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ECONOMIC VALUATION OF ENVIRONMENTALLY FRIENDLY AGRICULTURE FOR IMPROVING ENVIRONMENTAL QUALITY

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environmentally friendly agriculture, environmental quality, non-market valuation, double-bounded dichotomous choice, willingness to pay

Abstract
The purpose of this paper is to evaluate the economic valuation on improving the environmental quality of environmentally friendly agriculture by using the dichotomous choice contingent valuation method (DC-CVM). The analytical data were collected from a survey on the willingness to pay for improving the environmental qualities in Hongsung county in Chungnam province. The empirical result shows that environmentally-friendly agriculture has made contributions in improving the environmental qualities with respect to the conservation of water and soil, and species and ecosystem diversity in addition to stimulating agricultural production.

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I. Introduction

Traditionally agriculture was an environmentally friendly bio-industry that has harmonized with the nature based on the smooth resource cycling of the ecosystem. However, modern agriculture has been transforming into an industry that is highly dependent on intensive farming practices like a high input-high output operation, in which chemical fertilizers and agricultural chemicals are used in large quantities to increase productivity under the restricted conditions of farming with natural resources. This in turn is creating even larger environmental problems for the future.

Due to the increasing concerns over conserving the environmental quality recently, Environmentally Friendly Agriculture (EFA) has been a main focus of agricultural policy schemes. In this note, the korean government established a systemic foundation by declaring the first year of EFA in 1998 and enacting the Promotion Act of EFA. Not only policy makers but also farmers recognize the significance of EFA. Especially, a switchover to EFA is being promoted as an alternative for future agriculture.

There are a lot of studies on the economic valuation of environmental quality improvement drawn from practicing EFA. Oh et al.(1995) evaluated multifunctional value of rice paddies using the replacement cost method and contingent valuation method(CVM). Currently, CVM has become a widely used method to evaluate multifunctionality in Korea. Evaluation targets also exist in various fields. There have been several studies by Kim and Choi(1997) who applied CVM to food safety issues. Many studies by Kim and Kim (1997), Kwon (2003), and Yoo and Gong (2001) evaluated the non-market value of environmentally friendly farming practices. Rhee et al.(2003) evaluated the economic value of no-pesticide certified rice. Rhee et al.(2002) evaluated the economic value of rural area's landscape, and Yoo and Lee(2003) also evaluated less-favored agricultural and rural areas by using CVM. The number of studies which evaluated the economic value of agricultural multi-functionality by using CVM is increasing recently.

Especially, most studies related to EFA are focused on production-oriented discussions, policy-making studies or the distribution of EFA products.[1] There are a limited number of studies on the economic valuation of environmental quality improvement for EFA. Relevant researchers have a common consciousness that EFA produces safe agricultural products, conserves the rural environment and ecosystem, and plays an important role in maintaining the capacity to maintain agriculture and has multifunctionality such as the conservation of water and soil qualities, and species and ecosystem diversities. However, the domestic studies on that area are limited.[2]

The purpose of this study is to evaluate the economic valuation on improving environmental quality in consequence to the systemic switchover to an environmentally friendly agricultural system and to provide theoretical grounds related to it.

The remainder of this paper is organized as follows: Section 2 explains non-market valuation methods including the dichotomous choice contingent valuation method. Section 3 reviews the data and estimation results. Some concluding remarks are made in the final section.

II. Non-Market Valuation Methods

The notion of multifunctional agriculture refers to the fact that agricultural production provides not only food and fiber but also different non-market commodities. These non-commodity outputs include the impacts of agriculture

1 Studies on producing economically-friendly agriculture were conducted by Chun (2001), Kim et al. (2003), Oh et al. (2004), and Shin et al. (2005).

2 Mander et al. (1999) analyzed that lower chemicals-input farming is from 0.5 to 20 times more effective than commonly practiced farming in terms of ecological diversity and also more effective in view of the diverse patterns of land use, fertile land, rotation of crops, soil, climate, and the harmony of land utilization and visual value.

on environmental quality, such as water quality, biodiversity, and rural landscape. Thus, we need non-market valuation techniques for evaluating multifunctionality. Several methods have been developed to value non-market commodities in monetary terms consistent with the values of marketed goods.

These methods are based on individual preferences, which means that they are supposed to reflect preferences of individual consumers. the valuation techniques derived from individual preferences can be either a revealed preference or stated preferences.[3]

The contingent valuation method (CVM) is probably the most widely used method for placing monetary values on non-market goods such as environmental quality, biodiversity and soil conservation. Even though there are many relevant research results, dichotomous choice CVM (Bishop and Heberlein, 1979) is used widely. Dichotomous choice CVM (DC-CVM) is a method in which respondents express their willingness to pay for each one of some set prices given to them by answering yes or no. The monetary value of environmental resources is estimated with the distribution of the number of respondents. This valuation approach is known to show relatively narrow bias compared to other methods.[4]

This study evaluated the economic value of improving environmental quality of EFA by using Hanemann's(1984) utility difference model. It hypothesizes that the dichotomous choice decision depends on the difference of utility. Suppose that the initial price to respondents is T, then the second price to those who said ‘yes’ to T is Tu, and the second price to those who said ‘no’ is Td. Then, the following formula $Td<T<Tu$ could be formulated.

The DC-CVM is an expanded method of dichotomous choice CVM using double-bounded questions. DC-CVM repeats the questions of dichotomous choice CVM twice. If respondents show their willingness to pay the ini-

[3] Revealed preference methods are based on observed behavior towards some marketed goods connected to the examined non-market goods. Stated preference methods rest on surveys regarding the non-market goods.

[4] For more detailed explanation about comparing CVM methods, refer to Rhee et al.(2004).

tial price, a higher price is presented to them on the next step. If not, a lower price is given to them. So their willingness to pay is asked twice.

To estimate the amount of money people are willing to pay for improving the environmental quality of EFA, this study sets up a virtual situation in which were collected contributions for improving environmental quality, and willingness to pay for given prices was asked.

Questionnaire in Table 1 is set up for applying the double-bounded dichotomous choice CVM. The respondents showing positive willingness to pay for the initial price are asked the same question with a higher price again and those showing negative opinions are asked the same question with a lower price again.

TABLE 1. Survey Questionnaire on Willingness to Pay

Environmentally friendly agriculture can improve agricultural multifunctionality such as environmental conservation (water, soil, species and ecosystem) and food safety. But because of a decreasing labor force and increasing production costs, we have a long way to go to put environmentally-friendly agriculture into practice. More support is needed than just the efforts of farming families and the government. So, we plan to raise a 'Environmentally Friendly Agriculture Promotion Fund (a tentative name)' for improving food safety by developing environmentally-friendly agriculture.

Q1. To secure the 'Environmentally Friendly Agriculture Promotion Fund', are you willing to donate (X) won monthly?
(1) yes → go to Q2 (2) no → go to Q3

Q2. If so, are you willing to donate (2X) won monthly?
(1) yes → go to Q4 (2) no→> go to Q4

Q3. Then, are you willing to donate (1/2 X) won monthly?
(1) yes → go to next question (2) no → go to next question

Provided that the initial price for respondent i is T_i, the higher price given for positive response is T_{ui}, and the lower price given for negative response is T_{di}. Thus, the response probability from double-bounded dichotomous choice CVM is specified as follows:

$$P^{yy}(T_i, T_{ui}) = Pr\{T_i < T_{ui} \leqq max\,WTP_i\} = 1 - G(T_{ui};\beta X_i) \tag{1}$$

$$\begin{aligned} P^{yn}(T_i, T_{ui}) &= Pr\{T_i \leqq max\,WTP_i < T_{ui}\} \\ &= G(T_{ui};\beta X_i) - G(T_i;\beta X_i) \end{aligned} \tag{2}$$

$$\begin{aligned} P^{ny}(T_i, T_{di}) &= Pr\{T_{di} \leqq max\,WTP_i < T_i\} \\ &= G(T_i;\beta X_i) - G(T_{di};\beta X_i) \end{aligned} \tag{3}$$

$$P^{nn}(T_i, T_{di}) = Pr\{max\,WTP_i < T_{di} < T_i\} \quad = G(T_{di};\beta X_i) \tag{4}$$

If the respondents answer ‘yes-yes’, ‘yes-no’, ‘no-yes’, ‘no-no’ to the initial price and second prices respectively, D_{yy}, D_{yn}, D_{ny}, D_{nn} are 1 and variable is 0 for other responses, the likelihood function is formulated as follows (5):

$$lnL = \sum [D_{yy} lnP^{yy} + D_{yn} lnP^{yn} + D_{ny} lnP^{ny} + D_{nn} lnP^{nn}] \tag{5}$$

This study estimated the parameter of initial price(T) by applying the log likelihood function which maximized formula (5) after assuming the probability distribution of G(.) as logistic distribution. If P is acceptance probability and a_0, a_2 are estimated as population parameter, an initial price(T) is formulated as the logit model of formula (6).

$$P = \{1 + exp(-\alpha_0 - \alpha_1 \cdot ln\,T_i)\}^{-1} \tag{6}$$

There are two methods to estimate an initial price in (6); to integrate the whole acceptance probability or integrate with the maximum price. The former is difficult to test in a case that the acceptance probability doesn't converge, but diverges. So this study chose a method to integrate at the maximum price given to respondents.[5]

[5] The method to integrate the willingness to pay at the maximum price is a generalized estimation. According to Hanemann and Kanninen(1998), it gives a conservative presumed value compared to the method to integrate at limit.

$$\text{WTP}=\int_0^{B^{\max}} P\,dB \tag{7}$$

where the B_{max} represents the maximum price given to respondents.

III. The Data and Estimation

1. Data

The basic data, used to evaluate the value of improving environmental quality from a switchover to an environmentally friendly agricultural system, was obtained from the questionnaire whose objects were 300 adults who attended as urban-rural exchange event in the Hongdong area of Hongsung county at the beginning of June, 2005. Two hundred fifty nine of the total questionnaire sheets were selected as the objects of actual analysis, excluding 41 answered questionnaire sheets due to their unreliability and unreasonableness. The definitions of the variables used in the estimated model are as follows:

TABLE 2. Definitions of Variables

Variables	Definitions	Mean	Standard Deviation
Environment education	0 = get educated about environmental issues 1 = No	0.375	0.485
Consumer organization	0 = a member of consumer organization 1 = Non-member	0.449	0.499
Atopy-Suffering	0 = more than 1 family member 1 = No one	0.491	0.501
Place of Birth	0 = rural or fishing area 1 = urban area	0.218	0.414
Income (monthly)	1. below 2 million won 2. between 2 and 3 million won 3. between 3 and 4 million won 4. between 4 and 5 million won 5. above 5 million won	3.10	1.35

2. Estimation Procedure

First, the responses on the willingness to pay for improving the environmental quality of Environmentally Friendly Agriculture were analyzed(Refer to Table 3). The result shows that 83.4% of the respondents (216 people out of 259) have willingness to pay.

TABLE 3. Willingness to Pay for Environmental Quality of EFA

	Willingness to Pay	Unwillingness to Pay	Total
The number of respondents	216	43	259
Ratio(%)	83.4	16.6	100

The reasons for unwillingness to pay were collected from the respondents who were unwilling to pay (Refer to Table 4). Eighteen people (42%, the highest ratio) answered that environmental quality improvement is necessary but fund-raising is not needed. Thirteen people (30%, the second highest ratio) answered that the amount of the fund was set too high. But nobody answered that the environmental quality improvement of Environmentally Friendly Agriculture is unnecessary. And even the respondents who were unwilling to pay recognized that the environmental quality improvement of Environmentally Friendly Agriculture is necessary.

TABLE 4. Reasons for Unwillingness to Pay for Environmental Quality Improvement

	No need for improvement	Improvement needed, but objection to fund-raising	The amount of the fund set too high	others	Total
The number of respondents	0	18	13	12	43
Ratio(%)	0.0	41.9	30.2	27.9	100

Then, 216 respondents[6], who had willingness to pay for the environmental quality improvement of Environmentally Friendly Agriculture, answered randomly-chosen questions with 4 types of willingness to pay[7]. The results are as follows (Table 4): the expected signs of parameters are considered reasonable with all factors affecting willingness to pay examined carefully. The suggested price appeared as a minus sign. It means that the higher the suggested price is, the lower the acceptance probability is, making the descending payment function to the right. The social economic factors like income variables, having atopy and consumer organization membership were measured as plus signs. It means that high-income earners parents with atopy-suffering children and consumer organization members have a higher willingness to pay.

Using measured results related to improving the environmental quality of Environmentally Friendly Agriculture, the average amount each household was willing to pay was estimated to be 5,563 won per month out of the maximum presented price of 10 thousand won.

In Hongsung county, the effect from improving the environmental quality in consequence to the systemic switchover to Environmentally Friendly Agriculture was calculated by multiplying the amount each household of respondents was willing th pay by the ratio of willingness to pay and the number of households visited in Hongsung county. The result is as follows: The

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6 The number of used in CVM analysis is finally 216 samples excluding unreliable responses.

7 A preceding agricultural multi-functionality research was reviewed. It showed that a maximum of ten thousand won was paid for the public interest. So, in this study, up to ten thousand won of willingness to pay was presented. Only one set of price ranges was presented to each respondent and respondents gave their willingness to pay for each price.

Classification	Question 1 (initial price)	Question 2 (higher price)	Question 3 (lower price)
SET A	3,000 Won	4,000 Won	2,000 Won
SET B	5,000 Won	6,000 Won	4,000 Won
SET C	7,000 Won	8,000 Won	6,000 Won
SET D	9,000 Won	10,000 Won	8,000 Won

TABLE 5. Estimation Results of WTP

Variables	Coefficients	t-values
Constant	18.240	7.224
Dummy in environmental education	0.234	0.803
Consumer organization membership	0.564	2.008
Atopy experience (skin allergy)	0.543	1.870
Grown place	-0.404	-1.227
Income level	0.948	2.710
Suggested price	-2.743	-10.336
Number of samplings	216	
Log Likelihood	277	
Willingness to pay (censored average) (won/month/household)	5,563	

annual willingness to pay per household was calculated by multiplying the monthly willingness to pay (5,563 won) by 12(months). The ratio of the willingness to pay, eighty three percent, was adopted from the analysis of responses on improving the environmental quality. The annual number of households visited was calculated by dividing the number of visitors (1,837,334 people), who visited Hongsung county in 2004, by the national average number of household members (3.09 people).[8]

The analysis result shows that the economic valuation on improving the environmental quality of EFA in Hongsug is worth 32.9 billion won a year.

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[8] The number of visitors to Hong-Sung in 2004 was adopted from the summed-up data by the Statistics Section, Hongsung County Office. The national average number of household members was adopted from the data of the National Statistical Office.

TABLE 6. Calculation Method for Environmental Quality Improvement

■ Economic valuation on improving the environmental quality = Willingness to pay by each household of respondents × Ratio of willingness to pay × Number of households visited = 66,756 won × 0.83 × 594,607 = 32,945,675,460 won Notes: • Willingness to pay by each household of respondents = 66,756 won • Ratio of willingness to pay = 83% • Number of households visited = Number of visitors (in 2004)/ National average number of household members

If the above-mentioned method is applied, it is estimated that the economic valuation on improving the environmental quality of EFA in Hongsung county in consequence to the systemic switchover to an environmentally friendly agricultural system amounts to 32.9 billion won a year. This worth is considered as a rough economic value, admitted by consumers, of building up a sound environmentally friendly agricultural system in Hongsung county. Ultimately, it can be considered as an image improvement of Hongsung county as a result of the switchover to an environmentally friendly agricultural system.

4. Summary and Concluding Remarks

This study attempts to evaluate the economic valuation on improving the environmental quality in consequence of the systemic switchover to an environmentally friendly agricultural system and to provide theoretical grounds relevant to it. To this end, the DC-CVM is employed. The DC-CVM techniques are based on the premise that the maximum amount of money an individual is willing to pay for an environmental quality improvement of EFA is ten thousand won.

The survey results showed 83 percent of the respondents (216 people) have willingness to pay for improving the environmental quality of Environmentally Friendly Agriculture. Of the respondents who were unwilling to pay, nobody answered that the environmental quality improvement is unnecessary. It shows that the effect of improving the environmental quality of EFA is widely recognized as necessary.

The economic valuation on improving the environmental quality of EFA is summarized as follows:

First, the amount a household was willing to pay for improving the environmental quality of EFA was 5,563 won a month per the household.

Second, When the factors affecting the willingness to pay are considered, higher willingness to pay has a higher probability of minus sign responses, with the payment function descending to the right. In terms of social economic factors, high-income earners, parents with atopy-suffering children, and consumer organization members have higher willingness to pay.

Third, the economic valuation on improving the environmental quality of EFA in Hongsung county amounts to 32.9 billion won a year.

The estimated results suggest that EFA plays an important role in rural environment and ecosystem conservation such as the environmental conservation of water and soil quality, species and ecosystem diversity in addition to the production of safe agricultural products.

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