Ant*), and "beliefs on limiting growth" (*Gro*). For "living in southern Taiwan," participants who lived in southern Taiwan reported being willing to pay more for conventional dry farmland ecosystem services than their counterpart did; and the difference between groups was significant. For "living in eastern Taiwan," participants who lived in eastern Taiwan reported being willing to pay more for conventional dry farmland ecosystem services than their counterpart did; and the difference between groups was significant. For "average monthly income," participants with a higher average monthly income reported being willing to pay more for conventional dry farmland ecosystem services than those with lower did; and the difference between groups was significant. For "confidence in maintaining farmland ecosystems," participants who were more confident in the effectiveness of new subsidy measures implemented by government agencies for farmland ecosystem

services reported being willing to pay more for conventional dry farmland ecosystem services than those who were less did; and the difference between groups was significant. For "beliefs on anthropocentrism," participants who agreed more that humans were born with the right to use and manage all things in nature reported being willing to pay more for conventional dry farmland ecosystem services than those who agreed less did; and the difference between groups was significant. Finally, for "beliefs on limiting growth," participants who agreed more that humans should harmoniously coexist with nature and not exploit it at will reported being willing to pay more for conventional dry farmland ecosystem services than those who agreed less did; and the difference between groups was significant.

With respect to farmland for specialty crops cultivated using conventional farming methods, WTP for ecosystem services was significantly different between participants from different independent variable groups. These independent variables were "living in southern Taiwan" (*A_S*), "living in eastern Taiwan" (*A_E*), "average monthly income" (*Inc_Con*), "average number of times visiting or coming into contact with farmland" (*Visit_Con*), "confidence in maintaining farmland ecosystems" (*Con*), "beliefs on anthropocentrism" (*Ant*), and "reflections on development" (*Rec*). For "living in southern Taiwan," participants who lived in southern Taiwan reported being willing to pay more for conventional special crop farmland ecosystem services than their counterpart did; and the difference between the groups was significant. For "living in eastern Taiwan," participants who lived in eastern Taiwan reported being willing to pay more for conventional special crop farmland ecosystem services than their counterpart did; and the difference between the groups was significant. For "average monthly income," participants with a higher average monthly income reported being willing to pay more for conventional special crop farmland ecosystem services than those with lower did; and the difference between the groups was significant. For "average number of times visiting or coming into contact with farmland," participants who visited or came into contact with farmland more frequently reported being willing to pay more for conventional special crop farmland ecosystem services than those who did so infrequently did; and the difference between the groups was significant. For "confidence in maintaining farmland ecosystems," participants who were more confident in the effectiveness of new subsidy measures implemented by government agencies for farmland ecosystem services reported being willing to pay more for conventional special crop farmland ecosystem services than those who were less did; and the difference between the groups was significant. For "beliefs on anthropocentrism," participants who agreed more that humans were born with the right to use and manage all things in nature reported being willing to pay more for conventional special crop farmland ecosystem services than those who agreed less did; and the difference between the groups was significant. Finally, for "reflections on development," participants who agreed more that humans were abusing environmental resources reported being willing to pay less for conventional special crop farmland ecosystem services than those who agreed less did; and the difference was significant.

Concerning fallow farmland, WTP for ecosystem services was significantly different between participants from different independent variable groups. These independent variables were "average monthly income" (*Inc_Con*), "attention given to farmland ecosystems" (*Att*), "importance attached to farmland ecosystems" (*Imp*), and "confidence in maintaining farmland ecosystems" (*Con*). For "average monthly income," participants with a higher average monthly income reported being willing to pay more for fallow farmland ecosystem services than those with lower did; and the difference between the groups was significant. For "attention given to farmland ecosystems," participants who paid more attention to farmland ecosystem service–related issues reported being willing to pay more for fallow farmland ecosystem services than those who paid less did; and the difference between the groups was significant. For "importance attached to farmland ecosystems," participants who considered farmland ecosystem services and their value to be crucial to the environment and for the current and future generations reported being willing to pay more for fallow farmland ecosystem services than those who did not did; and the difference between the groups was significant. For "confidence in maintaining farmland ecosystems," participants who were more confident in the effectiveness of new subsidy measures implemented by government agencies for farmland ecosystem services reported being willing to pay more for fallow farmland ecosystem services than those who were not did; and the difference between the groups was significant.

Regarding abandoned farmland, WTP for ecosystem services was significantly different between participants from different independent variable groups. These independent variables were "average monthly income" (*Inc_Con*), "confidence in maintaining farmland ecosystems" (*Con*), and "beliefs on anthropocentrism" (*Ant*). For "average monthly income," participants with a higher average monthly income reported being willing to pay more for abandoned farmland ecosystem services than those with lower did; and the difference between the groups was significant. For "confidence in maintaining farmland ecosystems," participants who were more confident in the effectiveness of new subsidy measures implemented by government agencies for farmland ecosystem services reported being willing to pay more for abandoned farmland ecosystem services than those who were less did; and the difference between the groups was significant. For "beliefs on anthropocentrism," participants who agreed more that humans were born with the right to use and manage all things in nature reported being willing to pay more for abandoned farmland ecosystem services than those who agreed less did; and the difference between the groups was significant.

4.4. Estimated and actual value of farmland ecosystem services

Paired *t*-tests were performed on the estimated and actual amounts that the 1,088 participants would be willing to pay for ecosystem services offered by the eight farmland types (i.e., paddy fields, dry farmland, and farmland for specialty crops cultivated using organic farming methods; paddy fields, dry farmland, and farmland for specialty crops cultivated using conventional farming methods; fallow farmland; and abandoned farmland) as well as by all farmland types as a whole. H_0 signified that the actual amount that the participants would be willing to pay (i.e., WTP^{True}) was equal to the estimated amount (i.e., WTP^{Sim}), and H_1 signified that the actual amount that the participants would be willing to pay was not equal to the estimated amount. The difference between the actual and estimated amounts (i.e., ΔWTP) and the results are presented in Table 8. The Tobit method was used to estimate the amount that the participants would be willing to pay for ecosystem services offered by the eight farmland types as well as those offered by all farmland types as a whole. The estimated results were then compared with the actual results, and H_0 was accepted for all farmland types, indicating that, with a significance level of 5 %, the differences between the estimated and actual amounts that participants would be willing to pay for the ecosystem services offered by all farmland types were nonsignificant.

4.5. Estimated and actual value of ecosystem services offered by different farmland types

The value of farmland ecosystem services in Taiwan was used as a reference to calculate the amount that the participants would be willing to pay for ecosystem services offered by different farmland types. Farmland production and ecosystems are both heavily influenced by natural resources. When assessing the value of farmland ecosystem services in Taiwan, such natural resources can be divided into four categories (i.e., atmosphere, water, soil, and biodiversity resources) (The Economics of Ecosystems and Biodiversity [TEEB], 2018; IPBES et al., 2019). For each category, there were three types of farmland ecosystem services that served as indicators. In this study, water resources comprised storing water resources, purifying water, and

Table 8
Analysis of estimated and actual amounts that participants would pay for farmland ecosystem services.

Item	Organic farming methods			Conventional farming methods			Fallow farmland	Abandoned farmland
	Paddy fields	Dry farmland	Farmland for specialty crops	Paddy fields	Dry farmland	Farmland for specialty crops		
WTP^{True}	711.12	646.25	556.94	493.89	443.93	409.47	611.51	348.69
WTP^{Sim}	687.69	624.02	526.30	423.00	378.00	331.36	584.17	222.55
ΔWTP	23.43	22.23	30.64	70.89	65.93	78.11	27.34	126.14
SD	212.12	198.39	170.55	201.39	195.20	215.43	196.36	201.79
t	1.1739	1.1709	1.7255	4.1398	4.0830	4.9601	1.4791	8.2138
Results	H_0 *Accepted*	H_0 *Accepted*	H_0 *Accepted*	H_0 *Accepted*	H_0 *Accepted*	H_0 *Accepted*	H_0 *Accepted*	H_0 *Accepted*

Note: WTP^{True} represents the actual amount (NT$/person/year) that participants would be willing to pay for farmland ecosystem services. WTP^{Sim} represents the estimated amount (NT$/person/year) that participants would be willing to pay for farmland ecosystem services. H_0 signifies that the estimated and actual amount were equal, and H_1 signifies the estimated and actual amounts were not equal.
Source: compiled in this study.

mitigating flooding. Storing water resources denoted conserving water resources, with surface vegetation, forest trees, and long-term water storage increasing groundwater replenishment and water supplies. Purifying water denoted using vegetation and substances, such as soil, and biological effects to absorb or filter pollutants and thereby produce purified water. Mitigating flooding denoted using land and surface vegetation to reduce the risks and impact of flooding (Wang et al., 2019; Willot et al., 2019).

Soil resources comprised conserving soil, facilitating nutrient cycles, and inducing phytoremediation. Conserving soil denoted preventing soil erosion and loss. Soil erosion is a key factor that causes land degradation and desertification. Facilitating nutrient cycles denoted maintaining nutrient cycles in soil, thereby allowing minerals and chemical elements required by various organisms to flow, exchange, and transform normally in ecosystems. Inducing phytoremediation denoted using surface vegetation to repair soil and areas contaminated by organic and inorganic pollutants (Luo et al., 2019; Jeevanantham et al., 2019; Peiris et al., 2019).

Biodiversity resources comprised having biodiversity, inducing pollination or seed spreading, and biocontrol. Having biodiversity denoted having species, habitat, and genetic diversity, with habitats providing the conditions required for all organisms to survive. Inducing pollination or seed spreading denoted insects and wind inducing pollination and seed spreading for vegetation and trees, which affects the growth and production of fruits, vegetables, and seeds. Biocontrol denoted regulating insect populations and insect-borne diseases that are harmful to humans, plants, and animals by introducing parasites and natural enemies of the insects (de Graaff et al., 2019; Latif et al., 2019).

Atmosphere resources comprised purifying air, engendering carbon sequestration or reducing carbon concentrations, and regulating microclimates. Purifying air denoted vegetation and trees removing pollutants in the atmosphere and thereby improving air quality. Engendering carbon sequestration or reducing carbon concentrations denoted ecosystems using plant growth to sequester greenhouse gases and thereby regulate the global climate and mitigate the greenhouse effect. Regulating microclimates denoted trees providing shade and forests and paddy fields affecting regional rainfall and regulating temperature (Giannadaki et al., 2018).

In this study, the value weights of farmland ecosystem services were referenced from Liu (2020), who used the analytic network process of multiple criteria decision analysis to establish the weighted value framework. The CVM was employed to develop questionnaires to investigate the amount that the Taiwanese public would be willing to pay for farmland ecosystem services. The questionnaires were subsequently used to estimate the value that participants attached to the ecosystem services offered by the various farmland types. The estimated amounts that the participants would be willing to pay for ecosystem services offered by dry farmland, paddy fields, and farmland for specialty crops cultivated using conventional farming methods were obtained from the results of the questionnaires. Conversely, the estimated amounts that participants would be willing to pay for ecosystem services offered by dry farmland, paddy fields, and farmland for specialty crops cultivated using organic farming methods were obtained by multiplying weights (derived from the analytic network process) for the data obtained from the questionnaires.

The estimations of the amount that each participant would be willing to pay for the ecosystem services offered by the different farmland types are presented in Table 9. Participants reported being willing to pay an average NT$443.93 per year for ecosystem services offered by dry farmland. Furthermore, participants reported being willing to pay NT $202.32 more for ecosystem services offered by dry farmland cultivated using organic farming methods than those offered by dry farmland cultivated using conventional farming methods. Participants reported being willing to pay an average NT$493.89 per year for ecosystem services offered by paddy fields, which is within the range (NT $405.01–NT$648.82) presented by Chen et al. (2006) for the unused value of paddy fields. Additionally, participants reported being willing to pay NT$217.73 more per year for ecosystem services offered by paddy fields cultivated using organic farming methods than those offered by paddy fields cultivated using conventional farming methods. Participants reported being willing to pay NT$638.11 per year for ecosystem services offered by farmland cultivated using organic farming methods. Furthermore, participants reported being willing to pay NT$409.47 per year for ecosystem services provided farmland for specialty crops. Finally, participants reported being willing to pay NT$147.47 more for ecosystem services offered by farmland for specialty crops cultivated using organic farming methods than those offered by farmland for specialty crops cultivated using conventional farming methods.

5. Conclusion and suggestions

As the global population has become increasingly environmentally conscious, concepts such as sustainable development of ecological environment have gained much attention. Farmland ecosystems are closely related to human society and well-being. Because most ecosystem services exhibit public good–related characteristics, to effectively maintain the supply for these nonexclusive ecosystem services, governments and related agencies must support farmers by formulating and granting related policies and subsidies. Furthermore, relevant agencies may refer to studies assessing the value of farmland ecosystem services when planning and granting related subsidies for farmland ecosystem services.

According to the results of the survey in this study, the amounts that participants were willing to pay for ecosystem services offered by paddy fields, dry farmland, and special crop farmland cultivated using organic farming methods were NT$711.12, NT$626.25, and NT$556.94 per person per year, respectively. The amounts that participants were willing to pay for ecosystem services offered by paddy fields, dry farmland, and special crop farmland cultivated using conventional farming methods were NT$493.89, NT$443.93, and NT$409.47 per

Table 9
Estimated and actual amounts (NT$/person/year) that participants would be willing to pay for ecosystem services offered by different farmland types in Taiwan.

Farmland ecosystem services		Dry farmland	Paddy fields	Organic farming methods	Farmland for specialty crops
Storing water resources	Actual	45.09	50.12	64.84	41.44
	Estimated	38.39	42.92	63.96	33.54
Purifying water	Actual	33.82	37.66	48.56	31.08
	Estimated	28.79	32.25	47.91	25.15
Mitigating flooding	Actual	32.08	35.70	46.09	29.67
	Estimated	27.32	30.57	45.47	24.01
Conserving soil	Actual	43.35	48.16	62.24	40.03
	Estimated	36.91	41.24	61.39	32.39
Facilitating nutrient cycles	Actual	43.35	48.16	62.24	40.03
	Estimated	36.91	41.24	61.39	32.39
Inducing phytoremediation	Actual	24.28	27.16	35.02	22.37
	Estimated	20.67	23.26	34.55	18.10
Driving biodiversity	Actual	45.52	50.54	65.36	41.91
	Estimated	38.76	43.28	64.47	33.92
Inducing pollination or seed spreading	Actual	36.20	40.32	52.08	33.44
	Estimated	30.82	34.53	51.37	27.06
Controlling pests	Actual	29.26	32.62	42.05	27.08
	Estimated	24.92	27.94	41.48	21.91
Purifying air	Actual	41.62	46.20	59.76	38.38
	Estimated	35.44	39.57	58.95	31.06
Engendering carbon sequestration and reducing carbon concentrations	Actual	44.00	49.00	63.28	40.50
	Estimated	37.47	41.96	62.42	32.77
Regulating microclimates	Actual	25.36	28.28	36.59	23.55
	Estimated	21.59	24.22	36.09	19.05

Source: compiled in this study.
Note*: "Actual" signifies results obtained from actual questionnaire surveys (after WTP weighting had been multiplied), and "estimated" signifies results derived by multiplying weights for the results obtained from WTP estimation equations.

person per year, respectively. The amount that participants were willing to pay for ecosystem services offered by fallow farmland was NT$611.51 per person per year. Finally, the amount that participants were willing to pay for ecosystem services offered by abandoned farmland was NT $348.69 per person per year. These numbers differed slightly from those estimated using the study model, which are presented as follows: the amounts that participants were estimated to be willing to pay for ecosystem services offered by paddy fields, dry farmland, and special crop farmland cultivated using organic farming methods were NT $687.69, NT$624.02, and NT$526.30 per person per year, respectively. The amounts that participants were estimated to be willing to pay for ecosystem services offered by paddy fields, dry farmland, and special crop farmland cultivated using conventional farming methods were NT $423.00, NT$378.00, and NT$331.36 per person per year, respectively. The amounts that participants were estimated to be willing to pay for ecosystem services offered by fallow farmland and abandoned farmland were NT$584.17 and NT$222.55 per person per year, respectively.

The estimations of the empirical model revealed that the amount which participants would be willing to pay for ecosystem services offered by different farmland types was related to their average monthly income and their perception of farmland ecosystem services. Generally, participants with a higher average monthly income reported being willing to pay more for farmland ecosystem services. Similarly, participants who attached more importance to farmland ecosystems or who had more confidence in maintaining farmland ecosystems reported being willing to pay more for farmland ecosystem services.

The value that people attached to ecosystem services offered by different farmland types was referenced from Liu (2020), who used an analytic network process to estimate the value: the participants were found to be willing to pay the most for ecosystem services offered by farmland cultivated using organic farming methods (NT$638.11/person/year). After converting the population of Taiwan and the average farmland area of each farmland type, paddy fields have the highest total ecological value of agricultural land (NT$20.10989 billion).

Agricultural production has environmental externalities, which must be solved by government policies, such as subsidies or preferential tax policies, to maintain agricultural existence. In addition, since the yield of organic farming methods is less than that of conventional farming methods, it is more necessary to guide farmers for organic farming methods through government subsidies or incentive policies. If the Taiwanese government aims to increase the value of farmland ecosystem services in Taiwan, it should introduce farmland afforestation incentives, organic farmland incentives, and farmland-friendly incentives to encourage farmers to transform abandoned farmland or farmland cultivated using conventional farming methods into farmland cultivated using organic or environmentally friendly farming methods. Moreover, the government could increase subsidies granted for production environment maintenance and thereby induce farmers to allow farmland to lie fallow. Additionally, the government can guide and promote agricultural experience activities, such as one-day trips to villages and farmland ecosystems, to encourage individuals to leave urban environments during holidays and to experience organic or environmentally friendly farmland ecosystems; to learn farmland ecosystem services; and to develop a positive understanding of farmland ecosystem services.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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