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Contingent Valuation of Sustainable Integrated Agriculture–Aquaculture Products: The Case of Rice–Fish Farming Systems in South Korea

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Abstract: There has been growing acceptance in Asia that consumer participation in green consumption can lead to sustainable agriculture and aquaculture development. In this context, this study investigates how consumers' psychological (i.e., attitudes and social norms) and socio-economic characteristics affect their willingness to pay (WTP) for sustainable agricultural products. To this end, the study incorporates attitude and social norms as components of the theory of reasoned action into the contingent valuation method, thereby establishing an estimation model for consumers' WTP. Based on an online market survey of adults in South Korea from June to July 2018, the results show that consumers' attitudes and social norms positively affect WTP for the rice and loach produced through integrated agriculture–aquaculture (IAA). However, the variables in the model affect consumers' WTP differently, depending on the type of IAA product. For IAA rice, both socio-economic (e.g., income) and psychological variables affect WTP. However, in the case of IAA loach, only social norms are statistically significant in affecting consumers' WTP.

Keywords: contingent valuation method; integrated agriculture–aquaculture; rice–fish farming; sustainable agriculture; sustainable aquaculture; theory of reasoned action

1. Introduction

Integrated agriculture–aquaculture (IAA) is a complex production method, in which agriculture and fish farming are conducted simultaneously [1]. Rice–fish farming is one of the most popular IAA systems [2], being primarily undertaken in South Asia and southern China, where both rice farming and aquaculture are highly developed [3]. Rice–fish farming efficiently utilizes production spaces, similar to integrated multi-trophic aquaculture [4]. These systems produce grain and animal protein simultaneously, generating additional income source for farmers and reducing the adverse effects of agriculture on the environment [4]. These economic and environmental benefits can thus provide a solution to the sustainability issues faced by rural communities.

Rural communities in South Korea have suffered from an economic sustainability crisis due to the lack of income and an aging population. In 2018, Korean farmers earned, on average, 65.5% of the average urban household income in Korea [5] (Figure A1). This is because rural communities are strongly reliant on agriculture. Further, the main agricultural crop in Korea is rice, which generates limited income due to low prices. Therefore, to resolve these income-related sustainability issues, it is necessary for rural communities to diversify farmers' income sources.

Recently, rice–fish farming has been highlighted as a means of achieving income diversification. Recent IAA methods (e.g., rice–fish farming) have primarily been implemented in developing countries because they do not require extensive investment and can relieve food security issues [1]. By contrast, in South Korea, which is considered a developed country, the main purpose of rice–fish farming is to increase farmers' incomes by producing high-priced byproducts (i.e., farmed fish). Another purpose

of implementing this system in Korea is to improve environmental sustainability by increasing the multi-functionality of agriculture, as opposed to improving food security, which is the main benefit to developing countries. Additionally, another goal of Korean rice–fish farming is to convert conventional agriculture systems into sustainable ones. The system is based on an ecosystem producing organic agricultural and fishery products in a compound way, thereby ensuring environmental sustainability.

However, rice–fish farming systems inevitably demand a significant amount of labor, resulting in high production costs in developed countries. It is thus challenging to implement rice–fish farming without consumer support towards organic and environmentally friendly agriculture, which can be realized through green purchasing choices [6–9].

Green purchasing, also known as ethical consumption, is an important concept in consumer marketing. It assumes that consumers' choices reveal not only their preferences in terms of price and quality but also their adherence to social norms, values, judgments, and beliefs [10]. These preferences can be measured by the contingent valuation method (CVM) [11,12].

The purpose of this study is to investigate how psychological characteristics affect consumers' willingness to pay (WTP) for sustainable IAA products by estimating the value consumers place on sustainable rice–fish farming products (i.e., organic rice and loach from IAA systems). While the traditional CVM mainly considers economic variables, along with some demographic ones, this study integrates traditional CVM with the theory of reasoned action (TRA) to reflect the influence of psychological characteristics in economic valuation.

The contributions of this study to the literature are as follows. First, it proposes a new method to explain consumers' pro-environmental behaviors by integrating TRA and CVM in an analytical framework used to reflect consumers' support for sustainable IAA and green purchasing. Second, while IAA is a complex production method that produces two product types (i.e., rice and fish), the existing CVM is limited to the analysis of one type of product and its application to multiple products has not been yet attempted. This study thus proposes a new CVM approach that simultaneously considers multiple products, which is relevant because IAA products can share the passive use value of sustainable production [13,14]. As such, if two independent CVMs were to be conducted, the total economic value could be overestimated. Third, the results of this study contribute to the marketing literature by identifying how consumers' psychological characteristics affect sustainable product purchasing choices.

2. Literature Review

2.1. Sustainable Integrated Agriculture–Aquaculture

IAA is a way to produce grain and animal protein simultaneously, in the same place, as opposed to cultivating a single crop [15]. IAA systems recirculate agriculture–aquaculture resources, placing a high value on the ecological environment and promoting sustainability [16] (Figure 1). For example, crop residues and agricultural byproducts could be fed to cattle and animal manure may be used to fertilize crops. For rice–fish farming, waste from fish farming can also be used as fertilizer, while organisms (e.g., insects) in the rice field are used as natural feed for farmed fish. Therefore, IAA farms are integrated agroecosystems [17,18]. In other words, the farmland serves as an ecosystem for sustainable agriculture–aquaculture [19].

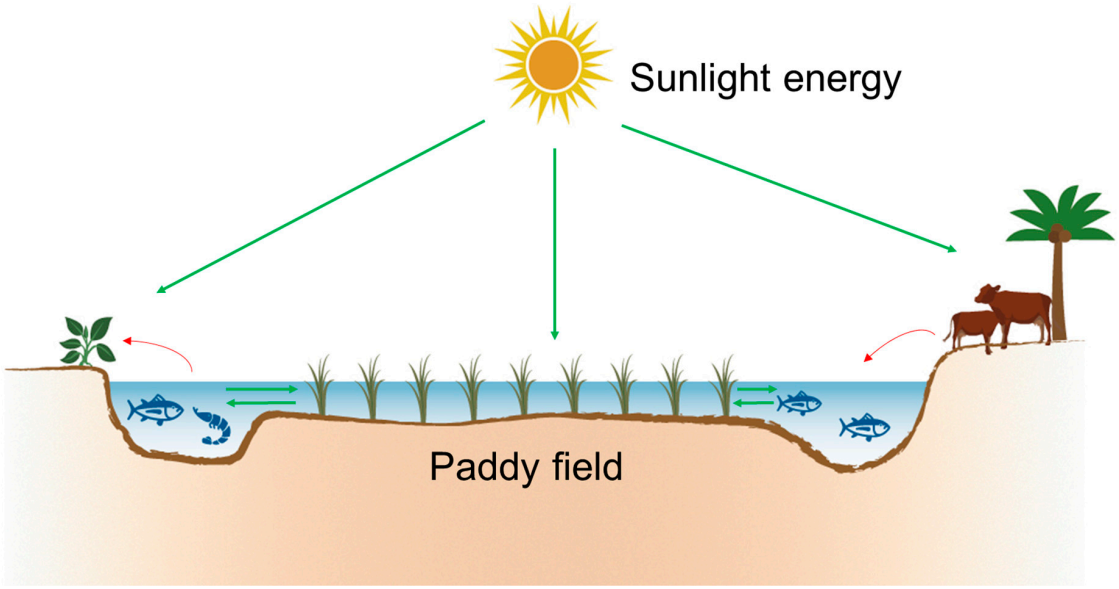


Figure 1. Material flow in integrated agriculture–aquaculture.

One benefit of IAA is that it can improve environmental sustainability because of its production mechanism. Further, IAA systems use fewer pesticides than conventional agricultural production systems [20]. As mentioned above, fish feed on harmful insects, thereby diminishing the need for insecticides for pest control, especially as most insecticides are harmful to fish farmed in IAA systems. Farmers are therefore less likely to use pesticides under IAA production. Similarly, the recirculation of agriculture–aquaculture resources reduces the need for chemical fertilizer applications, thereby improving environmental sustainability [20].

There exists a variety of IAA combinations, such as fish–horticulture, rice–fish, glass–fish, and animal–fish farming, depending on the type of production desired. Such production flexibility can be used to improve the livelihoods of rural communities [20–22].

One of the most popular methods of IAA production is rice–fish farming (Figure 2). Almost 90% of the irrigated rice fields worldwide can provide a suitable habitat for fish and aquatic organisms [20]. China, the leading adopter of rice–fish farming, has devoted 15% of its rice-suitable farmland to this type of farming, producing 1.2 million tons of fish and other aquatic organisms annually. In 2010, Indonesia farmed 92,000 tons of fish using rice–fish farming systems, while Egypt produced 29,000 tons of fish using this method [20].

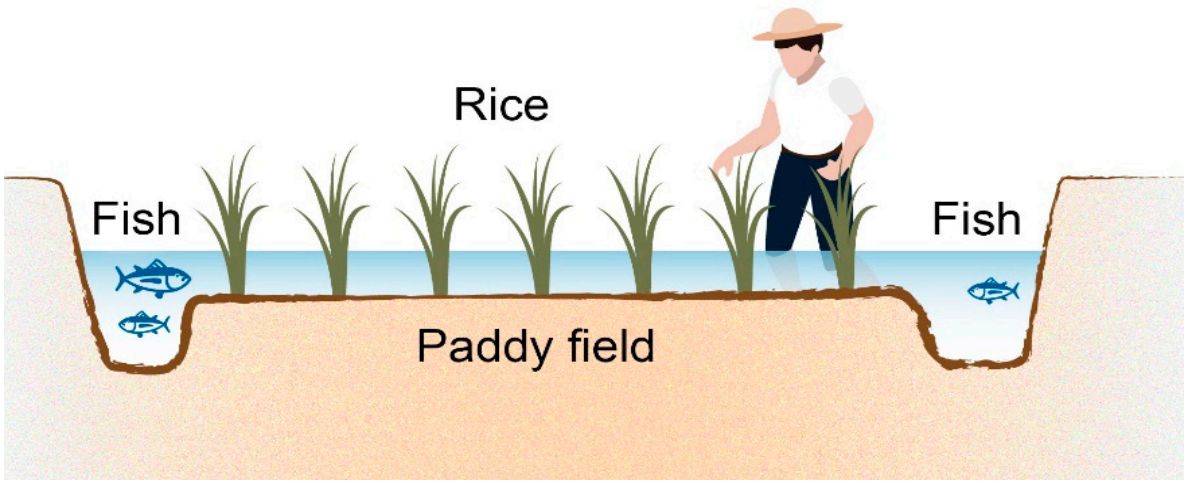
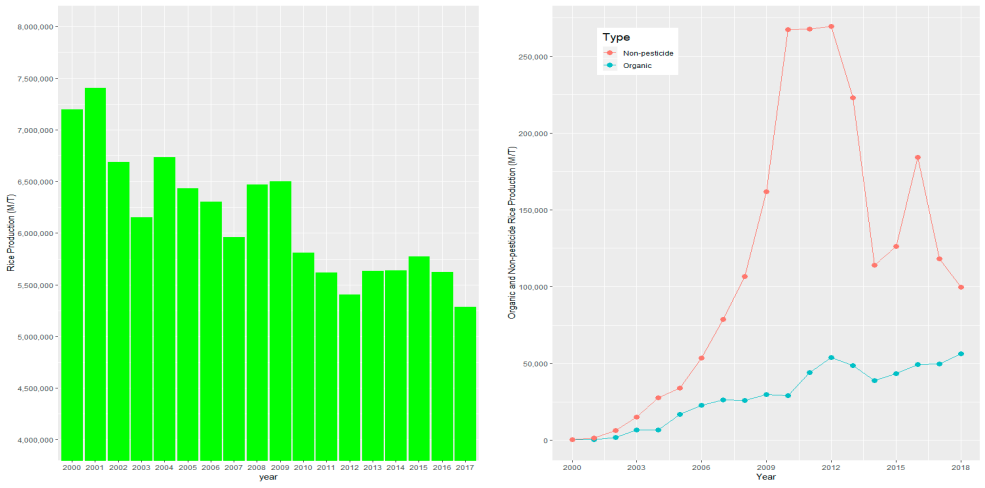


Figure 2. Integrated agriculture–aquaculture for rice–fish farming.

In Korea, rice–fish farming has been proposed as a method to improve the efficiency of resource use and to protect the natural environment [23]. Traditionally, loach (*Misgurnus mizolepis*) has been raised under rice–fish farming, but this method has largely disappeared due to industrialization and the transition to conventional agriculture, which uses pesticides and chemical fertilizers [24].

However, as the economic efficiency of rice farming has degraded and the multifunctionality of agriculture has been highlighted (Figure 3), rice–fish farming is once more receiving attention due to its potential to support sustainable agriculture–aquaculture.



(**a**) (**b**)

Figure 3. (**a**) Rice production in South Korea; (**b**) Organic and non-pesticide rice production. Source: [25].

In Korea, 840 tons of loach were produced by conventional aquaculture and 8,845 tons were imported from China in 2018 (Figure 4). The size of the market can be a determinant for rice–fish farming. The Korean government considers rice–fish farming to be eco-friendly, conducting research and development on the issue and providing training to farmers.

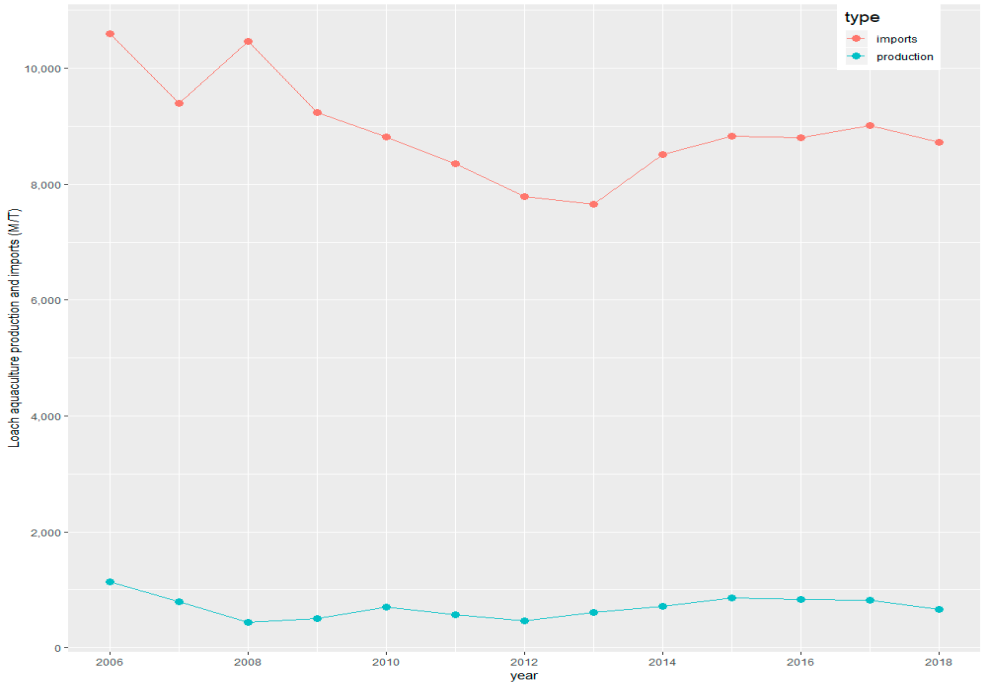


Figure 4. Loach aquaculture production and imports; Source: [26].

2.2. Integration of the Theory of Reasoned Action and Contingent Valuation Method

The TRA explains the relationship between beliefs and consumer behaviors. The theory was first proposed by Fishbein and Ajzen [27] and is widely used in the fields of social psychology, sociology, and marketing. The basic concept of TRA is that individual beliefs (i.e., attitudes and subjective norms) influence behavioral intentions, and behavioral intentions in turn affect actual behavior. Therefore, if we know an individual's attitude and subjective norms in relation to a specific behavior, we can predict that individual's future behavior. The attitude refers to an individual's feelings about a behavior, while subjective norms are the perceived social pressures involved in that behavior [28]. The significance of TRA is that it provides a theoretical basis for introducing psychological characteristics in economic models. In consumer economics, researchers describe such characteristics as consumers' tastes and preferences [29].

Under CVM, scholars focus on the effects of beliefs on consumer behavior, and CVM is a well-established estimation method for non-market products that provides practical implications for policy makers [30]. Although choice experiments are an emerging method in environmental research, CVM is relevant and useful for estimating total economic value. Scholars have thus attempted to integrate CVM with the attitude–behavior model [31]. Theoretically, the integrated model introduces psychological and socio-economic variables as CVM independent variables [32–34].

This study thus assumes that consumers' psychological characteristics (i.e., attitudes and social norms) affect their WTP for sustainable IAA products. The author posits the following research hypotheses.

- H1: Attitude affects consumers' WTP for sustainable IAA products.
- H2: Subjective norms influence consumers' WTP for sustainable IAA products.
- H3: Economic variables (e.g., household income) affect consumers' WTP for sustainable IAA products.
- H4: Socio-cultural characteristics affect consumers' WTP for sustainable IAA products.

3. Methods

3.1. Sample

The author used an online market survey company to collect a demographically balanced sample (n = 525) (Figures A2 and A3). The targets of the survey were adults residing in South Korea. Using stratified sampling, the survey was conducted from June to July 2018. A total of 2,302 potential respondents were invited to answer the survey, of which 846 participated in the survey, resulting in 525 usable responses (final response rate of 22.8%).

3.2. Survey Instrument

The survey instrument comprised three components. The first consisted of TRA constructs (i.e., attitudes and subjective norms). The second measured WTP for IAA products. The third component examined participants' demographic information. The survey instruments were adapted to the context of sustainable IAA production using TRA. The measurements for TRA items have been previously developed [35] and the survey instruments measured the attitudes toward sustainable IAA products and subjective norms (i.e., social pressure).

The survey respondents' WTP was measured by their responses to a suggested price for IAA products (i.e., organic rice and fish). The survey began with a text on IAA (Table 1). Next, a randomly selected price was proposed to determine participants' WTP for IAA products (Table 2). The survey contained two preference questions that required "yes/no" responses: one for the randomly selected price and another for a modified price.

Table 1. Description of sustainable integrated agriculture–aquaculture (IAA) and price information in the survey questionnaire.

Displayed Text
IAA for rice paddy fields is an eco-friendly and organic production method that simultaneously produces different types of agricultural products, such as rice and fish, in the same ecological space. To do this, farmers refrain from using herbicides or chemical fertilizers as to convert their paddy fields to small ecosystems. Rice production using IAA is costlier than under conventional agriculture, but it ensures food safety and environmental sustainability. Further, farmers can generate additional income by producing fish. You can support this eco-friendly production methods by purchasing IAA rice and fish.
The retail price of rice produced by conventional farming methods (using pesticides and chemical fertilizers) was, on average, ₩2150 (Korean won) per kg at the end of 2017, while the retail price of organic rice ranged from ₩3500 to ₩4100 per kg.
The average price of loach in the retail market is ₩22,000 per kg (minimum ₩20,000 and maximum ₩25,000). The loach produced in an eco-friendly manner is raised without the use of antibiotics and chemicals, which contributes to food safety. This is because, in the conventional farming environment in which pesticides and chemical fertilizers are used, the loach cannot survive.

Table 2. Sample of CVM questions.

CVM Questions
Randomly selected prices for IAA rice are: ₩3800, ₩4100, ₩4500, ₩5000, ₩5600, ₩6300, and ₩7100.
Specifically, the double-bounded dichotomous choice CVM question for IAA rice was:
Q1. Are you willing to pay [random price] per kg to buy sustainably produced IAA rice?
(1) Yes (2) No
Respondents who answered "Yes" were asked an additional question. The modified price was double the original random price:
Q2-a. Are you willing to pay [random price × 2] per kg to buy sustainably produced IAA rice?
(1) Yes (2) No
If respondents answered "No," they were asked another question. The modified price for the question was half the original random price:
Q2-b. Are you willing to pay [random price / 2] per kg to buy sustainably produced IAA rice?
(1) Yes (2) No
After conducting the CVM survey for IAA rice, another CVM survey for IAA fish was conducted.
Randomly selected prices for IAA fish are: ₩23,000, ₩24,000, ₩26,000, ₩29,000, ₩33,000, ₩38,000, and ₩44,000.
Q3. Are you willing to pay [random price] per kg to buy sustainably produced IAA fish?
(1) Yes (2) No
Respondents who answered "Yes" were asked an additional question. The modified price was double the original random price:
Q4-a. Are you willing to pay [random price × 2] per kg to buy sustainably produced IAA fish?
(1) Yes (2) No
If respondents answered "No," they were asked another question. The modified price for the question was half the original random price:
Q4-b. Are you willing to pay [random price / 2] per kg to buy sustainably produced IAA fish?
(1) Yes (2) No

3.3. Model

Double-bounded dichotomous-choice CVM was used in the present research [36]. The double-bounded model has four possible outcomes: (a) yes–yes, (b) no–no, (c) yes–no, and (d) no–yes. The likelihoods of these outcomes are π^{yy}, π^{nn}, π^{yn}, and π^{ny}, respectively. The formulas for these likelihoods are as follows. In the first case, in which both answers are "yes," we have $B_i^u > B_i$ and

$$\begin{aligned} \pi^{yy}\left(B_i, B_i^u\right) &= \Pr\left\{B_i \le \max WTP \text{ and } B_i^u \le \max WTP\right\} \\ &= \Pr\left\{B_i \le \max WTP \middle| B_i^u \le \max WTP\right\} \Pr\left\{B_i^u \le \max WTP\right\} \\ &= \Pr\left\{B_i^u \le \max WTP\right\} = 1 - G\left(B_i^u; \theta\right). \end{aligned} \quad (1)$$

For the second case, in which both answers are "no," we have

$$\pi^{nn}\left(B_i, B_i^d\right) = \Pr\left\{B_i > \max WTP \text{ and } B_i^d > \max WTP\right\} = G\left(B_i^d; \theta\right). \quad (2)$$

For the third case, in which the first answer is "yes" and the second is "no," we have

$$\pi^{yn}\left(B_i, B_i^u\right) = \Pr\left\{B_i \leq \max WTP \leq B_i^u\right\} = G\left(B_i^u; \theta\right) - G(B_i; \theta). \quad (3)$$

For the last case, in which the first answer is "no" and the second is "yes," we have

$$\pi^{ny}\left(B_i, B_i^d\right) = \Pr\left\{B_i \geq \max WTP \geq B_i^d\right\} = G(B_i; \theta) - G\left(B_i^u; \theta\right), \quad (4)$$

where B_i, B_i^u, and B_i^d are the suggested prices for the ith survey respondent.

The log-likelihood function takes the following form [36]:

$$\ln L^D(\theta) = \sum_{i=1}^{N} \{d_i^{yy} \ln \pi^{yy}(B_i, B_i^u) + d_i^{nn} \ln \pi^{nn}\left(B_i, B_i^d\right) + d_i^{yn} \ln \pi^{yn}\left(B_i, B_i^u\right) + d_i^{ny} \ln \pi^{ny}\left(B_i, B_i^d\right)\}, \quad (5)$$

where $d_i^{yy}, d_i^{nn}, d_i^{yn}$, and d_i^{ny} are binary-valued indicator variables and the formulas for the corresponding response probabilities are given by (1)–(4).

3.4. Empirical Analysis

To analyze the survey data, STATA 15 was utilized [37]. Exploratory factor analysis (EFA) was used to identify the underlying structure of key variables by conducting data reduction [38]. In this study, the reliability of measurement items for the TRA constructs is evaluated using EFA, thus building an index-based variable for CVM. After conducting EFA on the TRA measurement items, the results were used as independent variables in the CVM model for sustainable IAA products [39]. Seven TRA measurement items were analyzed using a principal-components factor approach. After identifying the factors, a varimax rotation was performed to identify the significant loading for each measurement item. The basic criteria for selecting reliable variables are loadings exceeding 0.7. The use of this approach in the rotation procedure eliminates cross-loading issues [38].

The estimation model consists of an economic variable (household income), socio-demographic variables (gender, age, and number of household members), and TRA components (attitudes and subjective norms). A conventional econometric model (e.g., consumer demand model) contains economic and socio-economic variables [29]. However, this study also includes TRA components as psychological characteristics in the CVM model.

Two sets of CVM estimations were conducted. Therefore, the CVM for IAA production needs to estimate consumers' WTP for two products—an agricultural product (i.e., rice) and a fishery product (i.e., fish)—at the same time. For rice, the prices of conventional and organic products were first suggested as reference prices. Then, the survey measured the WTP for sustainable agricultural products (i.e., IAA products). For fish (loach), only the market price for conventional production was offered as a reference price because there is no reference price for organic loach aquaculture products. The participants were then asked again about their WTP for loach as a sustainable IAA product.

4. Results

4.1. Descriptive Information

Of the respondents, 50.9% were male and 49.1% female, with a balanced age group distribution (Table 3). Furthermore, 68% of respondents were married and 32% were single. In terms of education level, 65.7% of respondents had a bachelor's or postgraduate degree. The median household income was between $54,654 and $76,363; 21% of respondents fell within this range.

Table 3. Socio-demographic information.

Variable	Categories	Frequency	Percentage
Gender	Male	267	50.9
	Female	258	49.1
Age (years)	20–29	95	18.1
	30–39	112	21.3
	40–49	126	24.0
	50–59	120	22.9
	More than 60	72	13.7
Marital status	Married	357	68.0
	Single	168	32.0
Family size (persons)	1	53	10.1
	2	113	21.5
	3	173	33.0
	4	158	30.1
	More than 5	28	5.3
Employment status	Primary/secondary occupation	38	7.2
	Self-employed	45	8.6
	Sales/customer service	18	3.4
	Office job	206	39.2
	Business/management	26	5.0
	Professional/freelance	58	11.0
	Homemaker	73	13.9
	Student	28	5.3
	Unemployed	33	6.3
Education	Equivalent to high school	79	15.0
	Two-year college degree	68	13.0
	Undergraduate student	33	6.3
	Bachelor's degree graduate	291	55.4
	Equivalent to postgraduate	54	10.3
Annual household income *	Less than $21,818	50	9.5
	$21,927–32,727	80	15.2
	$32,836–43,636	97	18.5
	$43,745–54,545	104	19.8
	$54,654~76,363	110	21.0
	$76,472–98,181	52	9.9
	More than $98,290	32	6.1
Total		525	100

* US dollars.

4.2. Exploratory Factor Analysis Results

The EFA confirmed the two-dimensional factor of attitude and subjective norms (Table 4, Item). The eigenvalues for these factors were 4.930 and 1.242, respectively (Table 4, Eigenvalues). The measurement items for attitude showed high factor loadings for factor 1, that is, over 0.8; the items for subjective norms also indicated high factor loadings on factor 2. Cronbach's α of the two factors exceeded 0.70, showing that the minimum requirement for item reliability is met [38].

Table 4. Exploratory factor analysis results.

Item	Factor 1 Loadings	Factor 2 Loadings	Uniqueness	Cronbach's α	Eigenvalues
Factor 1: Attitude					
Att1	0.897	0.247	0.135	0.96	4.930
Att2	0.907	0.288	0.095		
Att3	0.873	0.327	0.130		
Att4	0.896	0.295	0.111		
Factor 2: Subjective norms					
Sn1	0.351	0.842	0.169	0.93	1.242
Sn2	0.244	0.914	0.105		
Sn3	0.280	0.916	0.083		

The items are defined in Table A1.

4.3. Estimation of Willingness-To-Pay for Sustainable Integrated Agriculture-Aquaculture Products

Because IAA is a complex production system, a CVM should be performed for each IAA product. From the double-bounded choice model estimation for IAA rice, household income, attitude, social norms, and age variables are significant. Some demographic variables (i.e., gender and family size) are insignificant (Table 5, *p*-values).

Table 5. Estimated parameters of the double-bounded choice model for IAA rice.

Variables	Coefficient	Standard Error	*z*	*p*-Value
Household income	2.31	0.96	2.41	0.016
Attitudes	151.81	64.17	2.37	0.018
Social norms	247.15	81.04	3.05	0.002
Gender	–494.31	404.00	–1.22	0.221
Age	–39.59	16.82	–2.35	0.019
Family size	–203.64	198.39	–1.03	0.305
Constant	2730.19	1526.32	1.79	0.074

Log likelihood = –706.02, Wald Chi-square (6) = 42.54, *p*-value > Wald Chi-square = 0.0000, z = z-score

Consumers' WTP for IAA rice was estimated first. The WTP for 1 kg of IAA rice (a sustainable agricultural product) is ₩5,920 (Korean won), which is equivalent to $5.38/kg (USD; Table 6, coefficient). This amount is around $1.66 higher than for organic rice in the Korean domestic market. The insignificant demographic variables (gender and family size) were excluded from the estimation, and psychological characteristics (attitudes and social norms) and socio-demographic variables (household income and age) were considered.

Table 6. Willingness to pay for IAA rice.

	Coefficient	Standard Error	*z*	*p*-Value
Willingness to pay for IAA rice	₩ 5920	1298	4.56	0.000

The unit is Korean won; $1 (US dollar) = ₩1100, ₩5920 = $5.38 (US dollar).

After estimating WTP for IAA rice, the double-bounded choice model for IAA fish was estimated. Most of the independent variables are insignificant, whereas one psychological characteristic (i.e., social norms) is partially significant (Table 7, *p*-value).

Table 7. Estimated parameters for the double-bounded choice model for IAA fish.

Variables	Coefficient	Standard Error	*z*	*p*-Value
Household income	7.14	5.59	1.28	0.202
Attitudes	518.89	386.50	1.34	0.179
Social norms	2092.41	495.75	4.22	0.000
Gender	−1786.42	2377.01	−0.75	0.452
Age	−102.05	99.69	−1.02	0.306
Family size	893.12	1161.86	0.77	0.442
Constant	−17086.11	9258.41	−1.85	0.065

Log likelihood = −653.26, Wald chi-square (6) = 43.03, *p*-value > Wald chi-square = 0.0000, z = z-score.

Consumers' WTP for IAA fish was estimated based on the CVM results. The WTP for 1 kg of live IAA fish (i.e., loach) is ₩28,608, which is equivalent to $26 / kg (USD; Table 8, coefficient). This amount is around $6 higher than for the conventional aquaculture product.

Table 8. Willingness to pay for IAA fish

	Coefficient	Standard Error	*z*	*p*-Value
Willingness to pay for IAA fish	₩ 28,608	6778	4.22	0.000

The unit is Korean won; $1 (US dollar) = ₩1100, ₩28,608 = $26 (US dollar).

The test results of the double-bounded choice models support the four research hypotheses to varying degrees (Table 9). The results of the IAA rice model fully support the hypotheses, whereas those of the IAA fish model support only H2: subjective norms influence consumers' WTP for sustainable IAA products (i.e., live loach).

Table 9. Hypotheses testing results.

Hypothesis	Results
H1: Attitude affects consumers' WTP for sustainable IAA products.	Partially supported
H2: Subjective norms influences consumer's WTP for sustainable IAA products.	Supported
H3: Economic variables (e.g., household income) affect consumers' WTP for sustainable IAA products.	Partially supported
H4: Socio-cultural characteristics affect consumers' WTP for sustainable IAA products.	Partially supported

5. Discussion and Conclusions

This study shows that both psychological (i.e., attitude and social norms) and socio-economic characteristics affect consumers' WTP for sustainable IAA products. Specifically, this study combined TRA and CVM for establishing a novel estimation model for consumers' WTP. The results indicated that consumers' attitudes and social norms (i.e., main components of the TRA model) positively affect the WTP for IAA-produced rice and loach. However, the variables in the model affected consumers' WTP differently, depending on the type of IAA product. For IAA rice, both the socio-economic (e.g., income) and psychological variables affected WTP. However, for IAA loach, only social norms significantly affected consumers' WTP. Economic variables positively influenced WTP but were statistically insignificant.

The finding that consumers' WTP differs by product type is consistent with previous research [40]. This difference is likely due to survey respondents' consumption behaviors. For instance, rice itself is an essential grain and is consumed more frequently than other foods in South Korea. Therefore, consumers' attitudes and social norms regarding rice and sustainable agriculture prevail. A greater frequency of consumption may also help survey participants construct their WTP. By contrast, loach is mainly considered a specialty food item. As such, it is consumed less frequently and in lower amounts than rice (Figures A4 and A5). As consumers' attitudes and preferences toward loach may be unclear, the current market price of loach was provided to respondents as a reference price in helping them

construct their WTP. Therefore, the WTP for IAA loach may reflect both the social value of sustainable agriculture–aquaculture and its market value.

Interestingly, the WTP for IAA rice differs from that of conventional and organic rice. As with loach, prices information for conventionally farmed and organically farmed rice were given as reference. The results showed that IAA rice has a higher price premium than both organic and conventional rice. In Korea, organic food emphasizes food safety over social and environmental value. However, IAA reflects these values because it embodies both food safety and sustainable production. These findings thus provide substantial evidence for the ethical consumption of sustainably produced products. As previously described, ethical consumption, or green purchasing, is a form of consumption that pursues both personal and social value imultaneously in achieving various social objectives, such as fair trade and ecosystem protection.

Therefore, the above findings have important implications for farmers, consumers, and policymakers as follows. First, there is a need to expand direct payments for sustainable IAA. In Europe, direct payments for agriculture were introduced in 1992 as a result of the reform of the Common Agricultural Policy [41]. This was meant to protect farmers from income losses rather than as a price support for agricultural products. However, the main reason for these direct payments is that farmers produce both private (e.g., food) and public goods (e.g., public service in the form of improving the environment). IAA requires farmers to give up the conventional farming practices used to improve productivity and reduce labor, as a result of the use of pesticides, fertilizers, and antibiotics. Therefore, it inevitably leads to an increase in production costs, reducing market size even if consumers can adapt to the price increases. The results show that consumers have a slightly higher WTP for IAA products than for organic ones. The price differences might be considered acceptable by consumers due to the multi-functionality of IAA farming. However, it is unlikely that sustainable produce will be priced higher in the market than organic produce. Therefore, it is necessary to compensate the rising production costs through a direct payments policy.

The second implication is that the Korean government must improve market function by establishing public and private IAA certification systems. A sustainable production certification system can differentiate IAA products and improve market demand. However, the sustainable certification system for IAA is still in development in South Korea. In this study, sustainable products have a higher price premium than organic ones. There are currently two eco-friendly certifications for rice in South Korea: one is a no-pesticide certification and the other is an organic certification. Although farmers produce rice in a sustainable manner, there is no certification for sustainability. Therefore, sustainable products are currently in the same category as organic products. Therefore, a price premium between sustainable products and organic ones cannot be expected. For aquaculture, a privately led sustainable aquaculture certification has emerged and it is leading the market [42–45].

One representative sustainable production certification for aquaculture is the Aquaculture Stewardship Council (ASC) certification, which was initiated by two non-governmental organizations, the World Wide Fund for Nature and the Dutch Sustainable Trade Initiative in 2010 [46]. ASC's vision is "To transform aquaculture towards environmental sustainability and social responsibility using efficient market mechanisms that create value across the chain" [46]. Because IAA is a combination of agriculture and aquaculture, such an effort to transform the production system through market mechanisms could be applied to such sustainable production initiatives. In South Korea, agricultural products are certified by the government [47]. However, the scope of certification is limited to organic rather than sustainable production. Due to the limited workforce and budget of government agencies, it is unlikely to expand its scope to sustainable production certification. Therefore, it would be reasonable to leverage a private sustainable certification (e.g., ASC) to promote sustainable production. In this case, the government's role would be to build social consensus on sustainable production, establishing a basis for sustainable development in IAA.

The last implication is that it is essential to expand the consumer market for sustainable IAA. The proliferation of eco-friendly, organic, and sustainable IAA ultimately depends on the expansion

of the market for related products. The consumption of such IAA products could be improved through public policy programs and marketing efforts, which would in turn change consumers' attitudes and social norms. In South Korea, the consumption of eco-friendly agricultural products has been expanded by school meal programs, which consume large quantities and prefer high-quality ingredients. For example, 137,558 tons of agricultural products were consumed in 2018 through school meals, of which 57% (79,339 tons) were eco-friendly [48]. This is because parents believe eco-friendly products are healthy food options and a way to protect the environment. If such a practice is applied to the institutional food service markets, such as companies, the military, and nursing homes, the sustainable products market would expand accordingly.

This study has some limitations. It estimated consumers' WTP for sustainable IAA products, specifically rice and loach, using CVM. However, IAA product combinations could vary by culture, country, and target market. Therefore, the research findings may only apply to the Korean domestic market for the analyzed IAA products; additional research in different settings (i.e., different cultures, countries, IAA products, and systems) is thus needed to confirm these findings.

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Appendix A

Table A1. TRA measurement statement.

Items	Statement
	I think that sustainable integrated agriculture-aquaculture (IAA) is
Att1:	Extremely bad (1) / Extremely good (7)
Att2:	Extremely stupid (1) / Extremely wise (7)
Att3:	Extremely unnecessary (1) / Extremely necessary (7)
Att4:	Extremely undesirable (1) / Extremely desirable (7)
	Strongly disagree (1) / Strongly agree (7)
SN1	Most people who are important to me would want me to support sustainable IAA.
SN2	Most people who are important to me think I should support sustainable IAA.
SN3	Most people who are important to me expect I support sustainable IAA.

Source: Items are modified from previous research [35].

Appendix B

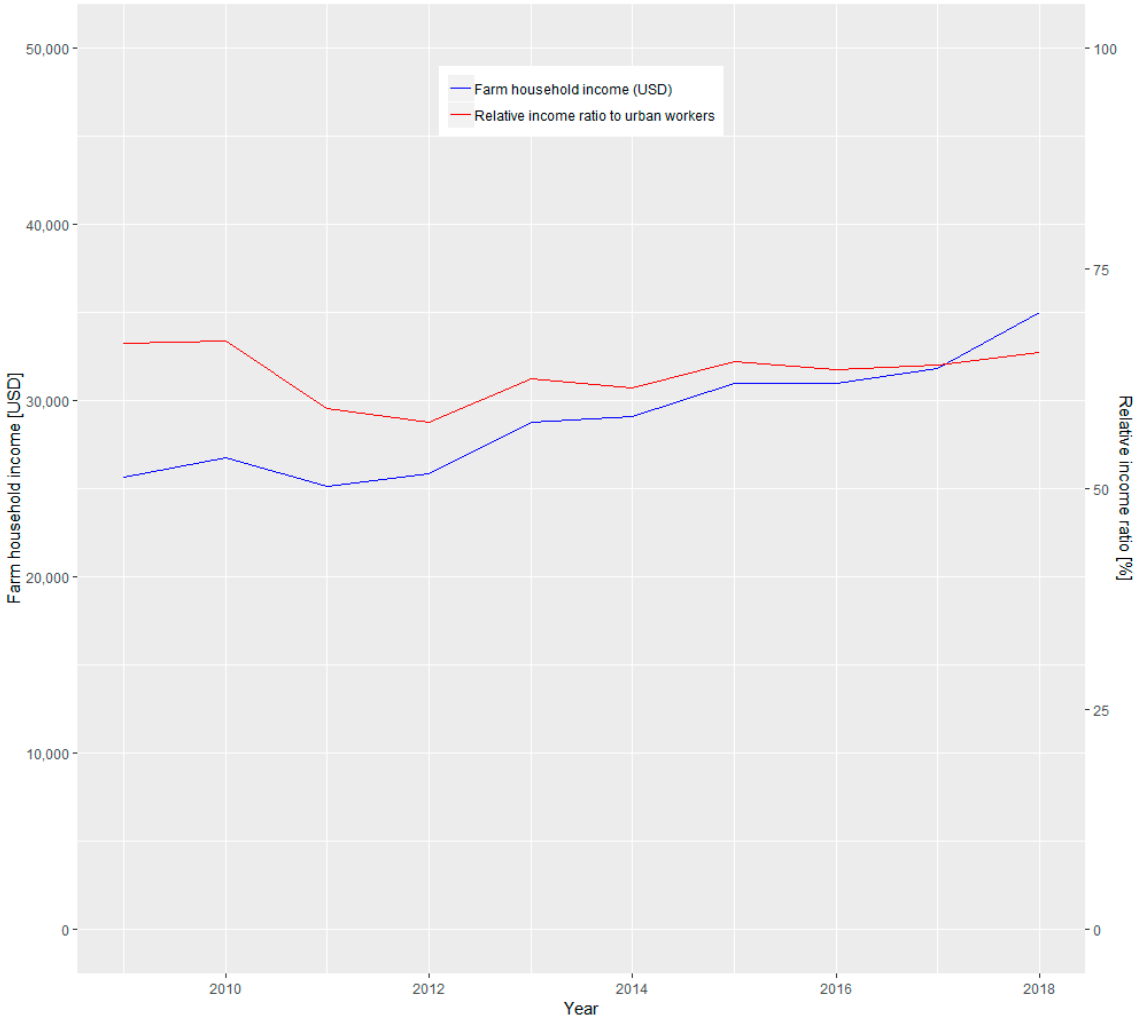
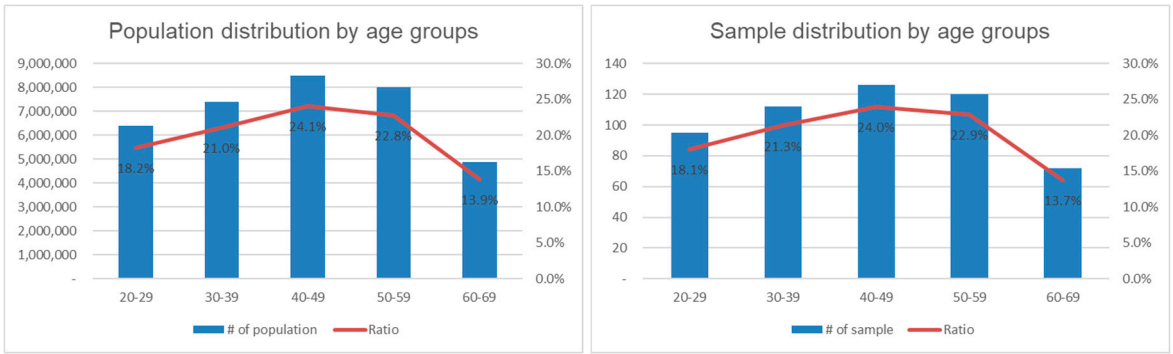


Figure A1. Trend of Korean farm household income and relative income ratio [5].



(**a**) (**b**)

Figure A2. Comparison between research population and survey sample by age composition; (**a**) Population distribution; (**b**) Sample distribution; Source: Statistic Korea [49].

(**a**) (**b**)

Figure A3. Comparison between research population and survey sample by gender; (**a**) Population distribution; (**b**) Sample distribution; Source: Statistic Korea [49].

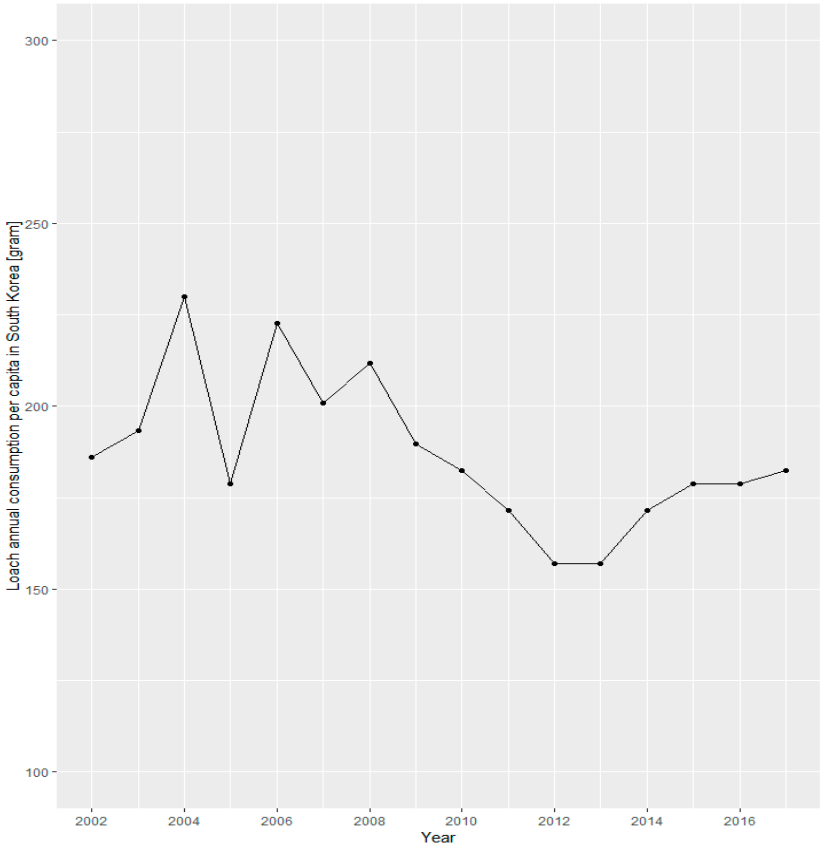


Figure A4. Trend of loach consumption per capita (unit: gram); Source: Korea Rural Economy Institute [50]; 2017 Food Balance Sheet.

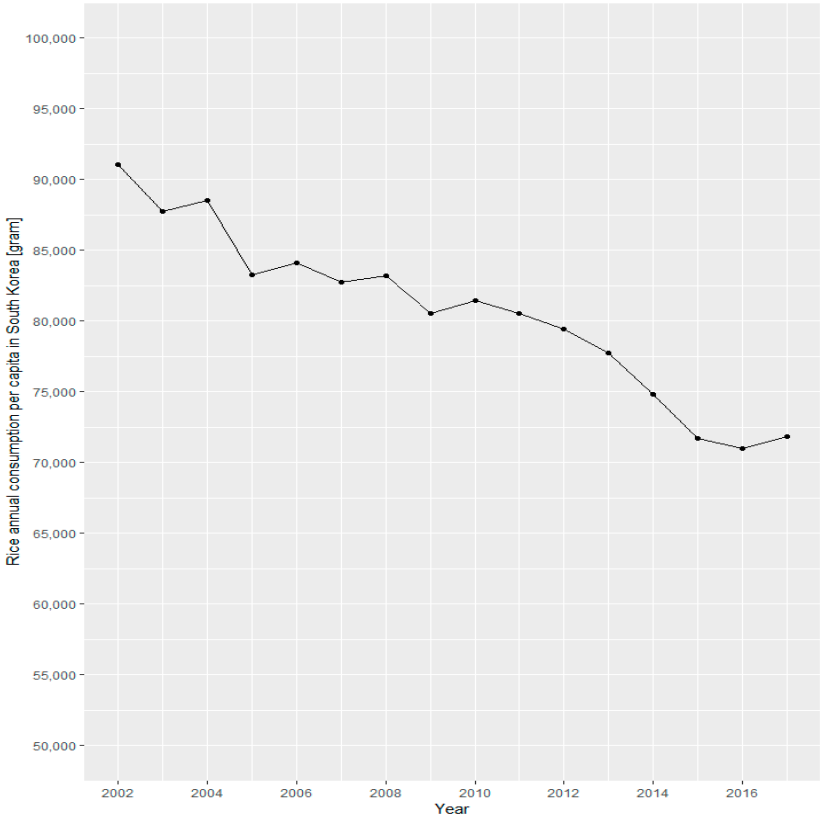


Figure A5. Trend of rice consumption per capita (unit: gram); Source: Korea Rural Economy Institute [50]; 2017 Food Balance Sheet.

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