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# Estimation of the economic trade-offs between farmers and consumers for water quality improvement in Soyang watershed, South Korea

Dissertation

to attain the academic degree of Doctor of Natural Science (Dr. rer. nat.) of the Bayreuth Graduate School of Mathematical and Natural Sciences (BayNAT) of the University of Bayreuth

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# Summary

A paradigm shift in global trends for natural resources has supported the concept of ecosystem services (ES) for sustainable management. With increasing recognition of relationships between ecosystem functions and human activity, the concept of ES plays a crucial role in the identification of trade-offs between human well-being and ecosystem services. The newly established paradigm is based on an ecosystem approach to decision-making as reciprocity of environment-human linkages, unlike classical approaches for conservation, which feature unidirectional flow of benefit from ecosystems.

The concept of ES highlights a holistic and integrated approach for sustainable ecosystem-based management. This underlines appreciation of whole ecosystem process and functions which contribute to human well-being and emphasizes multi-scale benefits of ES provided by tangible and intangible forms. However, a multidisciplinary approach for integrated ecosystem assessments has significant challenges to a pragmatic view of policy decision-making. Moreover, the concept of ES can be particularly useful as a policy instrument to reduce environmental pollution and degradation. Nevertheless, a lack of mechanisms for policy instruments in multi-scale approaches is a critical research gap and a lack of information about economic values for ES likewise remains an important knowledge gap in existing researches.

This thesis aims at estimating the economic value of ecosystem services, focusing on water quality issues with specific applications such as drinking water supply. The papers attempted to reduce the aforementioned gaps by analyzing how benefits from ES influence the decision-making of both upstream farmers in farm management and downstream water consumers. With respect to the standing lack of information about economic valuation for ES in Asia (especially South Korea), this study focused on upstream regions (Gangwon Province) and downstream areas (Seoul, along South Korea's Soyang watershed). As water quality degradation occurs by intensive agricultural production in the upstream area, water quality protection is essential for the preservation of a main drinking water source between upstream farm and downstream households.

In the first paper, multinational logistic modelling was used to identify the key factors affecting farmers' choices regarding the adoption of farming methods, based on interviews with conventional, partially converted and environmentally friendly farm

households. In the second paper, contingent valuation methods were used to estimate the willingness to pay (WTP) for water quality improvement through the adoption of environmentally friendly farming. Lastly, in the third paper I used choice experiment method specifically stated preference techniques for the estimation of WTP based on three attributes: water quality, biodiversity levels and agricultural profits.

The results from paper 1 showed that education level and subsidy positively and significantly influenced the probability of farmers' choice on partially converted and environmentally friendly farming, relative to conventional farming. The results from paper 2 showed that the expected annual mean WTP for water quality improvement through the adoption of environmentally friendly farming was KRW 36,115 per household. The results indicated that the estimated annual aggregate WTP might fully offset total income loss of the entire highland farmland which is affecting the water quality. The results of paper 3 indicated that the estimated annual marginal WTP of the upstream farm household for each water quality attribute ranged from KRW 3,484,673 to KRW 9,616,920 while the annual marginal WTP of downstream consumers for water quality ranged from KRW 1,773,511 to KRW 5,420,074. In the results of the papers, both upstream farm households and downstream water users placed substantial values on the water quality improvement of Soyang watershed in South Korea.

In conclusion, the results of this study demonstrated the importance of water quality conservation in Soyang watershed in relation with agriculture. Evaluation of the economic benefits which emphasizes dual role relationships between both upstream farmers and downstream consumers are critically needed. As awareness of the value of ecosystems and the concept of ecosystem services are increasing, methods for valuing the benefits from ecosystems should be developed respectively. Our empirical case study could be extended with spatial modeling, such as InVEST, GIS, and Agent-based modeling to measure the multi-scale benefits from ES for an integrated water resource management.

# Zusammenfassung

Ein Paradigmenwechsel in globalen Trends für natürliche Ressourcen hat das Konzept der Ökosystemleistungen (ÖSL) für nachhaltige Bewirtschaftung unterstützt. Mit zunehmender Anerkennung der Beziehungen zwischen Ökosystemfunktionen und menschlicher Aktivität, spielt das Konzept der ÖSL eine entscheidende Rolle in der Identifikation von trade-offs zwischen menschlichem Wohlergehen und Ökosystemleistungen. Im Gegensatz zu klassischen Schutzansätzen, welche einen einseitigen Fluss von Nutzen aus Ökosystemen annehmen, basiert das neu eingeführte Paradigma auf einem Ökosystemansatz, der eine Wechselwirkung von Mensch-Umwelt Verbindungen annimmt.

Das Konzept der Ökosystemleistungen stellt einen holistischen und integrativen Ansatz zur nachhaltigen, ökosystembasierten Bewirtschaftung in den Vordergrund. Dieser unterstreicht die Anerkennung ganzer Ökosystemprozesse und -funktionen, welche zum menschlichen Wohlergehen beitragen und betont einen mehrstufigen Nutzen in materieller und immaterieller Form. Ein multidisziplinärer Ansatz für eine integrierte Bewertung von Ökosystemen stellt jedoch signifikante Herausforderungen an die pragmatische Sicht von politischer Entscheidungsfindung. Darüber hinaus kann das Konzept der ÖSL ein besonders hilfreiches Politikinstrument sein, um Umweltverschmutzung und –degradierung zu reduzieren. Nichtsdestotrotz ist der Mangel an Mechanismen für Politikinstrumente in mehrstufigen Ansätzen eine kritische Forschungslücke und ein Mangel an Informationen über ökonomische Werte von ÖSL bleibt ebenfalls eine wichtige Wissenslücke in der vorhandenen Forschung.

Diese Doktorarbeit beabsichtigt, den ökonomische Wert von Ökosystemleistungen zu schätzen und fokussiert dabei auf Probleme der Wasserqualität im Anwendungsbereich von Trinkwasserversorgung. Die Artikel versuchten die zuvor erwähnten Lücken zu reduzieren, indem sie analysieren wie Nutzen von ÖSL die Entscheidungsfindung von sowohl Landwirten in der Landbewirtschaftung flussaufwärts, als auch von Wasserkonsumenten flussabwärts beeinflussen. Mit Bezug auf den Informationsmangel an ökonomischer Bewertung für ÖSL in Asien (besonders Süd-Korea), fokussierte diese Studie auf Regionen flussaufwärts (Gangwon Provinz) und Gebiete flussabwärts (Seoul, entlang Süd-Koreas Soyang Wassereinzugsgebiet). Da Wasserqualitätsdegradierung durch intensive Landwirtschaftsproduktion flussaufwärts hervorgerufen wird, ist Wasserqualitätsschutz

essentiell für die Erhaltung einer Hauptquelle für Trinkwasser zwischen Landwirtschaftsbetrieben flussaufwärts und Haushalten flussabwärts.

Im ersten Artikel wurde multinationale logistische Modellierung benutzt, um die Schlüsselfaktoren zu identifizieren, welche, basierend auf Interviews mit konventionellen, teilweise konvertierten und umweltfreundlichen Landwirtschaftshaushalten, die Auswahl von Landwirten in Bezug auf die Einführung von Bewirtschaftungsmethoden beeinflusst. Im zweiten Artikel wurden Methoden des kontingenten Bewertungsansatzes benutzt, um die Zahlungsbereitschaft (WTP) für Wasserqualitätsverbesserung durch die Einführung von umweltfreundlicher Landwirtschaft zu schätzen. Zuletzt habe ich im dritten Artikel die Wahlversuchsmethode, genauer gesagt Präferenztechniken, zur Schätzung der WTP basierend auf drei Attributen benutzt: Wasserqualität, Biodiversitätslevel und landwirtschaftliche Profite.

Die Ergebnisse aus Artikel 1 zeigten, dass Bildungsstand und Subvention positiv und signifikant die Wahrscheinlichkeit der Auswahl von Landwirten von teilweise konvertierter und umweltfreundlicher Bewirtschaftung, relativ zur konventionellen Bewirtschaftung, beeinflussten. Die Ergebnisse von Artikel 2 zeigten, dass die erwartete, jährliche WTP für Wasserqualitätsverbesserung durch die Einführung von umweltfreundlicher Bewirtschaftung im Mittel 36.115 KRW pro Haushalt betrug. Die Ergebnisse zeigten an, dass die geschätzte, jährliche, aggregierte WTP den kompletten Einkommensverlust der gesamten Landwirtschaftsfläche im Hochland ausgleichen könnte, welche die Wasserqualität beeinflusst. Die Ergebnisse aus Artikel 3 zeigten an, dass die geschätzte, jährliche, marginale WTP von Landwirten flussaufwärts für jedes Wasserqualitätsattribut zwischen 3.484.673 KRW und 9.616.920 KRW schwankte, während die jährliche, marginale WTP für Wasserqualität von Konsumenten flussabwärts zwischen 1.773.511 KRW und 5.420.074 KRW schwankte. In den Ergebnissen der Artikel wiesen sowohl Landwirtschaftshaushalte flussaufwärts, als auch Wassernutzer flussabwärts der Wasserqualitätsverbesserung des Soyang Wassereinzuggebietes substantiellen Wert zu.

Zusammengefasst demonstrierten die Ergebnisse dieser Studie die Wichtigkeit der Erhaltung der Wasserqualität im Soyang Wassereinzugsgebiet in der Verbindung mit Landwirtschaft. Bewertung der ökonomischen Nutzen, welche die duale Rolle-Beziehungen zwischen sowohl Landwirten flussaufwärts, als auch Konsumenten flussabwärts betonen, werden kritisch benötigt. Mit steigendem Bewusstsein zum Wert von Ökosystemen und des Konzeptes der Ökosystemleistungen, sollten Methoden zur Bewertung von Nutzen durch Ökosysteme entsprechend entwickelt werden. Unsere empirische Fallstudie könnte durch räumliche Modellierung erweitert werden, beispielsweise InVEST, GIS und Agenten-basierte Modellierung, um die mehrstufigen Nutzen durch ÖSL für ein integriertes Management von Wasserressourcen zu messen.

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# Table of contents

# List of figures

## List of tables

# List of individual contributions

The work presented in this dissertation refers to the following three papers. Paper 1 is published in *Sustainability* (Chapter 2). Paper 2 is in *Water* (Chapter 3). Paper 3 is *in preparation* for publication (Chapter 4).

<u>Paper 1 (Chapter 2)</u>

Author(s): Saem Lee, Trung Thanh Nguyen, Patrick Poppenborg, Hio-Jung Shin and Thomas Koellner

Title: Conventional, Partially Converted and Environmentally Friendly Farming in South Korea: Profitability and Factors Affecting Farmers' Choice

Journal: *Sustainability*

Status: Published (2016)

Own and author contribution statement:

Own contribution: Study design 60%, Data collection 100%, Statistical analysis 90%, discussion 80%, manuscript writing 80%

Saem Lee, Trung Thanh Nguyen, Hio-Jung Shin and Thomas Koellner designed the research; Saem Lee collected research data; Saem Lee and Trung Thanh Nguyen analyzed the data and created figures and tables; Saem Lee, Trung Thanh Nguyen, Patrick Poppenborg and Thomas Koellner interpreted and discussed results; Saem Lee wrote the first draft of the manuscript; Saem Lee, Trung Thanh Nguyen, Patrick Poppenborg, Hio-Jung Shin and Thomas Koellner revised the manuscript.

Saem Lee is the corresponding and first author.

Paper 2 (Chapter 3)

Title: Do Consumers of Environmentally Friendly Farming Products in Downstream Areas Have a WTP for Water Quality Protection in Upstream Areas?

Author(s): Saem Lee, Trung Thanh Nguyen, Hyun No Kim, Thomas Koellner, Hio-Jung Shin

Journal: *Water*

Status: Published (2017)

Own and author contribution statement : Study design 60%, Data collection 100%, Statistical analysis 90%, discussion 80%, manuscript writing 80%

Saem Lee, Trung Thanh Nguyen, Hio-Jung Shin and Thomas Koellner designed the research; Saem Lee collected research data; Saem Lee, Hyun No Kim and Trung Thanh Nguyen analyzed the data and created figures and tables; Saem Lee, Hyun No Kim and Hio-Jung Shin interpreted and discussed results; Saem Lee wrote the first draft of the manuscript; Saem Lee, Trung Thanh Nguyen, Hyun No Kim, Hio-Jung Shin and Thomas Koellner revised the manuscript.

Saem Lee is the corresponding and first author.

Paper 3 (Chapter 4)

Title: Farmers and consumers' preferences for drinking water quality improvement through land practice management in South Korea - The case study of Soyang watershed, South Korea -

Author(s): Saem Lee, Hyun No Kim, Trung Thanh Nguyen, Thomas Koellner and Hio-Jung Shin

Status: In preparation for publication

Own and author contribution statement : Study design 60%, Data collection 100%, Statistical analysis 90%, discussion 80%, manuscript writing 80%

Saem Lee, Trung Thanh Nguyen, Hio-Jung Shin and Thomas Koellner designed the research; Saem Lee collected research data; Saem Lee, Hyun No Kim and Trung Thanh Nguyen analyzed the data and created figures and tables; Saem Lee, Hyun No Kim and Hio-Jung Shin interpreted and discussed results; Saem Lee wrote the first draft of the manuscript; Saem Lee, Trung Thanh Nguyen, Hyun No Kim, Hio-Jung Shin and Thomas Koellner revised the manuscript.

Saem Lee is the corresponding and first author.

# Chapter 1: Synopsis

## 1.1. Introduction

### 1.1.1. The concept of ecosystem services and its holistic approach

Earth's ecosystems are important for human life. However, unprecedented sweeping changes of land degradation, soil depletion, water pollution, resource depletion, loss of biodiversity and climate change have led to paradigm shift of academic researchers in conservation initiatives (Secretariat of the Convention on Biological Diversity, 2010; MA, 2005). The new paradigm approach has been created by emphasizing a complex relationship between ecosystem services and human well-being for sustainable ecosystem management, in stark contrast with a classical approach, which considers the relationship between ecosystems and human life in a largely one-sided manner. The alarming rates of worldwide environmental degradation on Earth have required better information and understanding of social-ecological systems, specifically in regard to ecosystems and their services for sustainable ecosystem management (TEEB, 2010).

To support sustainable management and policies related to global ecosystems, more than 1,360 leading experts contributed to the report of the Millennium Ecosystem Assessment (MA) from 2001 to 2005 (MA, 2005). In the MA report, the concept of ecosystem services (ES) was defined as the benefits people obtain from ecosystems, including provisioning services (such as food and water), regulating services (such as flood control), supporting services (such as soil formation and nutrient cycling) and cultural services (such as recreational and other nonmaterial benefits). The concept of ES and its classifications play an important role in identifying the dynamic linkages that can demonstrate synergies and trade-offs in natural resource management. The main focus of the MA was to establish and accumulate comprehensive scientific knowledge about the assessment for ecosystem change consequences. The global assessment highlighted a holistic approach considering spatial scales from local to global and multiple stakeholders who can help derive knowledge for sustainability.

As ES are interconnected, synergies and trade-offs between ES frequently occur (Turkelboom et al, 2015). In agricultural ecosystems, intensively managed agriculture with overuse of chemical fertilizers increases food supply. The intensive farming activities can produce an increase in provisioning services such as food, fiber or bioenergy. However, these same human activities can lead to a degradation of water quality in surface water and groundwater. This has contributed to decreases in regulating and cultural services, such as water purification, soil conservation or carbon sequestration. The relationship of trade-offs between gains and losses has been emphasized in ecosystem functionality and human well-being (MA, 2005; Nguyen and Tenhunen, 2013). Incentives created by policy instruments can result in reduction of associated pollution costs by negative environmental externality (Elmqvist et al., 2011). Therefore, global government initiatives have focused on agricultural programs that provide incentives for farmers to promote the supply of various ecosystem services for sustainable management.

### 1.1.2. State of the art and research gaps

*State of the art*

Recent research has focused on interdisciplinary approaches for institutional design and policy implementation with emphasis on an integrated framework (Secretariat of the Convention on Biological Diversity, 2010; MA, 2005; Tavoni and Levin, 2014). The integrated conceptual framework is demonstrated in Figure 1.1 (moving clockwise from the left corner of the figure). The framework takes into account ecological, cultural and economic values at temporal dimension and multiple-spatial scales for ecosystem management decisions. To pursue a rational decision-making process, the integrated framework has been used to emphasize the relationships between the ES and socio-economic activities, considering ecological and cultural factors. However, methodologically, its integration efforts are challenging. Despite the growing demand for interdisciplinary approaches, comprehensive modelling work of processes and feedbacks considering biophysical and socio-economic factors still remains difficult.

Moreover, as recognized by scarcity of natural resources, ES sciences (including ecology and economics) attempt to integrate different disciplines to better inform policy makers (Koellner, 2010). In particular, integrating ecology and economics has gained considerable interest in the inquiry of integrated frameworks. However, the work of ecological modeling combined with economic studies is often limited. While a number of studies focus on ecological modeling work, few researches have included economic theoretical considerations in ES studies (Farley et al., 2012). In addition, sustainability and effectiveness are key issues in ES sciences. Nevertheless, recent studies dealing with economic efficiency have paid less attention in ES approaches, whereas sustainability economics has been developed specifically with a conceptualization of such relationships (Baumgärtner and Quaas, 2010). It is thus still necessary to further examine ES from an economic perspective. This was the first motivation of this dissertation.

When examining ES changes in an integrated framework, economic valuation is used in a narrow sense. Nevertheless, more importantly, economic valuation is essential to reduce misinformed policy actions and to support strategic social actions. Economic valuation provides a tool that can develop the ability of decision-makers to evaluate trade-offs between the alternative programs and social behaviors that can change the use of ES.

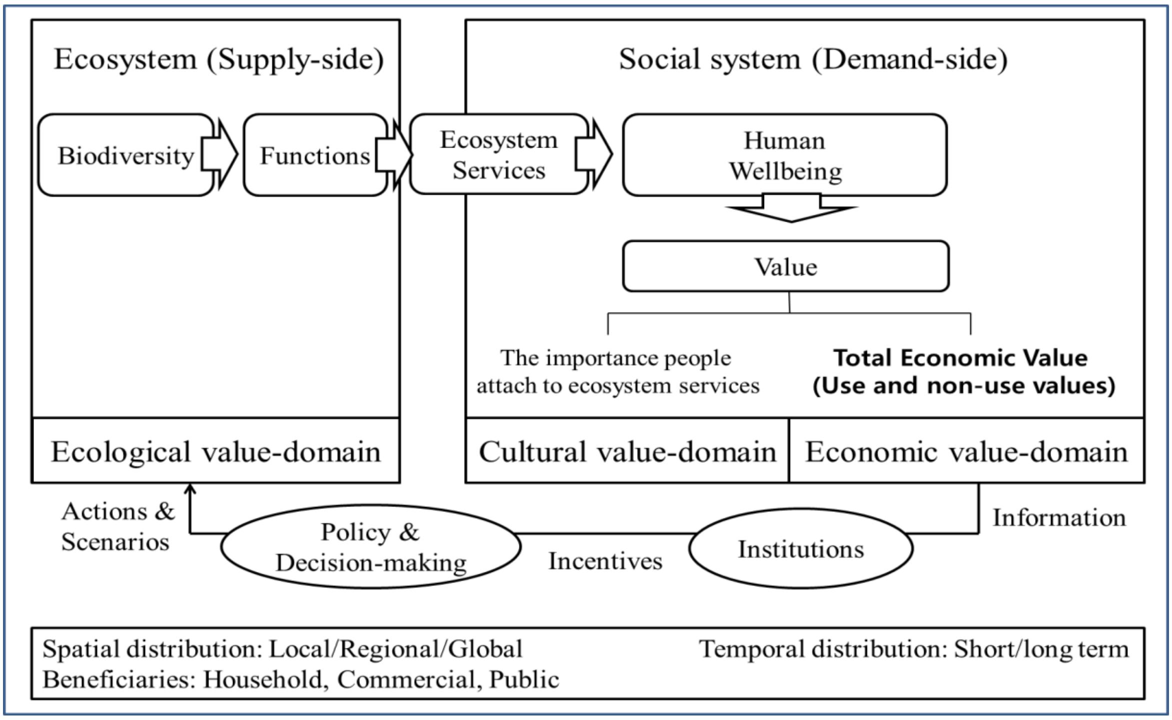


Figure 1.1: An integrated conceptual framework for ecosystem management (Modified from de Liu et al., [8] and Gómez-Baggethun et al. [9])

The concept of ES underscores the economic value and utility to societies as people derive from their actual use directly or indirectly which is known as use values and from their potential use, which is known as non-use values. This paradigm of values is based on the utilitarian (anthropocentric) concept of human welfare. Total economic value (TEV) is utilized to demonstrate the whole value of ecosystem services, which can be understood as a heuristic approach considering different value dimensions (Bateman et al., 2002). This encompasses all components of utility by adding both use and non-use values of the overall value. Depending on the type of ecosystem services, valuation techniques are selected to assess relative economic value for ecosystem services which have no market price. All valuation approaches aim to aggregate people's preferences associated with their choice and trade-offs in decision-making processes. These approaches are an essential component of integrating the concept of ES into sustainable ES management.

Methodologically, economic valuation approaches have focused on measuring benefits and costs related to individuals' preferences for non-marketed services being influenced by a management decision-making, whereas classical approaches concentrate on growing production returns in marketed services. The underlying concept of benefits and costs is the notion of economic efficiency, which is based on the economic welfare theory. Basic economic approaches typically attempt to reveal monetary values in dollar terms through preferences of individual for non-marketed ES. When money is available as the standard to measure welfare, benefit estimation is willingness to pay (WTP) for the benefit or willingness to accept (WTA) for compensation to give up. Given that an individual has clear preferences for ES, WTP or WTA is helpful to support decision-making for the provision of ES.

From an economic point of view, many ES have no market price but nevertheless provide positive externalities beneficial to societies. However, underpriced or unpriced ES lead to inefficient and unsustainable use of environment resources. Thus, it is necessary to estimate the economic values of underpriced or unpriced ES (such as water quality, climate regulations and flood risk management) and to establish markets for such ES. Increasing awareness for and better information on marketable ES can support policy decision-making affecting stakeholders such as farmers and consumers. Policy instruments and programs related to ES influence the processes and functions of ecosystems and the level of ES provision.

Policy instruments are needed to internalize positive externalities for sustainable ecosystem management. These instruments must originate from good governance in a sustainable manner that includes fairness, transparency, accountability and effectiveness. However, in the integrated framework, the shortage of market-based mechanisms complicates any shift of the valuation of ES into effective policy and governance (Gómez-Baggethun et al, 2010). This is attributed to a lack of understanding within ES management decision making

(Daily et al., 2009), which can result from a shortfall of integrated studies in institutional planning and policy practices.

One of the instruments is payments for ecosystem services (PES). PES can be implemented at various spatial and temporal scales (Smith et al., 2013; Engel et al, 2008). For example, there are international (e.g. REDD+, green development mechanism), national (e.g. agri-environmental schemes), catchment (e.g. downstream water uses paying for watershed management on upstream land use) and local (e.g. residents' collectively funding an NGO for local green spaces) scales. The mode of payment, as an essential variable in scheme design, can be divided into two approaches: input-based and output-based payments. Within input-based approaches, payments depend upon agreed changes in management practices, such as change in farmland management, based on the assumption that these are likely to produce the required change in service provision, whereas within output-based approaches, payments are based on actual ES offered.

More specifically, PES schemes consider the beneficiaries (those should pay for the benefits from ES) and service providers who generate the services required to be compensated or rewarded (those are paid). For example, in the case of agriculture related catchments, upstream farmers in upland areas are the service providers as the land managers of agricultural ecosystems, whereas downstream residents are the beneficiaries. In order to manage catchments, the relationship between upstream water manager and downstream water users occurs explicitly. PES schemes are creating significant attention toward the foundation of new funding sources for ES and their providers in several countries (Rode et al., 2016; Morrison and Aubrey, 2010). However, few studies utilized economic valuation in examining how PES have been implemented in Asia, in particular, in South Korea. This was the second motivation of this dissertation.

The total economic value (TEV) indicates benefits (gains) or costs (losses) of individuals and societies from marginal changes of value in ES. In general, the benefits from a program or a policy are measured by using several techniques. Two main techniques, namely, revealed and stated preferences are widely utilized for estimating monetary values through sophisticated statistical models (Whitehead et al., 2008; Bateman, 2007). Revealed preference techniques depend on actual markets. These are based on survey data with respect to direct observation of individuals' behavior for marketable goods and services which contain environmental attributes. Revealed preference (RP) techniques include market methods, travel cost method (TCM), hedonic pricing methods (HPM) and production approaches. For instance, TCM is mainly used for calculating recreation values, while HPM is used for estimating property values related to the aesthetic qualities of natural ecosystems.

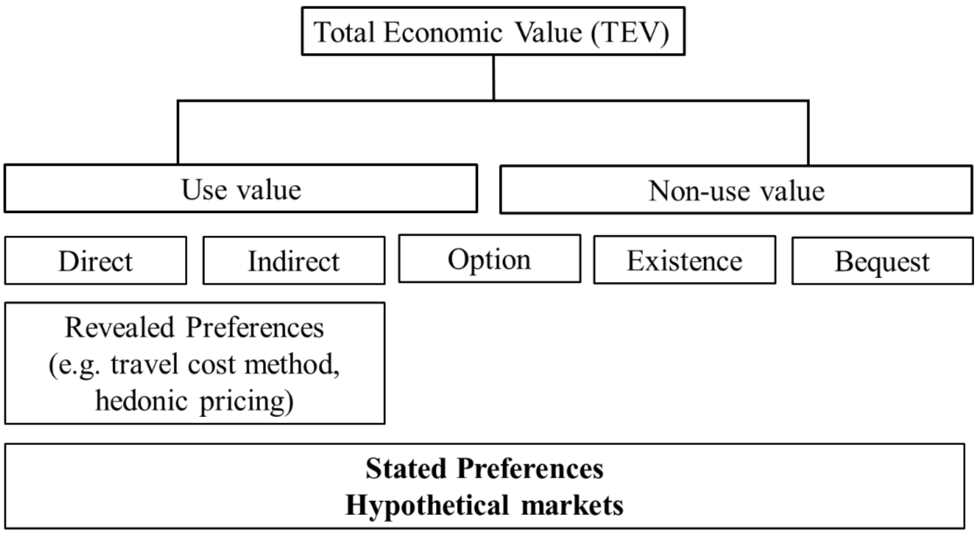


Figure 1.2: A framework of total economic value that includes use and non-use value (Modified from Bateman et al. [19]).

Another major techniques for eliciting economic valuation are stated preference (SP). In contrast with RP techniques, SP techniques have an advantage in terms of flexible application and are possible to estimate both use and non-use values (Bateman et al., 2011). In other words, SP is the only technique capable of estimating non-use values, which has no substitutes, in a wide range of contexts. According to Marchado and Mourato (1999), SP techniques can be facilitated to evaluate trade-offs between efficiency and equity.

SP techniques are regarded as questionnaire-based techniques because they utilize carefully structured questionnaires to elicit individuals' preferences for a given change in an environmental attribute (Adamowicz et al., 2004). This offers information about WTP or WTA of respondents and socio-economic characteristics. Thus, it is crucial to identify multiple stakeholders to measure the benefits (gains) and costs (losses) by different socio-economic groups of respondents.

The contingent valuation method (CVM) and choice modeling are primarily used in SP approaches (Adamowicz et al., 1998). In general, CVM is helpful for estimating the WTP for environmental quality changes. On the other hand, CM is useful to investigate relative values for different attributes of an environmental good with the WTP. The application of choice modeling is a relatively new approach in stated preference techniques compared to CVM (Boxall et al., 1996). Thus, further studies are needed using choice modeling, since relatively numerous CVM studies have been implemented. Choice modeling contains choice experiments (CE), contingent ranking, contingent rating and paired comparisons (Hanley et al., 2001). Among these four types, CE is the only CM approach that is linked with economic theory and is widely used in CM.

The main difference between CVM and CE is the form of asking questions in questionnaire. CVM reveals estimates of WTP by asking questions directly, whereas CE elicits the WTP by asking questions indirectly with several choice sets. CE includes various environmental attributes in an experiment design which presents repeated choices among bundles of attributes (Bennett et al., 2001). While CVM makes questions easier to understand, CE gives more efficient estimates of WTP with mean or median values than CVM results. Moreover, CE is able to obtain a rich dataset by several attribute values and an array of different alternative (Adamowicz et al., 1998). The advantage of CE is its ability to solve the problem of CVM in terms of hypothetical scenario design.

In this context, an example of empirical applications of CVM and CE is important to value environmental quality changes and to assist in understanding ES trade-offs. This can be useful for the provision of better information to policy makers which, in turn, can reduce the challenges of poor understanding and shortage of information within the integrated framework. Furthermore, much research focuses on the use of only one technique, either CVM or CE in stated preference methods. Much less attention has been paid to the comparison between CVM and CE in an empirical application. Moreover, although the effectiveness of PES programs is affected by various stakeholders (especially upstream farmers and downstream water users), few ES studies have considered both of these perspectives simultaneously. This was the third motivation of this dissertation.

*Research gaps*

- A core conceptual foundation in interdisciplinary approaches is value pluralism toward sustainable ecosystem-based management. Global trends in ecosystem services have been built in integrated approaches by international initiatives such as the Millennium Ecosystem Assessment (Reid et al., 2006) and TEEB (Brondizio et al., 2010). However, a key issue in interdisciplinary approaches is the methodological challenge of combining multiple types of ecosystem service values.
- The standing challenge is in line with a boundary of integrating ecology and economics in ecosystem service sciences. From an economic point of view, economic valuation methods with stated preference techniques have potential application combined with ecological modeling work toward integrated frameworks. Thus, the development of stated preference techniques is necessary in order to identify individuals' or stakeholders' preferences and behaviors for hypothetical environmental changes and address respective benefits and costs.

- Payments for ecosystem services (PES), as a policy instrument design are helpful in the determination of policy decisions and priorities for sustainable ecosystem-based management. The use of stated preference techniques is recommended to represent upstream farmers and downstream consumers' preferences and behaviors for hypothetical environmental changes and address gains and losses, based on the scheme of PES. However, applications using stated preferences are far more developed in certain countries such as Canada, UK, but not for Asia, in particular South Korea.
- Contingent valuation method (CVM) has been developed extensively as a traditional method in stated preference techniques. However, in the case of agricultural ecosystem services along river basins, few empirical studies have made efforts to deal with both upstream farmers and downstream consumers perspectives using CVM despite the increasing awareness of the value in local-specific situation. Yet many researchers have focused on one stakeholder perspective. For example, only certain farmers' or consumers' preferences have been considered in academic research.
- Choice experiments (CE) are a relatively new method in stated preference techniques which correct the shortcoming of the contingent valuation method. Thus, the use of CE is required to develop the application. Moreover, local communities' awareness and preferences for the value of agricultural ecosystems and water-related services are increasing. However, investigations using CE have received less attention in economic valuation approaches.

## 1.2. Research purpose and methodological approach

### 1.2.1. Research goals

The broad purpose of this thesis is to provide a better understanding of farmers' and consumers' decision-making in terms of ecosystem services as a political framework towards sustainable ecosystem management. More specifically, the purpose of this thesis is to estimate the economic value of changes in environmental quality, specifically, water quality combined with agriculture, in monetary terms by means of stated preference techniques. The main questions relevant to achieving this aim were:

1) What factors influence farmers' decision making regarding the adoption of farming techniques in the context of benefits from crop cultivations and ecosystem services for sustainable management?

2) Do downstream residents have a willingness to pay for water quality improvement through land use change, such as the adoption of environmentally friendly farming in application of contingent valuation method?

3) How can the choice experiment method overcome the disadvantage of the contingent valuation method in questionnaire-based economic techniques used to identify farmers and consumers' preferences for levels of drinking water services combined with agricultural ecosystems?

These fundamental questions constitute the entire framework for this thesis. Based on aims of this thesis, case study regions will be provided in the following section. Afterwards, used methodological approaches are presented with the specific explanation of contingent valuation method and choice experiment method. It is followed by summarized results and discussion from three papers. Finally, conclusions and research outlooks are presented in the finalization of this cumulative dissertation.

### 1.2.2. Study region

*Soyang catchment in South Korea: Gangwon Province (Inje, Yanggu, Hongcheon) and Seoul*

This thesis implements a case study for the water quality issues associated with agriculture in South Korea. We selected Gangwon Province as an upstream area and Seoul as a downstream area of Soyang Lake which is the key source of drinking water for the metropolitan areas in South Korea. More specifically, the study regions selected are environmentally sensitive areas: three regions (Yanggu, Inje, and Hongcheon) in Gangwon Province and Seoul, capital city within Soyang Lake watershed of South Korea.

The Gangwon Province including the three districts, is located in the mountainous northeastern part of South Korea (latitude 37°02'N–38°37'N and longitude 127°05'E–129°22'E). Water quality problem in the three major regions has become an important issue between upstream farmers and downstream consumers due to intensively managed farming within the upstream watershed of Soyang Lake in Gangwon Province. Since 2006, selected areas have been designated as initial nonpoint pollution source management areas with the aim of reducing sediment yields from agricultural practices in the mountainous areas of South Korea and protecting the water quality of the Soyang watershed. The Soyang Lake is the largest reservoir and tributary north of the Han River of South Korea. The water pollution in surrounding environmentally sensitive areas, especially in the selected area, is seriously affected by intensive farming and can seriously damage clean drinking water use of the citizens.

Considering the low adoption level of organic farming in Gangwon Province and potential hazard of water pollution from intensively managed practices in the districts during monsoon climate along the Soyang watershed, the upstream areas in agricultural land use management have an important role in farmers' decision making reflecting profitability and factors affecting change in farming methods. The Gangwon Province occupies approximately 20,569 $km^2$. The total agricultural area of the province was 109,496 ha. Rice paddies comprise 41,086 ha and field land comprises 68,410 ha. The dominant landscape of the catchment area is in highland regions with upland fields. In 2011, the average farm size, from a total of 71,687 farm households in Gangwon Province, was 1.5 ha per farm, of which 0.57 ha was occupied by rice and 0.95 ha of field land, respectively. At this time, the total EFF cultivated farmland was 7,962 ha with 5,854 EFF farm households in this province. Organic farmland was 1,976 ha and 1,093 farm households while no-pesticide farmland was 4,899 ha and 3,561 farm households. Low-pesticide was 1,088 ha and 1,200 farm households. The certified EFF area accounted for only about 4.6% of the certified areas in South Korea. In the three district of Gangwon Province, the main crops cultivated in the mountainous area were Chinese cabbage and radish, which depend heavily on chemical fertilizers and pesticides. In these areas, intensive agricultural practices with high concentrations of phosphorous and nitrogen on steep slopes and at relatively high altitudes caused eutrophication of the reservoir and negatively affected the habitat of endangered species in the aquatic ecosystems of the watershed.

In addition, the study area, Seoul (latitude 37° 33' N, longitude 126° 58' E.), is located in the downstream areas of Soyang watershed. Seoul is the largest city (25 districts, 605.25km2) in South Korea with a population of approximately 10 million people. The citizens in the downstream area utilize the water resource at an overwhelming rate due to high population density of the capital area, which shared 48.3% of the country’s population in 2011. Seoul is a representative downstream beneficiary along the Soyang watershed, obtaining the clean water supply and benefits of aquatic ecosystem services that the upstream area provides. In order to protect the water quality of the watershed, examination of the downstream households’ preferences for e water quality through land use change options is crucial.

The Soyang watershed is a major river and a main drinking water resource in South Korea, flowing to Seoul from the upstream Gangwon Province. Issues of water quality protection of Soyang watershed have emerged from muddy water problems caused by the concentrations of N and P during the monsoon period in summer season. A crucial contributor affecting the muddy water is highland agricultural land use in the upstream area. Excessive nutrients from fertilizers and pesticides associated with intensive managed agriculture are a main non-point source pollution impacting the decrease in water quality of the watershed. The nutrient runoffs associated with eutrophication led to the reduction in biodiversity around the watershed and posed a serious threat to the aquatic ecosystem. The water degradation issue faces the challenge with potential health and environmental risks in South Korea.

### 1.2.3. Research methods

#### 1.2.3.1. Contingent valuation method

Contingent valuation method (CVM) was selected within the context of the aforementioned research question and situations of the study areas along Soyang watershed. The CVM is a commonly used economic tool for assessing the value of environmental goods and services by individuals. Based on hypothetical scenarios for the proposed policy, people were asked directly for the WTP for environmental changes. Although the National Oceanic Atmospheric Administration (NOAA) emphasizes single bounded referendum method for eliciting WTP for nonmarket goods and services using CVM, the single bounded model has a disadvantage: it provides inefficient welfare measures due to limited information gained from individual respondents. Thus, double bounded dichotomous choice (DBDC) elicitation method using CVM was used to estimate the WTP for water quality improvement through the adoption of EFF.

A questionnaire, classified according to whether they have purchased EFF products or not, was targeted to Seoul citizens. Series of questions were asked through a face-to-face interview. We provided WTP questions associated with hypothetical information stating that the water quality of the watershed is severely deteriorated by the muddy water problem in monsoon season as the result of overuse of chemical pesticides and fertilizers in conventional farming (reflecting the existing situation of the watershed). To ensure credibility for the proposed policy, influx of muddy water was presented with contaminated pollutants by overused fertilizers and pesticides. In the hypothetical scenario, the conversion to EFF for the protection of water quality was provided as an alternative approach to reduce nonpoint source pollution.

The WTP questions were a close-ended format consisting of a binary response of initial and follow-up a yes or no answer applied in a DBDC model. In DBDC format, a bivariate Probit model was utilized in order to calculate the mean WTP for the water quality improvement. With the randomly assigned initial bids for the WTP ranging from KRW 2,000 to KRW 8,000 per month, the dependent variable takes 1 if the respondents are willing to pay for the conversion to EFF to improve water quality and 0 otherwise. The *bid* variable was a bid amount in KRW as a form of tax for conservation of water quality by adopting EFF. The variable *buyer* takes the value 1 if respondent bought EFF products; 0 otherwise. Furthermore, socio-economic variables and environmental awareness in the questionnaire were used through ordinary least squares (OLS) regression.

Considering the assumption that the conversion to EFF in the upstream area is a substantial alternative to protecting the watershed which provides potable water, the analysis for the WTP questions was designed to test the following expectations. The presented bid values will have a negative and statistically significant effect on the consumer’s probability to accept the bid. Consumers buying EFF products might appear to have an influence on the WTP for the water quality improvement through conversion to EFF, since they could have additional environmental and health concerns. The WTP for water quality improvement through the adoption of EFF could be closely associated with compensation costs for income loss during transition period of EFF in the upstream area.

Furthermore, with respect to upstream farm households, a questionnaire was constructed to identify farmers' choice on farmland management in the upstream area. The questionnaire included three main sections among conventional farming, partially converted farming and EFF in order to compare more reliable financial profitability among different farming techniques. The questionnaire contained farm size and number of cultivated crops in arable areas. Regarding conventional and partially converted farmers, we asked whether they have the willingness to adopt the EFF for their profit and environmental protection when their income loss is fully compensated during the transition period. If they are not willing to convert to EFF, we asked the reasons for their opposition to adopting the EFF. Conversely, we asked EFF farmers how much of their income loss occurred during the transition period during each 5 initial years. In order to check a decreased/increased rate of production amounts during the period, it was classified into 11 groups from less than 40% to more than 40%. The final section was the identification of the social, economic and demographic characteristics of interviewed farm households such as age, income, education level and farming experience.

#### 1.2.3.2. Choice experiment method

Choice experiment method (CEM) utilized to identify the preferences of upstream farm households and downstream water users in environmental changes such as water quality and biodiversity level through different agricultural practices. In stated preferences, a main difference with the contingent valuation method mentioned above is a questionnaire structure presenting the hypothetical choice. This method provides bundles of choices including two or three environmental resource use alternatives in each choice set, while the CVM presents only one choice or two choices directly in any hypothetical situation. From each choice set in CEM, respondents are requested to state their preferred set of attributes/characteristics with different levels among presented alternatives. In random utility models, welfare measures can be estimated with individual WTP for a change in offered attribute levels. The welfare measurement estimations are obtained from statistical models.

Accordingly, the same questionnaire was constructed for both upstream farmers in Gangwon Province and downstream water users in Seoul. The questionnaire described agricultural profit, water quality and biodiversity levels in one choice card and provided the information regarding a status quo as a base option in Soyang watershed as well as two alternatives. Each respondent was presented with 9 choice sets, each with two alternatives to the status quo produced by an orthogonal fractional factorial design. Moreover, in the same hypothetical scenario for ecosystem services through land use changes by conversion to farming techniques, the socio-economic information was included in both upstream farm and consumer households.

A classic conditional logit model (CLM) and the CLM with interactions were chosen to compare the results to estimate more accurate welfare measurements. The classic CLM tends to be used as a basic model due to the characteristics of homogeneity based on IIA assumption. The CLM with interactions incorporated with socio-economic characteristics can supplement the weakness for the characteristic as relaxing the homogeneity. Accordingly, considering the heterogeneity issue, a basic CLM, CLM with two-way and three-way interactions were performed to estimate the value for environmental changes; in particular, change in water quality, with an importance of economic and geographical characteristics related to income levels and districts.

## 1.3. Key results

### 1.3.1. Chapter 2:

Conventional, Partially Converted and Environmentally Friendly Farming in South Korea: Profitability and Factors Affecting Farmers' Choice

The result of descriptive statistics showed that environmentally friendly farming (EFF) had the highest education level among conventional farming (CF), partially converted farming (PCF) and EFF. The three groups of farmers showed homogenous with age. With respect to the EFF experience, environmentally friendly farmers had more experience of farming management compared to partially converted farmers. The average number of cultivated crops for PCF farmers was higher, compared to the two other groups of farmers. The average farm size for PCF was 4.0 ha. EFF occupied approximately half of the total PCF cultivated area. The findings of the ANOVA analysis indicated that farmland size and average number of cultivated crops among the three farming techniques differed significantly.

Regarding annual average costs and benefits per farm, PCF had the largest average costs per farm household. EFF had the lowest land rental costs and fertilizer costs. Moreover, PCF had the largest wage cost, fertilizer and pesticide expenditure, whereas EFF had the smallest fertilizer expenditure. In terms of pesticide costs per farm household, pesticide expenditures of PCF were higher than that of EFF. With respect to benefits per farm household, EFF had the highest annual benefits. PCF had the largest annual revenues compared to two farming techniques. However, in the case of annual net income, EFF had the largest income, while PCF had the smallest income alongside the largest costs for farming activities. EFF had the highest subsidies from the government or province.

In addition, we investigated the costs and benefits per ha per farm household according to farm size in different groups. The results of annual average costs and benefits per ha were somewhat different, compared to the results per farm household. The land rental costs per ha were closely similar between CF and EFF. Regarding average labor costs per ha, EFF had the largest labor costs. CF had the smallest fertilizer costs, whereas PCF had the largest fertilizer costs. With respect to pesticide costs pe ha per household, CF had the highest expenditure compared to other farming techniques. EFF farmers had the largest annual total costs. Simultaneously, EFF had the highest total annual benefit per ha per household compared with the other two groups. In the case of subsidy per ha per household, EFF had the largest subsidy while PCF had the lowest amount of subsidy in their farming activities. Regarding annual farm net income per ha per household, EFF had the highest annual income amount of the three groups.

In addition, a multinomial logistic analysis showed which factors are affected by the farmers' choice on farming techniques. The coefficient for education level was statistically significant and positively correlated to the probability on PCF and relative to CF. Farm size was found to be positively correlated with the probability of adopting EFF, whereas farm size was not statistically significantly related to the PCF. The coefficient of subsidy indicates a strong positive relationship between the subsidy and the likelihood of farmers' adoption of PCF and EFF relative to CF. Based on the relative risk ratio using this model, our study found that if the farmers would increase their education level by one unit, the relative risk for PCF and EFF relative to CF would be expected to increase by the determinants of 1.42, given that other variables are held constant in the model. With regard to farm size for their cultivated farmland, the relative risk ratio for EFF, relative to CF would be expected to decrease by a factor of 0.80, given that the other variables are held constant in the model. Finally, farmers who received subsidies were more likely to choose PCF and EFF by a factor of 2.73 and 5.20, respectively.

### 1.3.2. Chapter 3:

Do Consumers of Environmentally Friendly Farming Products in Downstream Areas Have a WTP for Water Quality Protection in Upstream Areas?

The work in paper 2 (chapter 3) focused on downstream consumers' choices and their benefits from the drinking water quality of Soyang watershed using contingent valuation method (CVM). Based on downstream citizen's survey data, the results from the bivariate Probit model and OLS analysis were shown. Moreover, in order to contrast the benefits of downstream consumers with their annual income loss of upstream farm households, we calculated the substantial income loss when conventional farmers change their farm management to EFF. Thus, the estimated WTP for water quality improvement was included and then compared with the income loss of the upstream farm households during transition period.

With respect to the response of upstream farmers for the willingness to adopt EFF when their compensation is guaranteed, 47.1% of conventional farmers and 60.0% of partially converted farmers had positive responses. The results show that about half of total upstream farm households (52.7%) are willing to convert their farming techniques to EFF if their income loss is offset. The key barriers against EFF adoption were farm profitability and age.

Applied in the bivariate probit model to estimate the expected WTP of downstream consumers, we found that the annual mean WTP for water quality improvement through the adoption of EFF was KRW 36,115. Moreover, in order to identify the factors affecting the WTP, we implemented an OLS model. The OLS result showed that the two explanatory variables, *Future purchase intention of current consumers with EFF products* and *Label*, are found to be positively significant on the lnWTP. Thus, the result found that current consumers who have the intention of buying EFF products in the future and consumers' awareness for EFF product labels are positively related with the lnWTP. Finally, the result of the aggregate estimated WTP of downstream respondents indicated that the calculated compensation costs (KRW 60 billion) accounts for about 40% less than the downstream consumers' annual WTP (KRW 151 billion).

### 1.3.3. Chapter 4:

Farmers and consumers' preferences for drinking water quality improvement through land practice management in South Korea: The case study of Soyang watershed, South Korea

The work in paper 3 (Chapter 4) included three models using the choice experiment method. The first model was a basic model including alternative specific constant ASC and selected attributes containing agricultural profit, water quality and biodiversity levels. Furthermore, additional conditional models using two-way and three-way interaction terms were included with different income levels and local communities. The two-way interaction terms were utilized with low, middle and high income levels multiplied by each attribute. The three-way interaction terms, upstream and downstream areas, low/middle/high income and each attribute (agricultural profit, water quality, biodiversity) were included.

The result of the basic model showed that the variables agricultural profit, water quality and ASC were statistically significant. However, the biodiversity variable was statistically insignificant. The result of conditional logit with two-way interaction terms showed that the interaction terms Low income level*Agricultural profit, Middle income level*Agricultural profit, High income level*Agricultural profit, and ASC were statistically significant with positive sign. The three income levels based on percentile of the sample variable to be interacted with the biodiversity variable were not statically significant. In addition, the results of the three-way interactions showed that the parameters of *Upstream/Downstream*Low/Middle income level*Agricultural profi*t were statistically significant at the 1% significance level. The parameter of *Upstream*High income level*Agricultural profit* was statistically significant at the 10% significance level. This means that low and middle income level upstream and downstream respondents prefer increases in water quality of the Soyang watershed. However, the coefficient of Downstream*High income level*Agricultural profit was statistically insignificant.

In addition, the results of the marginal willingness to pay (MWTP) estimates for the water quality by the local communities and income levels were included. This result implied that monetary trade-offs between the two significant attributes in income levels (low, middle and high) and different local communities (upstream and downstream) for the change in each of the selected values of the two-way and three way interactions. With respect to income levels, the result of estimated annual MWTP for upstream respondents showed differences ranging from KRW 3,484,673 to KRW 9,616,920. Among downstream respondents, the difference between low and high income level ranged from KRW 1,773,511 to KRW 5,420,074. This result implied the MWTP was relatively different at different income levels and local communities.

## 1.4. Discussion

The work from paper 1 showed which farming technique is more profitable in upstream highland areas of Soyang Lake in terms of annual income and costs per farm household and ha. In our study, fertilizer costs for environmentally friendly farmers per ha were higher than for other farming techniques. The use of low-quality organic fertilizers could lead to less crop production and caused higher costs within the area. In light of water quality degradation of the catchment from soil erosion and nutrient run-off in this area, the proper application of fertilizers in accordance with the local geographical conditions is required in order to protect water quality. Therefore, proper quality and quantity of fertilizers, including different nutrients and ingredients on soil fertility, should be investigated for the multiple crop choices in each local scale.

With respect to annual net income per farm and ha, EFF were higher compared to CF and PCF, despite higher total costs per ha of EFF, we found that EFF was more financially attractive with higher price premiums of the products in this area. This is coherent with the results of Kristiansen et al. (2006) and Halpin and Brueckner et al. (2004), who showed the profitability of organic farming and higher net returns can be attributed to the premium price of organic products. In South Korea, EFFs obtain a price premium around 1.2~2.0 times depending on their crop choices as an incentive in the EFF products market (Kim et al., 2012). However, our results associated with profits in our study area were in contrast with the study by Kim et al., EFF cultivation of rice, vegetable and fruits had higher costs and lower benefits due to a transition period in terms of different crops in various provinces.

Applied in multinomial logistic regression (MNL), we found the significant determinants affecting the likelihood of the farmers' choice on farming techniques to identify important factors determining their farming method. The results showed that education level of farmers was positively correlated to PCF and EFF. This implies that more educated farmers would have acquired the knowledge necessary to adopt advanced techniques relatively easily. This finding confirms those of Weir and Knight (2000) and Lapar and Ehui (2004), who argue that an increase in farmers' education level increases the likelihood of adopting advanced farming techniques. In addition, the parameter of EFF farm size was statistically significant with negative sign. This is inconsistent with the results of Karki et al. (2011), showing that larger farm size has the potential for higher costs in labor and inevitable larger income loss during their transition period after adopting EFF. It can thus be interpreted that farm households with larger farmland are less likely to adopt organic farming as it causes higher labor costs and relatively higher risks in farm management. Moreover, the results demonstrate that receiving subsidies is the most significant positive influence on farmers' decisions. This reveals that the subsidy can be considered as a key factor to encourage farmers to convert to EFF and expand arable land area of EFF (Jánský et al., 2007).

Although upstream farmers' choice on farming techniques was investigated in paper 1 through financial analysis and multinomial logistic regression, the input-based results were insufficient to elicit farmers' preferences about economic and environmental benefits. Thus, paper 2 attempted to identify farmers' willingness to adopt EFF as a means of sustainable land use management in the selected study regions. Moreover, in the scheme of payments for ecosystem services, paper 2 was expanded to the scope of stakeholder to downstream residents. Accordingly, in paper 2, a contingent valuation method (CVM) for estimating the expected willingness to pay for water quality improvement through the adoption of EFF was applied to downstream residents. In CVM, the estimates of the expected WTP were successfully analyzed using a double-bounded model. The work in paper 2 was developed from that of paper 1 with an emphasis on a relationship between both upstream farmers as environmental stewardship and downstream water users as beneficiaries of ecosystem services in water resource management.

With respect to the upstream farmer survey in paper 2, it was found that a half of the surveyed farmers are not willing to adopt EFF. The main reason for this rejection of EFF was attributed to financial returns. The results are in line with the existing research, which revealed that economic and institutional barriers such as unstable crop production and insufficient financial support from governments for the adoption of organic farming (Tiwari et al. (2008), Menozzi (2015), Nguyen et al., (2012)).

In addition, regarding the downstream consumers' preferences for water quality improvement by converting to EFF, the results indicated that the estimated mean values occupied about 0.08% of the average annual income per household of Seoul citizens reported by Statistic Korea in 2013 (Seoul Metropolitan Government, 2014). Moreover, our findings showed that the average income loss of EFF during the transition period accounted for about 40% of the aggregate WTP for water quality. This means that the aggregated WTP might fully cover the income loss by agricultural production reduction in the whole highland farm area of the upstream watershed.

Using a double bounded dichotomous choice elicitation format, we methodologically attempted to have more efficient WTP measures than single bounded format in CVM. We determined that CVM analysis provides flexibility and has a capacity for estimating economic values of all types placed on environmental assets. However, CVM is still developing to obtain more reliable estimates which depend on hypothetical situations in questionnaire design. Choice experiment method (CPM) is considered as an alternative stated preference design in parallel with CVM analysis and as a relatively new concept in stated preference techniques. Thus, the work from paper 2 is extended to the idea of paper 3, which attempts to use the CPM.

The work in paper 3 focused on understanding both upstream and downstream households' preferences for water quality improvements through change in farming techniques along Soyang watershed using choice experiment method. The results of a basic CLM and CLM with interactions were compared to measure more accurate MWTP and examine the preferences of the upstream farmers and downstream water users. In the basic

CLM model, coefficients of agricultural profit and water quality were positively and statistically significant while the variable biodiversity was not statistically significant. This might reflect the stronger concern about water quality preservation, but is inconsistent with results showing the importance of biodiversity level (Khai and Yabe, 2014).

The result of the model with two-way interactions incorporating income levels implied the *water quality* is an important factor on the choice option of respondents of all income levels. This is consistent with the existing studies indicating consumers place a high value on maintaining a clean water supply (Willis et al., 2005). The results with three-way interactions implied that upstream and downstream respondents in low and middle income levels tend to prefer increases in water quality of the Soyang watershed. It implies that the respondents are prone to significant concern about the water quality in economic characteristics and districts affecting the water quality of Soyang watershed. This is in line with the results showing importance of socio-economic determinants in heterogeneous choice of respondents (Blazy et al., 2011, Yamada et al., 2009).

Methodologically, an empirical application of CPM in paper 3 was to state both upstream farmers' and downstream consumers' preferences for environmental quality changes. In terms of welfare estimates based on choice behavior, the empirical analysis of CPM is consistent with that of CVM from paper 2. Both applications involved the influence on water quality changes arising from agricultural management practices. In contrast with CVM, the main difference of CPM was the use of various environmental attributes in an experimental design which creates repeated choices between bundles of provided attributes. Thus, the work of paper 3 showed that CPM differs from CVM by using choice sets and providing different levels for environmental quality changes. Considerable differences between CPM and CVM were found between estimated values for the water quality changes through agricultural management practices. The application of CPM were successfully demonstrated by comparing the use of CVM, which offers environmental quality changes in total, rather than for each level in questionnaire design.

## 1.5. Conclusions and research outlook

*Conclusion*

The applied financial analysis and multinomial logistic regression identified the key factors affecting farmers' choice regarding the adoption of farming techniques. The results implied that financial reasons such as economic benefits and incentives are the main determinants affecting farmers' decision making on the adoption of farming techniques. These results showed economic rationale in farmers' decision making process based on input-based survey data. However, these results seem to be insufficient in integrated valuation of ecosystem services toward sustainable ecosystem-based management. In the context of farmers' decision-making in sustainable land use planning, nonmonetary valuation methods in psychological theories, such as the theory of planned behavior, would be needed to examine how farmers perceive their farm management and environmental benefits.

Despite the requirement of additional information about farmers' decision making, economic incentives can be expanded to a financial reward through payments for ecosystem services in agriculture on a catchment-wide scale. Thus, in the concept of payments for ecosystem services, the application of CVM addressed downstream consumers' preferences and behavior concerning water quality improvement through the adoption of environmentally friendly farming. Moreover, upstream farmers' income losses during transition periods were investigated to contrast with the estimates of willingness to pay for the water quality improvement.

These results from the paper 2 indicated assigned benefits from water ecosystem services can be invested in water quality conservation combined with agricultural practices. In addition, we found that the downstream consumers who recognize the label for EFF products and who intend to purchase EFF products in the future have a considerable influence on the willingness to pay for water quality improvement through the OLS analysis. In this regard, with emphasis on their dual roles in environmental stewardship and agricultural development, the application of contingent valuation method considering both upstream farmers' and downstream consumers' approaches could be essential in further researches.

In addition, choice experiments identified the differences of preferences between individuals with greater clarity in terms of income levels and different local communities (upstream farmers/downstream consumers). These results from paper 2 and 3 could strongly contribute to environmental policy making related to water resource management, providing an importance for water quality protection combined with land use planning. In stated preference techniques, CVM and CPM are to elicit individuals' willingness to pay and preferences using a survey. With this common feature, the work from paper 2 and 3 showed that both methods have different features with respect to presentation of the hypothetical scenario that provides respondents with information by using both methods. However, in the scope of this thesis, we have only addressed a basic comparison by means of both CVM and CPM. With respect to the specific differences regarding bias or estimates, an empirical comparison handling with problematic aspects between both methods would be helpful to develop stated preference techniques for validity and reliability.

*Summary*

In short, the findings obtained from thesis provide valuable insights for the policy decision making process of sustainable ecosystem-based management.

- Valuation techniques have a long history of use in the ecosystem services field, aimed at the provision of information for policy and investment decisions. They are key components of wiliness to pay studies of environmental quality changes.

- Of the diverse valuation techniques, stated preference techniques have flexibility and practicality, insofar as they are the only technique available in many circumstances. This suggests great potential to combine with the work of ecological modeling as part of the global trend toward integrating ecology and economics.

- Stated preference techniques were provided by showing the relative features of contingent valuation method and choice experiments. The results from this thesis will contribute to the promotion of stated preference technique accessibility.

- The works of paper 2 and 3 highlighted the stated preference approach to valuing environmental quality changes, in particular, water quality changes--within the context of the adoption of environmentally friendly farming. Stated preference techniques seem to be effective for the identification of consumer-based choice and preferences in decision making. Choice experiments could possess potential merit for exploring heterogeneous consumers' preferences in relation to the more traditional contingent valuation method.

- Whereas numerous studies featuring applied stated preference techniques have already focused on either upstream farmers' or downstream consumer's preferences, joint consideration of both sides is still lacking. Thus, this thesis, together with contingent valuation method and choice experiments, was targeted to both upstream farmers and downstream consumers in the scheme of payments for ecosystem services.

- Moreover, in terms of these aspects, the results indicated the importance of dual reciprocal roles between upstream farmers and downstream water users along watersheds in regard to agriculture. The farmers act as suppliers for ecosystem services and producers of agricultural food products, while the water users play a key role as demanders of clean water and consumers of agricultural food products.

- As agricultural land use management practices hinges on farmers' decision-making, it is imperative to identify the main factors affecting farmers' choices on the adoption of farming techniques. As a result of multinomial logistic regression, it found that financial benefit and incentives play a substantial role in farmers' decisions regarding farming techniques.

*Research outlook*

The worthwhile information produced by this thesis could be increased by more advanced further research using stated preferences techniques for sustainable ecosystem management. In stated preferences techniques, a distinct difference between contingent method and choice experiments is the experimental design within the questionnaire. The main controversial issues in stated preference techniques include which method is preferable to a given situation as well as the methodological robustness of the competing methods for producing more accurate estimation. Thus, consideration of these main issues distinctions would be necessary in the application of both methods within the context of ecosystem services.

Additionally, our paper focused on the willingness to pay analysis for water pollution abatement through the adoption of EFF using CVM, with respect to environmental problems related to excessively abundant nutrients. In order to determine more effective policy programs, future studies could be developed by extending the scope to cost-effective conservation practices. A focus on the emerging water quality trading markets, such as transaction costs, trading costs and imposed trading ratios, would be critical in order to account for cost-effective solutions for combating eutrophication of coastal ecosystem in spatial and dynamic management.

Lastly, a key next step to contemplate in further advanced research would be research collaborations of multiple stakeholders in temporal and spatial scales with consideration of various socio-economic characteristics. The results obtained from an empirical case study could be expanded with spatial modeling studies, such as InVEST, GIS, and Agent based modeling in integrated water resource management. The effort to combine coupled biogeochemical models with monetary evaluation methods will represent a valuable step forward in the challenge of meeting the global trend toward interdisciplinary approaches, in particular, the integration of ecology and economics for sustainable ecosystem-based management.

## 1.6. References

Adamowicz, W.L., Louviere, J. J., & Swait, J., 1998. Introduction to Attribute-Based Stated Choice Models, US Department of Commerce, NOAA.

Adamowicz, W.L., Boxall P.C., Williams M., Louviere J., 1998. Stated preference approache s for measuring passive use values: choice experiments and contingent valuation. American J ournal of Agricultural Economics 80(1) 64–75.

Adamowicz, W.L., Boxall, P. C., Haener, M., Zhang, Y., Dosman, D., Marois, J., 2004. An a ssessment of the impacts of forest management on Aboriginal hunters: evidence from stated a nd revealed preference data. Forest Science 50(2) 139–152.

Bateman, I.J., 2007. Valuing preferences regarding environmental change. In: Pretty, J., Ball, A., Benton, T., Guivant, J., Lee, D., Orr, D., Pfeffer, M., Ward, H. (Ed.), The SAGE handboo k of environment and society. Sage, London, 155–171.

Bateman, I.J., Carson, R.T., Day, B., Hanemann, M., Hanley, N., Hett, T., Jones-Lee, M., Lo omes, G., Mourato, S., Ö zdemiroglu, E., Pearce, D.W., Sugden, R., Swanson, J., 2002. Econo mic Valuation with Stated Preference Techniques: a Manual. Edward Elgar Publishing Limite d, Cheltenham.

Bateman, I., Mace, G., Fezzi, C., Atkinson, G., Turner, K., 2011. Economic Analysis for Eco system Service Assessments. Environmental and Resource Economics 48(2) 177-218.

Baumgärtner, S., Quaas, M., 2010. Sustainability economics - general versus specific, and co nceptual versus practical. Ecological Economics 69 2056-2059.

BennettE, J., Blamey, R., 2001. The Choice Modelling Approach to Environmental Valuation. Edward Elgar Publishing Limited, Massachusetts.

Blazy, J.M., Alain C., Alban T., 2011. The willingness to adopt agro-ecological innovations: Application of choice modelling to Caribbean banana planters. Ecological Economics 72 (15) 140-150.

Boxall, P.C., Adamowicz, W.L., Swait, J., Williams, M., Louviere, J., 1996. A Comparison o f Stated Preference Methods for Environmental Valuation, Ecological Economics 18 243–25 3.

Brondizio, E.S., W., G. F, Zografos, C., Kumar, M., 2010. Socio-cultural context of ecosyste m and biodiversity valuation. In: Kumar, P. (Ed.), The Economics of Ecosystems and Biodive rsity Ecological and Economic Foundations. Earthscan, London and Washington.

Daily, G.C., Polasky, S., Goldstein, J., Kareiva, P.M., Mooney, H.A., Pejchar, L., Ricketts, T. H., Salzman, J., Shallenberger, R., 2009. Ecosystem services in decision making: time to deli ver. Frontiers in Ecology and the Environment 7(1) 21-28.

Elmqvist, T., Tuvendal, M., Krishnaswamy, J., Hylander., K., 2011. Managing Tradeoffs in Ecosystem Services. UNEP Division of Environmental Policy Implementation: Ecosystem Services Economics (ESE) Working Paper Series. Paper 4., Stockholm.

Engel, S., Pagiola, S., Wunder, S., 2008. Designing payments for environmental services in theory and practice: An overview of the issue. Economics 65 663-674.

Farley, J., 2012. Ecosystem services: The economic debates. Ecosystem Services 1 40-49.

Gómez-Baggethun, E., de Groot, R., Lomas, P. L., Montes, C., 2010. The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes. Ecological Economics 69(6) 1209-1218.

Halpin, D., Brueckner, M., 2004. The retail pricing, labelling and promotion of organic food in Australia. The Australian organic industry. A profile; Department of Agriculture, Fisheries, and Forestry, Canberra, Australia.

Jánský, J., Živělová, I., 2007. Subsidies for the organic agriculture. Agricultural Economics Czech 53(9) 393–402.

Karki, L., Schleenbecker, R., Hamm, U., 2011. Factors influencing a conversion to organic farming in Nepalese tea farms. Journal of Agriculture and Rural Development in the Tropics and Subtropics 112(2) 113–123.

Khai, H.V., Yabe, M., 2014. Choice modeling: assessing the non-market environmental values of the biodiversity conservation of swamp forest in Vietnam. International Journal of Energy and Environmental Engineering 5(1) 77.

Kim, C.-G., Jeong, H.-K., Moon, D.-H., 2012. Production and Consumption Status and Market Prospects for Environment-Friendly Agri-foods; Korea Rural Economic Institute (KREI): Seoul, Korea, (In Korean).

Koellner, T., Sell, J., Navarro, G., 2010. Why and how much are firms willing to invest in ecosystem services from tropical forests? A comparison of international and Costa Rican firms. Ecological Economics 69(11) 2127-2139.

Kristiansen, P., Merfield, C.H., 2006. Overview of organic agriculture. In Organic Agricultur e: A Global Perspective; Kristiansen, P., Ed.; CSIRO: Clayton South, Australia, pp. 1–19.

Lapar, M.L.A.; Ehui, S.K., 2004. Factors affecting adoption of dual-purpose forages in the Philippine uplands. Agricultural Systems 81(2) 95–114.

Liu, S., Costanza, R., Farber, S, Troy, A., 2010. Valuing ecosystem services: theory, practice, and the need for a transdisciplinary synthesis. Annals of the New York Academy of Sciences 1185 54-78.

MA, 2005. Millennium Ecosystem Assessment. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

Machado, F., Mourato S., 1999. Improving the assessment of water related health impacts: evidence from coastal waters in Portugal, CSERGE Working Paper GEC 99-09.

Menozzi, D., Martina F., Michele, D., 2015. Farmer's motivation to adopt sustainable agricultural practices. Bio-based and Applied Economics 4 125–147.

Morrison, A., Aubrey, W., 2010. Payments for Ecosystem Services Literature Review: A review of lessons learned, and a framework for assessing PES feasibility, World Wildlife Fund for Nature (WWF).

Hanley, N., Mourato, S., Wright R.E., 2001. Choice modelling approaches: a superior alternative for environmental valuatioin?. Journal of Economic Surveys 15 (3), 435-462.

Nguyen, T.T., Hoang, V.-N., Seo, B., 2012. Cost and environmental efficiency of rice farms in South Korea. Agricultural Economics 43 369–378.

Nguyen, T.T., Tenhunen, J., 2013. Review of integrated ecological-economic analyses for bioenergy plants under climate change at local scale. International Journal of Climate Change Strategies and Management 5 324-343.

Reid, W.V., Berkes, F., Wilbanks, T.J., Capistrano, D., 2006. Introduction. In: Reid, W.V., Berkes, F., Wilbanks, T., Capistrano, D. (Eds.), Bridging Scales and Knowledge Systems: Concepts and Applications in Ecosystem Assessment. Island Press, Washington, 1-20.

Rode, J., Wittmer, H., Emerton, L., Schröter-Schlaack, C., 2016. "Ecosystem service opportu nities": A practice-oriented framework for identifying economic instruments to enhance biodi versity and human livelihoods. Journal for Nature Conservation 33 35–47.

Secretariat of the Convention on Biological Diversity, 2010. Global Biodiversity Outlook 3. Montréal, Canada.

Seoul, 2014. Seoul Statistical Yearbook, Seoul Metropolitan Government. Available online: h ttp://ebook.seoul.go.kr/Viewer/ZV975O62TBCW (accessed on 31 January 2017).

Smith, S., Rowcroft, P., Everard, M., Couldrick, L., Reed, M., Rogers, H., Quick, T., Eves, C., White, C., 2013. Payments for Ecosystem Services: A Best Practice Guide. Department for E nvironment, Food and Rural Affairs, London.

Tavoni, A. Levin, S., 2014. Managing the climate commons at the nexus of ecology, behavio ur and economics. Nature Climate Change 4(12), 1057–1063..

TEEB, 2008. The economics of ecosystems and biodiversity - an interim report, available at www.teebweb.org, accessed 3 March 2017.

Tiwari, K.R., Sitaula, B.K., Nyborg, I.L., Paudel, G.S., 2008. Determinants of Farmers' Adop tion of Improved Soil Conservation Technology in a Middle Mountain Watershed of Central Nepal. Environmental Management 42 210–222.

Turkelboom, F., Thoonen, M., Jacobs, S., García-Llorente, M., Martín-López, B., Berry, P., 2 015. Ecosystem services trade-offs and synergies (draft). In: Potschin, M. and K. Jax (eds): O penNESS Reference Book. EC FP7 Grant Agreement no. 308428.

Turkelboom, F., Thoonen, M., Jacobs, S., García-Llorente, M., Martín-López B., Berry, P., 2016. Ecosystem services trade-offs and synergies (draft). In Potschin M. and Jax K, (eds) OpenNESS Ecosystem Services Reference Book. EC FP7 Grant Agreement no. 308428. Available via: www. openness-project.eu/library/reference-book.

Adamowicz, W.L., 2004. What's it worth? an examination of historical trends and future directions in environmental valuation. Australian Journal of Agricultural and Resource Economics 48 (3) 419-443.

Weir, S., Knight, J., 2000. Adoption and diffusion of agricultural innovations in Ethiopia: the role of education. Centre for the Study of African Economies working paper 2000-5. Institute of Economics and Statistics, University of Oxford, Oxford, UK.

Whitehead, J.C., Pattanayak, S.K., Van Houtven, G.L., Gelso, B.R., 2008. Combining revealed and stated preference data to estimate the nonmarket value of ecological services: An assessment of the state of the science. Journal of Economic Surveys 22(5) 872-908.

Willis, K.G., Scarpa, R., Acutt, M., 2005. Assessing water company customer preferences and willingness to pay for service improvements: A stated choice analysis, Water Resources Research 41(2) 1-11.

Yamada, K., Sato, M., Nakamoto, Y., 2009. Measurement of Social Preference from Utility-Based Choice Experiments. ISER Discussion Paper 0759, Institute of Social and Economic Research, Osaka University.

# Chapter 2: Conventional, Partially Converted and Environmentally Friendly Farming in South Korea: Profitability and Factors Affecting Farmers' Choice

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## 2.1. Abstract

While organic farming is well established in Europe a nd USA, it is still catching up in Asian countries. The government of South Korea has implemented environmentally friendly farming that encompasses organic farming. Despite the promotion of environmentally friendly farming, it still has a low share in South Korea and partially converted farming has emerged in some districts of South Korea. However, the partially converted farming has not yet been investigated by the government. Thus, our study implemented a financial analysis to compare the annual costs and net returns of conventional, partially converted and environmentally friendly farming in Gangwon Province. The result showed that environmentally friendly farming was more profitable with respect to farm net returns. To find out the factors affecting the adoption of environmentally friendly farming, multinomial logistic regression was implemented. The findings revealed that education and subsidy positively and significantly influenced the probability of farmers' choice on partially converted and environmentally friendly farming. Farm size had a negative and significant relationship with only environmentally friendly farming. This study will contribute to future

policy establishment for sustainable agriculture as recommended by improving the quality of fertilizers, suggesting the additional investigation associated with partially converted farmers.

**Keywords:** environmentally friendly farming; partial conversion; economic benefits; decision-making

## 2.2. Introduction

Agriculture creates benefits for humans by providing fiber, food and fuel. However, intensively managed farms have increased various adverse effects including soil degradation, biodiversity loss, water pollution and agro-chemical pollution. Due to heavily managed intensive farming targeting yield maximization, environmental concerns over negative externality of agricultural production have been increasing. Therefore, sustainable agriculture has been developed as the alternative under conservation of environmental quality and the scarcity of natural resources. One of the alternatives can be several advanced farming management practices such as organic, environmentally friendly and partially converted and low-pesticides farming.

Organic farming is one of the most widespread farming techniques that balance social, economic and environmental sustainability. Although there are many definitions of organic farming [1], it is generally defined that it avoids the use of synthetic chemical fertilizers and pesticides, and regulates the application of agriculture practices [2,3]. Organic farming emphasizes ecological processes, human health and renewable resources adapted to the local agricultural system [4]. Despite the contentious issue on economic and environmental effects, organic farming has the potential to reduce environmental pollution [5–7], with higher farm household income and benefits to rural economies [8,9]. Moreover, in response to consumer demand for healthy food products, many farmers are converting their production method from conventional to organic farming [10].

In contrast with other developed countries like those in the European Union, which have adopted strict organic farming, the government of South Korea has adopted environmentally friendly farming since 1999. Due to the more flexible regulations than those supporting organic farming in the European Union, environmentally friendly farming in South Korea includes organic, no-pesticide and low-pesticide farming [11]. While the use of chemical fertilizers and pesticides of organic farming is forbidden like in other developed countries, the no-pesticide farming standard in South Korea allows the use of a certain level of chemical fertilizers. The low-pesticide farming allowed the use of both a certain level of chemical fertilizers and synthetic pesticides was abolished in 2015. The government of South Korea has implemented a long-term plan to promote environmentally friendly farming since 2000. The plan aimed to extend cultivated areas, to decrease the synthetic chemical inputs such as fertilizers and pesticides and to expand the organic products market [12]. This plan increased certified areas of environmentally friendly farming up to 172,674 ha cultivated by 160,628 farm households in 2011. These produced and supplied 1,819,228 tons of environmentally friendly agricultural products in 2011. The main cultivated products of environmentally friendly farming were vegetables (38.5%), fruits (23.8%), and cereal crops (22.3%). The area of environmentally friendly cultivation was approximately 10% in 2011 [12]. However, organic agricultural area was only about 1.1% in 2011 (Table S1), still accounting for a small proportion [11]. This is similar to the global organic agricultural land, accounting for approximately 1% [13]. Although North America, Africa, and Asia are lagging behind Europe and Latin America that are leading the growth of organic farming, the proportion of land cultivated using organic farming method is still low all over the world [13].

In the context of the low adoption rate of organic farming all over the world, considerable research attention has been paid to economic differences between conventional and organic farming [7,14]. The differences between net returns and costs analyzed by previous studies show that organic farming can be profitable [15,16]. Considering higher willingness to pay for organic products and the price premium paid by consumers [8,17], organic farming is more financially lucrative than conventional farming [18,19]. The majority of previous studies examined the driving forces leading to organic farming in conjunction with biophysical, institutional, socio-economic and political factors influencing farmers' choices [20–23]. In South Korea, a number of studies have contributed to the development of environmentally friendly farming including organic farming in the context of the production, consumption and distribution for environmentally friendly farming [24–26].

Furthermore, in South Korea, through only our field survey, it was observed that partially converted farmers existed. Partially converted organic farming has emerged in some countries, however, it is not allowed in some other countries which require compliance with rigorous regulations for organic farming in the various developmental paths [27]. The partially converted farming is defined so that farmers can decide to use only part of their land for organic production [28]. In other words, the partially converted farmers are using both conventional and environmentally friendly farming practices according to their own choices. They can become completely organic farmers in the near future, but are starting by implementing some organic practices now. Consequently, their farms are less than "half-organic". While previous studies shed light on the profitability of different types of farming, including partially converted farming in Europe and Canada [28,29], less is known for Asian countries. Only some studies in this important world region focus on environmentally friendly or organic farming [30,31] and the issue of partially converted farming is not yet covered. The missing differentiation between fully and partially converted organic farming is certainly a limitation of current empirical studies on organic farming [8].

Therefore, the first objective of our research was to identify the profitability among different farming techniques; i.e., conventional farming (CF), partially converted farming (PCF) and environmentally friendly farming (EFF), hereafter abbreviated with CF, PCF and EFF respectively. The second objective was to examine the key factors influencing the adoption of farming techniques in South Korea. This paper draws crucial conclusions based on a detailed discussion of the financial analysis with descriptive statistics and multinomial logistic regressions. The findings and policy recommendations can make valuable contributions to development of policies to promote organic farming in South Korea and other Asian countries.

## 2.3. Methods

### 2.3.1. Study area and background

This study was conducted in the Soyang catchment of Yanggu-Gun (Nam-Myeon, Yanggu-Eup and Haean-Myeon), Inje-Gun (Girin-Myeon, Nam-Myeon, Buk-Myeon, Sangnam-Myeon, Seohwa-Myeon and Inje-Eup) and Hongcheon-Gun (Nae-Myeon) in Gangwon Province, South Korea (Figure 2.1b). The study site was selected based on consideration of the low adoption level of organic farming in South Korea, as well as the potential hazard of water pollution within Soyang watershed from intensively managed practices in the Gangwon Province of South Korea. The Gangwon Province in South Korea plays a key role in protecting the water quality of the upper Soyang watershed, which provides water supplies to downstream residents of several, densely populated cities of South Korea. Accordingly, EFF has been promoted in the Gangwon Province, to improve the water quality in Soyang watershed, which comprises environmentally sensitive area. Despite the promotion of environmentally friendly farming by the local and central government, water quality issues coming from intensive farming activities in the area have been continued. Therefore, based on the low adoption rate of EFF and the desired reduction of water pollution from CF, we selected the main environmentally sensitive area, the three districts in Gangwon Province of South Korea as our study area.

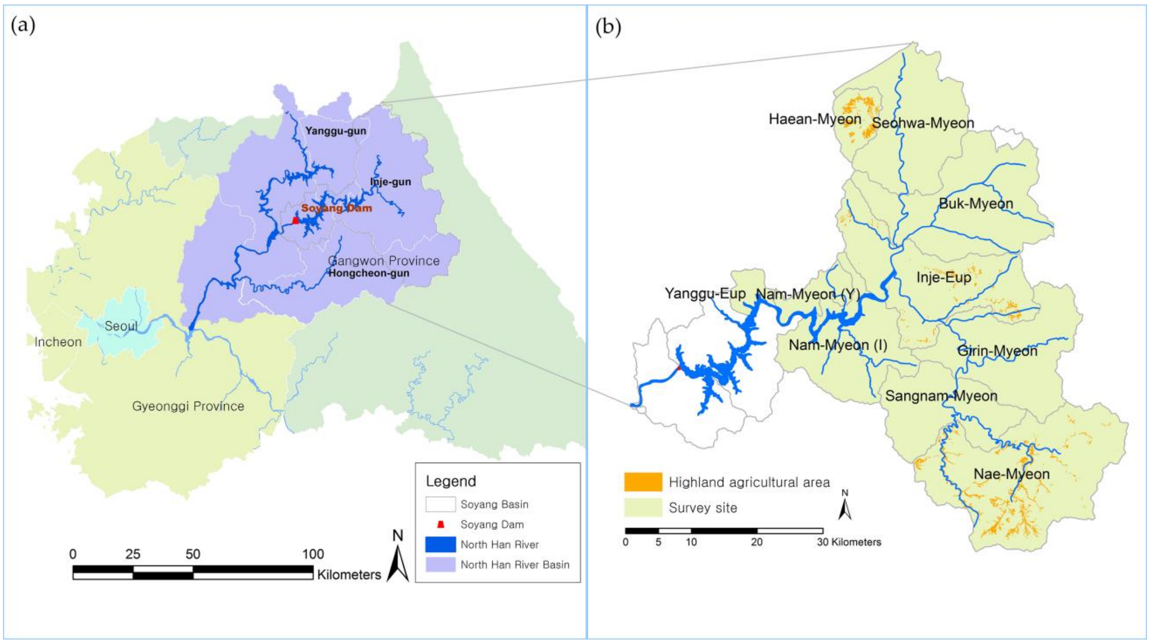


Figure 2.1: Location map of: (a) Soyang watershed in Gangwon Province; (b) three districts showing highland agricultural area.

The Gangwon Province of South Korea, which includes the catchment of the three districts, is located in the mountainous northeastern part of South Korea (latitude 37°02'N–38°37'N and longitudes 127°05'E–129°22'E). The Gangwon Province occupies around 20,569 km$^2$. The total agricultural area of the province was 109,496 ha which consists of rice paddies (41,086 ha) and field land (68,410 ha). The total population of farmers in the provin0ce was 191,922 in 2011 [32]. In 2011 the average farm size, from a total of 71,687 farm households in Gangwon Province, was 1.5 ha per farm, of which 0.57 ha was occupied by rice and 0.95 ha of field land, respectively. As of 2011, the total EFF cultivated farmland was 7,962 ha with 5,854 EFF farm households in this province; organic was 1,976 ha and 1,093 farm households, no-pesticide was 4,899 ha and 3,561 farm households, low-pesticide was 1,088 ha and 1,200 farm households [32]. The certified EFF area accounted for only about 4.6% of the whole of the certified areas in South Korea [26].

For this study, the three areas were selected within the watershed of Soyang Lake in Gangwon Province (Figure 2.1a). The Soyang watershed (2,694.35 km$^2$) is the largest reservoir and tributary located North of the Han River in South Korea. The watershed is important as one of the main drinking water sources of Seoul, capital of South Korea, and other metropolitan areas in South Korea. The residents in the downstream area of the watershed utilize the water resource overwhelmingly due to high population density of the capital area that shared 48.3% of the country's population in 2011. In other words, the water pollution in surrounding environmentally sensitive areas, especially in the selected area, is seriously affected by intensive farming, and can seriously damage fresh drinking water use of the citizens.

During the 2006 monsoon period, the water quality was seriously reduced brought by Typhoon "EWINER", resulting in high levels of turbidity (328NTU (Number of Transfer Units)), which was nearly four times the turbidity level observed the previous year. At that time, the sediment yields (865,062 ton/year) within the watershed were substantially higher from agricultural practices in the mountainous area. In order to protect the water quality of the Soyang watershed for the province, since 2006, selected areas have been designated as initial nonpoint pollution source management areas, with the aim of reducing sediment yields from agricultural practices in the mountainous areas of South Korea [33].

The three major regions causing the water quality problem from farming activities accounted for about 82.7% of the watershed in Gangwon Province [33]. The main areas of the Soyang watershed affecting from agricultural practices were Yanggu-Gun (146.44 $km^2$), Inje-Gun (1678.48 $km^2$) and Hongcheon-Gun (447.83 $km^2$). The landscape of the catchment area is dominated in highland regions by upland fields. Out of the total highland farmland area (7313 ha) of South Korea, the majority of the highland upland areas were found in Yagngu-Gun (143.97 $km^2$), Inje-Gun (1636.32 $km^2$) and Hongcheon-Gun (447.51 $km^2$) of the Province [33]. Regarding the water pollution associated with farming activities, the crucial problem identified was over-use of pesticides and fertilizers on steep slopes and at relatively high altitudes [34–36]. The main crops cultivated in the mountainous area were Chinese cabbage and radish, which rely heavily on chemical fertilizers and pesticides. In these areas, intensive agricultural practices with high concentrations of phosphorous and nitrogen, led to eutrophication of the reservoir [37,38]. This negatively affected the habitat of endangered species in the aquatic ecosystems of the watershed. Considering that the adverse effects could appear occasionally, although stable drinking water quality has been maintained in South Korea, there is potential for degradation of water quality from intensively managed farming activities still remaining in the districts during monsoon climate.

### 2.3.2. Sampling of farm households and data collection

Data were collected by face-to-face interviews. The survey period was between 19 March 2012 and 6 April 2012. The lists of residential farmers were received from local leaders and governmental staff after focus group meetings. During a pilot survey, we found that partially converted farmers existed between conventional and environmentally friendly farmers. Thus, stratified random sampling was selected from two farming techniques (CF and EFF) to three farming techniques (CF, PCF, and EFF). The sampling was applied to draw an estimated 7% sample size based on total population of farmers in three regions, due to time and budget constraints. Before the main survey of farm households, we contacted the farmers in the list by phone to check their production method and arrange the interviews from the contact lists. In addition, after the survey, in order to obtain more exact information on the survey, a gift was offered to the participants. Due to no responses and outliers in the key questions (Figures S1–S4), 218 farm households' interviews were analyzed from a total of 224 interviews. The data consisted finally of 85 conventional farmers, 65 partially converted farmers and 68 environmentally friendly farmers.

For the questionnaire, a pilot survey was carried out in order to check accuracy of the questionnaire and modify sentences to avoid misunderstanding. Through discussions with heads of the local farm households and governmental staff that were responsible for EFF, a semi-structured questionnaire was constructed. Based on feedback from the pilot survey with trained interviewers, a final questionnaire was completed. All data were investigated based on their farming activities in 2011, a year previous to the survey period. In order to compare more reliable financial profitability by farming techniques, data related to livestock were excluded from the survey. The questionnaire included farm size and number of cultivated crops in arable areas. The farmers were asked about their financial returns such as agricultural revenue and subsidies, as well as their cultivation costs, including expenditures for labor, seeds, installation and management of green houses, fertilizers, pesticides and agricultural machines. The final part of the survey collected socio-economic information of the farmers such as their age, education and farming experience.

### 2.3.3. Analytical framework for data analysis

Descriptive statistics were used to give basic information on farm households. The descriptive indicators were average values with standard deviation and frequency, which applied as independent variables in dummy or mean values of multinomial logistic regression. In addition, financial analysis was carried out to compare costs and profits among the three farming methods. The calculation is specified by the following formula: The total benefit (E) = total revenue (B) − total costs (A) + total supported subsidy (D) (Tables 2 and 3). All costs included labor, land rent, mechanical operations, installation, management and maintenance in 2011. The farmers' net returns determined by the costs were calculated based on the revenue and subsidies obtained in 2011.

In our study, a multinomial logistic regression model was used to analyze the influence of socio-economic characteristics of farm households on different farming techniques. Multinomial logistic regression is an extended binary logistic regression model that has more than two categories of unordered outcome variables. The multinomial logistic model was estimated using normalization with one category, which is regarded as the "base category." In this study, the explanatory variable took different from one to three depending on their farming techniques. CF was used as the base category, which took one in the model. PCF took two in the explanatory variable and environmentally friendly farmers, which took three in the explanatory variable. There are several factors leading to choice decisions in the context of socio-economic background, and what we are interested in lies in the effect of each explanatory variable on individual outcomes. Therefore, we considered seven independent variables; age, education, labor of farm household, farm size, ownership, net return, and subsidy, which were simultaneously hypothesized as vital factors for the farmers' decisions.

Thus, the outcome variable can take on the variables, $j = 1,2,3, \cdots j$, with $j$, a positive integer. The model explains the probability of CF ($j = 1$) or PCF ($j = 2$), EFF ($j = 3$). The determinants associated with each category can be contrasted with the base category, which is CF in this study. In addition, this is to find out ceteris paribus changes in the elements of that affect the response probabilities, $\mathrm{p}(y_i = k|x_i) = \frac{\exp(\beta_k x_i)}{\sum_{j=1}^{J} \exp(\beta_j x_i)}, j = 1, 2,3, \dots, J$, where $k$ is one of the sub-groups and $\mathrm{P}(y_i = k)$ is the probability that the farmer belongs to the subgroup and where $x_i$ describes farmer characteristics. In order to identify this model, constraints for the assumptions must be applied. A common approach is to assume that $\beta_1 = 0$ [39]. This normalization makes it possible to identify the coefficients relative to the base outcome. Applying the constraint, the model can be written as:

$$\mathrm{p}(y_i = k|x_i) = \frac{\exp(\beta_k x_i)}{1 + \sum_{j=2}^{J} \exp(\beta_j x_i)}, for\ K > 1$$
$$\mathrm{p}(y_i = k|x_i) = \frac{1}{1 + \sum_{j=2}^{J} \exp(\beta_j x_i)} \tag{1}$$

The multinomial logit model utilizes maximum likelihood estimation to evaluate the probability of a categorical group using the following equation:

$\mathrm{L}(\beta_2, \dots, \beta_j | y, X) = \prod_{k=1}^{j} \prod_{y_i = k} \frac{\exp(\beta_k x_i)}{\sum_{j=1}^{J} \exp(\beta_j x_i)}$, where $\prod y_i = k$ is the product over all cases for which $y_i = k$ [40]. Coefficients are interpreted using the relative risk ratios, which is the relative probability of $y_i = k$, for k > 1. The relative risk ratio is calculated without reference to the remaining two groups, PCF and EFF. This shows the underlying assumption that the model has independence from irrelevant alternatives which is regarded as binary independence [40,41]. Although statistical tests are available to confirm this proposition, the use is not recommended due to unreliable test results [42,43]. Thus, based on the recommendation by Amemiya [44], a multinomial logistic model was selected among three types of farming techniques. Overall, the model helps to indicate significant differences between PCF and EFF in the study area, relative to CF. The utilized data were analyzed by IBM SPSS statistics. The parameter estimates for the vectors that maximize the log likelihood function can be achieved [45]. Relative risk ratios, meaning probabilities of choice, can be calculated from Equation (2):

$$\frac{\partial P_{iy}}{\partial x_i} = P_{ij}\left[\beta_j - \sum_{k=1}^{J} P_{ik}\beta_{k0}\right] \text{ for } J = 1,2,\ldots J \tag{2}$$

Applying Equation (2), we can observe changes in probabilities for their choice in farming techniques due to a small change in one of the farmers' characteristics, when all other independent variables are fixed [46]. The relative risk ratios for the multinomial logistic model were obtained by exponentiation of the coefficient. The exponent of the coefficients are commonly interpreted as odds ratios like logistic regression models and regarded as a marginal effect. The interpretation of the relative risk ratios is for a unit change in the predictor variable The relative risk ratio of base outcome relative to the reference group is expected to change by the factor of a respective parameter estimate, given the variables in the model are held constant.

Based on the findings of earlier studies, our study hypothesized that social and economic characteristics of farmers can be fundamental components in the adoption of farming practices. The age of farmers plays a significant role on the farmer's decision regarding conversion because younger farmers are expected to be more progressive and accepting of new farming techniques relative to older farmers [22,47]. The level of education is considered as an influencing factor. This is because well-educated farmers are more likely to utilize new advanced technologies efficiently and recognize the benefits for agricultural practices [48,49]. Farm size plays a crucial role in the conversion to EFF in terms of costs and benefits. Furthermore, higher costs of labor and time are inevitable during the conversion process [50,51]. Land ownership can be an advantage in terms of reducing the land rent cost [52]. As subsidies affect the profitability of EFF [53–55], farm net returns have also been identified as a key driver of the conversion to EFF [56,57].

Therefore, it is expected that the sign on the age variable will be negative because older farmers may set their sights on investments for farming activities over a short period of time. Education level is expected to have a positive influence on the adoption of EFF. The higher the education, the higher the probability that farmers may consider the benefits from EFF practices to recoup their costs and reap their future profits. The variable farm size was expected to have a negative sign due to the risk of income loss during the transition period and higher labor costs to convert farming techniques to EFF. The expected sign of the variable labor is negative. This is because labor is associated with additional costs and investments in the long term. Land ownership is expected to have a positive impact on the conversion to EFF in terms of fixed costs for farm management. It is clear that higher benefits were hypothesized to be positively associated with adoption of EFF. Obtaining a subsidy was perceived as a positive economic factor that affects farmers' choice on converting to EFF.

## 2.4. Results

The characteristics of the 218 farmers among three types of farming techniques are presented in Table 2.1. The general characteristics of the farmers are shown by descriptive statistics and the results of the one-way ANOVA. In regards to education, EFF farmers had the highest education level, with 17.6% university alumni and 25% high school graduates. The average farm size for CF was 3.4 ha. The average farm size for PCF was 4.0 ha, which included farmland area of 63.8% CF and 36.2% EFF. EFF occupied an average farm size of 2.3 ha, approximately half of the total PCF cultivated area. The age of farmers was homogenously distributed between the three groups. The group of CF was on average 55.7 years, whereas the group of partially converted farmers was on average 52.5 years old. The environmentally friendly farmers were on average 54.3 years of age. CF and PCF farmers had similar farming experience while EFF farmers had less farming experience. With respect to the EFF experience, environmentally friendly farmers had been doing EFF for nine years, about three years more experience compared to partially converted farmers. The average number of cultivated crops for PCF farmers was 5.4 ha with a range of 2–9 crops in both farming techniques. CF and EFF had similar crop numbers (3.4 and 3.8 crops, respectively). The findings of the ANOVA analysis showed that the three farming techniques differ significantly in their farmland size (F (218) = 4.5, $p$ < 0.10)) and average number of cultivated crops (F (218) = 22.5, $p$ < 0.01)). The distribution of main crops among the three groups is shown in Table S2.1 of appendix.

Table 2.1**:** Descriptive statistics of characteristics of farm types.

| Characteristics | Description (Unit) | Conventional Farming CF (N: 85) | Partially Converted Farming PCF (N: 65) | Environmentally-Friendly Farming EFF (N: 68) | Total (N: 218) | |
|---|---|---|---|---|---|---|
| Education | Primary School (%) | 38.8 | 23.1 | 26.5 | 30.3 | |
| | Secondary School (%) | 35.3 | 29.2 | 30.9 | 32.1 | |
| | High School (%) | 22.4 | 41.5 | 25.0 | 28.9 | |
| | University (%) | 3.5 | 6.2 | 17.6 | 8.7 | |
| CF | Area under management (%) | 100 | 63.8 | NA | 35.3 | |
| EFF | Area under management (%) | NA | 36.2 | 100 | 23.3 | |
| | | Mean(Std. Dev.) | | | | F-value [a] |
| Farm size | (ha) | 3.4 (3.8) | 4.0 (4.2) | 2.2 (1.8) | 3.2 (3.5) | 4.5 * |
| Age | (Years) | 55.7 (10.2) | 52.5 (7.9) | 54.3 (9.4) | 54.3 (9.3) | 2.3 |
| Farm experience | (Years) | 29.7 (14.1) | 29.0 (11.2) | 25.9 (14.4) | 28.3 (13.4) | 1.6 |
| EFF practices | (Years) | NA | 6.1 (5.0) | 9.1 (5.4) | 7.6 (5.4) | NA |
| Average number of crops | (N) | 3.4 (1.4) | 5.4 (1.8) | 3.8 (2.2) | 4.1 (2.0) | 22.5 *** |

[a] Generated from one way ANOVA; * Statistical significance at the 10% level; *** Statistical significance at the 1% level.

Table 2.2 presents the results on differences for annual average costs and benefits per farm. PCF had the largest average costs per farm with most expenditure for farm management. CF had no big difference with PCF for land rental costs. EFF had the lowest land rental costs of 1.37 million KRW and fertilizer costs of 3 million KRW. Regarding the average cost of labor, PCF had the largest wage cost of 14.70 million KRW, compared to CF and EFF. PCF had the largest fertilizer expenditure, whereas EFF had the smallest fertilizer expenditure. In terms of cost of pesticides per farm, PCF had higher pesticide expenditures than that of EFF farms. PCF had the largest other costs compared to CF and EFF.

With respect to benefits per farm household, PCF had the largest annual revenues with 61.10 million KRW compared to CF and EFF. However, the EFF net income was the largest with 26.29 million in comparison to CF and PCF. The annual net income of a PCF farm household was the smallest which was similar to CF as the PCF farmers have the highest costs for their farming activities. Although EFF had the largest subsidies from the government or province, the amount of the annual subsidy among different farming techniques had no large difference. The total annual benefit (farm net income plus subsidies) per farm was the largest for EFF, about 1.5 times greater than the benefit of PCF and CF.

Table 2.2: Difference of the three different production modes in annual costs, revenues and total benefits per farm household per year. The numbers display the mean of all farms and in brackets the standard deviation.

| | Conventional Farming CF (N: 85) | Partially Converted Farming PCF (N: 65) | Environmentally-Friendly Farming EFF (N: 68) | Total (N: 218) |
|---|---|---|---|---|
| Costs (10,000 KRW [(a)]/farm household/year) | | | | |
| Land rent | 230 (422) | 233 (475) | 137 (325) | 202 (412) |
| Labor | 942 (1884) | 1470 (1898) | 1084 (1904) | 1144 (1899) |
| Fertilizer | 463 (620) | 649 (715) | 300 (381) | 467 (602) |
| Pesticides | 503 (810) | 545 (808) | 182 (303) | 416 (707) |
| Other costs [(b)] | 874 (1500) | 1390 (1979) | 580 (685) | 936 (1508) |
| Total cost (A) | 3012 (4055) | 4287 (4471) | 2284 (2957) | 3165 (3948) |
| Benefits (10,000 KRW [(a)]/farm household/ year) | | | | |
| Revenue (B) | 4840 (6554) | 6110 (5424) | 4913 (6305) | 5241 (6157) |
| Farm net income (C = B − A) | 1828 (4711) | 1823 (3566) | 2629 (4156) | 2076 (4221) |
| Subsidy (D) | 109 (314) | 119 (261) | 131 (231) | 119 (274) |
| Total benefit (E = C + D) | 1936 (4744) | 1942 (3609) | 2760 (4220) | 2195 (4266) |

[(a)] Unit: 10,000 KRW = 7.56 euro; **[(b)]** Other costs mean extra costs for cultivating crops excepting the above mentioned costs, such as seeding, renting agricultural machinery, etc.

The results of annual average costs and benefits per ha are shown in Table 2.3. Compared to the costs per farm (Table 2.2), the results for costs per ha were somewhat different. The land rental cost per ha was almost the same for CF and EFF. There was no big difference in land rental costs per ha. PCF had the smallest costs for their farmland. Average labor costs per ha were the largest for EFF, which was the highest expenditure compared of all farming techniques. CF had the lowest expenditure for labor costs. Contrary to the result of fertilizer cost per farm, the costs of fertilizer were the largest for EFF. CF had the smallest fertilizer costs and PCF was the largest. In terms of cost of pesticides per ha, CF had the highest pesticide expenditures compared to that of PCF and EFF farms. Regarding other costs, PCF farmers spent the most on other costs, whereas CF farmers spent the least. Thus, total annual cost per ha of EFF was 12.85 million KRW. The EFF farmers had the largest annual costs compared to CF and PCF.

Table 2.3: The result for annual average costs, revenues and benefits standardized per hectare and year. All units are 10,000 KRW/ha·year. The numbers display the mean of all farms and in brackets the standard deviation.

| | Conventional Farming CF (N: 85) | Partially Converted Farming PCF (N: 65) | Environmentally-Friendly Farming EFF (N: 68) | Total (N: 218) |
|---|---|---|---|---|
| Costs (10,000 KRW [(a)]/farm household/year) | | | | |
| Land rent | 50 (68) | 47 (59) | 50 (100) | 49 (77) |
| Labor | 236 (389) | 344 (389) | 410 (610) | 323 (473) |
| Fertilizer | 157 (187) | 195 (203) | 251 (410) | 197 (281) |
| Pesticides | 155 (181) | 144 (160) | 109 (177) | 137 (174) |
| Other costs [(b)] | 303 (431) | 540 (1442) | 464 (680) | 424 (916) |
| Total cost (A) | 901 (862) | 1270 (1564) | 1285 (1322) | 1131 (1258) |
| Benefits (10,000 KRW [(a)]/farm household/year) | | | | |
| Revenue (B) | 1697 (1584) | 2087 (2959) | 2854 (2668) | 2174 (2447) |
| Farm net income (C = B − A) | 796 (1132) | 817 (1764) | 1570 (2183) | 1044 (1735) |
| Subsidy (D) | 57 (216) | 49 (139) | 89 (186) | 65 (186) |
| Total benefit (E = C + D) | 853 (1200) | 866 (1805) | 1658 (2151) | 1108 (1756) |

[(a)] Unit: 10,000 KRW = 7.56 euro; [(b)] Other costs mean extra costs for cultivating crops excepting the above mentioned costs, such as seeding, renting agricultural machinery, etc.

The farming technique with the largest annual revenue per ha was EFF, which made 28.54 million KRW. The annual revenues per ha of CF and PCF were 16.97 million KRW and 20.87 million KRW, respectively. EFF had the highest annual farm net income per ha with 15.70 million KRW. The net income of CF was 7.96 million KRW and the net income of PCF was 8.17 million KRW. In the case of their subsidy per ha, EFF had the largest subsidy, which was 0.89 million KRW. PCF had the lowest amount of subsidy in their farming activities at 0.49 million KRW. Therefore, total annual benefit per ha of EFF was the highest compared to CF and PCF. The difference of the benefits between EFF and other farming techniques was about double. The total benefit of CF and PCF was slightly different, as the total benefits of CF and PCF were 8.53 million KRW and 8.66 million KRW, respectively.

The result of multinomial logistic regression model is presented in Table 2.4. Based on the $R^2$ pseudo statistics and Chi-Square test, this multinomial logistic regression model shows that the estimated model is well fitted and statistically significant at the 1% level. It is important to note that likelihood ratio statistics indicated by $X^2$ statistics (52.57) are highly significant ($p$ = 0.0001), suggesting that this makes the estimates obtained good enough for running this analysis. The Log likelihood value suggests that the model has adequately explained the farmers' choices on farming techniques. In all cases, the estimated coefficients are compared with the base category of conventional farming. Conventional farmers occupied 39.0% of our survey. The partially converted farmers accounted for 29.8%, whereas environmentally friendly farmers accounted for 31.2% of the sample.

Table 2.4: Coefficient estimates and standard errors in parentheses for multinomial logistic regression model.

| Variable | Partially Converted Farming PCF | | Environmentally Friendly Farming EFF | |
|---|---|---|---|---|
| | Coeff. | Std. Error | Coeff. | Std. Error |
| Intercept | −1.212 | 1.293 | −1.760 | 1.306 |
| Age | −0.103 | 0.224 | 0.129 | 0.224 |
| Education (1) | 0.353 * | 0.188 | 0.354 * | 0.190 |
| Farm size | 0.015 | 0.050 | −0.219 ** | 0.104 |
| Labor of farm household (2) | 0.247 | 0.437 | 0.361 | 0.436 |
| Land ownership of land (3) | 0.195 | 0.382 | −0.586 | 0.391 |
| Subsidy (4) | 1.005 *** | 0.356 | 1.649 *** | 0.378 |

| | | | | |
|---|---|---|---|---|
| Farm net income | −0.035 | 0.049 | 0.047 | 0.054 |

Number of observations 218; Pseudo $R^2$: Cox and Snell 0.21; Nagelkerke 0.24; McFadden 0.11; LR $chi^2(12)$ 52.57; Log likelihood −211.65.

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. (1) 0 = no education; 1 = primary education; 2 = secondary education; 3 = high school; 4 = college and university; (2) 0 = farmers who had no farm laborer, 1 = farmers who had own farm laborers; (3) 0 = farmers who rented farmland, 1 = farmers who possess farmland; (4) 0 = farmers who did not receive subsidy, 1 = farmer who received subsidy.

The estimates for PCF and EFF relative to CF were observed differently with positive signs across the groups. The result showed that age, labor of farm household, land ownership, and farm net income were not statistically significant. However, education level, farm size and subsidy were significantly related to the farmers' choice on farming techniques. The coefficient for education level was statistically significant and positively correlated to the probability on PCF and EFF at 10% significance level, relative to CF. Farm size was found to be statistically significant at 5% significance level and positive correlation with the probability of adopting EFF, whereas farm size was not significantly related to the PCF. The coefficient for subsidy was highly significant for both farm groups relative to the base outcome at the 1% significance level. This indicates a strong positive relationship between the subsidy and the likelihood of farmers' adoption of PCF and EFF relative to CF. Therefore, these results show that as farmers' education level and subsidy increase, the likelihood of farmers' choice for PCF and EFF increases. Moreover, as the farm size decreases the probability of farmers' choice on EFF increases.

Table 2.5: The results of marginal effects by multinomial logistic regression model.

| Variable | Marginal Effect (1) | |
|---|---|---|
| | Partially Converted Farming PCF | Environmentally Friendly Farming EFF |
| Age | 0.902 | 1.138 |
| Education | 1.423 * | 1.425 * |
| Farm size | 1.015 | 0.803 ** |
| Labor of farm household | 1.280 | 1.435 |
| Land ownership | 1.216 | 0.556 |

| | | |
|---|---|---|
| Subsidy | 2.733 *** | 5.200 *** |
| Farm net income | 0.966 | 1.048 |

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. (1) Marginal effect means exponentiation of the coefficients which is regarded as odds ratios for the predictors.

The relative risk ratios of the multinomial logistic model are shown in Table 2.5. This result was obtained by the exponential of the coefficients, which provide estimates of the relative risks. The result showed that one unit change in education level had no significant differences between PCF and EFF, whereas relative risk ratios of the variable increased. It was expected that the relative risk of practicing PCF and EFF over CF (base category) increased by Exp. (0.35) = 1.42. If the farmers would increase their education level by one unit, the relative risk for PCF and EFF relative to CF would be expected to increase by the determinants of 1.42, given other variables in the model are held constant. With regard to farm size for their cultivated land, the relative risk ratio for EFF relative to CF would be expected to decrease by a factor of 0.80 given the other variables in the model are held constant. As farm size is negatively related to the EFF, an increase in farm size by one unit reduces the likelihood that a farmers' chose EFF by 80.3%. In addition, the relative risk ratios of the variable subsidy for PCF and EFF were 2.73 and 5.20, respectively. Given a one unit increase in subsidy, the relative risk of having adopted PCF and EFF would be 2.73 times and 5.20 times, respectively, more compared with the CF. This means farmers who received subsidies were more likely to choose PCF and EFF by a factor of 2.73 and 5.20, respectively, as partially converted and environmentally friendly farmers require subsides for the adoption.

## 2.5. Discussion

Organic farming is one of several advanced farming techniques considered to provide environmental benefits and fit within the spectrum of sustainable economic development. In environmentally sensitive areas, organic farming supports water conservation as it reduces the rate of damaging runoff coming from insensitively managed farming. The national government of South Korea has adopted environmentally friendly farming (EFF) in order to move towards sustainable agriculture. The adoption rate of EFF in South Korea is, however, still low as it is in other developed and developing countries. Additionally, the selected area of our study is relative to other regions in South Korea more important with respect to farmers' decision on practices for watershed protection. Historically, during the monsoon period, in the selected area in Gangwon Province, the excess use of chemical fertilizers and pesticides has caused the permeation of these chemicals into surface waters, leading to negative effects on the water quality of the Soyang watershed, a main source of drinking water of South Korea. Thus, in order to identify which farming techniques are profitable and what factors influence farmers' choices, we compared the costs and benefits of various farming techniques and examined socio-economic factors affecting adoption of farming techniques, based on survey data. The findings of this study can contribute to the promotion and development of organic farming in South Korea. In addition, this study can be developed into similar studies in other Asia countries and in environmentally sensitive areas using multi-year data.

### 2.5.1. Environmentally friendly farming in South Korea

In South Korea, agriculture can be generally categorized into conventional farming (CF) and EFF. However, in this field survey, we found that partially converted farming (PCF) is emerging. Accordingly, the survey was conducted with the three types of farming techniques, namely CF, PCF and EFF. Moreover, the study site was a part of the nonpoint pollution sources management areas (Hongcheon-Gun, Inje-Gun, and Yanggu-Gun) within the catchment of the Soyang watershed in Gangwon Province, South Korea. The management area for nonpoint pollution sources was designated to prevent water quality degradation due to eroded soil from agricultural areas in this province. The Soyang catchment of this province has an important role in the supply of potable water for the metropolitan area Seoul. Despite the promotion of EFF by the local authorities and government of South Korea, the Gangwon Province contained a low certified area of EFF. Thus, with the importance of the study sites, this research aimed to identify which farming technique is more profitable by financial analysis and to examine which factors affect the adoption of farming techniques in South Korea using multinomial logistic regression.

### 2.5.2. Cost and benefits of the three farming techniques

The results of the financial analysis showed that the EFF labor costs per ha were higher than CF and PCF. This is in line with previous studies that have shown that organic farming has more labor requirements than CF [9,58]. In our study, fertilizer costs for EFF per ha were higher than for other farming techniques. This finding is inconsistent with the result of Sgroi et al. [59], who found that CF had higher fertilizer costs when compared to organic one. The reason for the higher fertilizer costs in this area might be caused by the use of low quality organic fertilizer, which led not only to less crop production but also caused higher costs. Due to a short history of EFF in South Korea, the adequate production, distribution and quality assurance of organic fertilizer are problematic and tend to increase their production costs [26]. This is in line with the studies of Bernal et al. [60] who mentioned that an increase in yields would require high compost quality and improved quality of organic fertilizer. Therefore, in order to promote the EFF, proper quality and quantity of fertilizers including different nutrients and ingredients should be investigated for the various crop choices reflected in different districts. An alternative way to reduce production costs substantially would be improved soil fertility, by promoting compost and nutrient management strategies. Considering water quality degradation of the catchment from soil erosion and nutrient run-off in this study area, the moderate application of fertilizers, dependent on the local geographical conditions, is required to protect the fresh water quality.

With regard to the benefits, financial net returns per farm and ha of EFF were higher compared to CF and PCF, when considering the total expenses, annual income and subsidies. This is coherent with the results of Kristiansen et al. [61], Delbridge et al. [16], Patil et al. [7] and Salvioni et al. [28] who showed the profitability of organic farming. In the benefit of EFF, the higher revenues per ha might be due to the price premium of the produce. This is consistent with findings of studies which indicated that the higher net returns can be attributed to the premium price of organic products [62,63]. In South Korea, with the certification system of EFF, a price premium incentivizes the farmers into the EFF products market like in other developed countries [64]. The price premium was about 1.2~2.0 times depending on different crop choices [26]. In the study area, we found with the personal interviews, that some farmers had contracts with a big market in the capital city as they guarantee relatively higher selling prices. Therefore, despite higher total costs per ha of EFF, compared to those of CF and PCF, the EFF was more financially attractive in this area with higher price premiums of the products. The results associated with profits in our study area were in contrast with the study by Kim et al. [26] that also surveyed in South Korea in terms of different crops in various provinces; they found that EFF cultivation of rice, vegetable and fruits had higher costs and lower benefits due to a transition period which caused low yields and hence income loss. Even though our work provides a number of interesting results, it should be extended in the future by interviewing more households in different areas of South Korea in different years so that the results can be generalized and are more robust. Thus, we suggest that future studies should survey more data in multiple years.

### 2.5.3. Factors influencing the adoption of Partially Converted Farming PCF and Environmentally Friendly Farming EFF

In our survey, most of the farmers that were interviewed as representatives of their farm households were male. With respect to the education level in our survey, EFF farmers were found to be better educated than the CF and PCF counterparts. Among the three agricultural groups, age differed only little, between one to three years on average. Among the farming techniques, the farming experience between CF and PCF was almost identical while the standard deviation for CF experience was slightly larger than the farming experience of PCF. Regarding the green farming experience, PCF farmers had less experience by about three years, compared with the EFF farmers. Farm size and number of crops were statistically significant as shown by ANOVA. The EFF had the smallest cultivated area, whereas PCF had largest farm size, which is in line with the results of the largest number of cultivated crops in

PCF. PCF farms had a higher cultivated farm area per farm household than the South Korean average (1.23 ha in 2010).

To identify influencing factors determining the three farming techniques multinomial logistic regression (MNL) was used. Before implementing a variance inflation test was implemented to consider the risk of multicollinearity between selected explanatory variables. While the estimates of the parameter in MNL model gives the direction of the effect of predictors on the explanatory variable, the marginal effects in the model offer the actual magnitude of change in probability. Thus, in MNL, we showed the coefficients and marginal effects indicating relative risk ratios (Tables 4 and 5) are significant determinants that have an influence on the likelihood of the farmers' choice on farming techniques. The MNL model included important socio-economic variables such as age, education level, farm size, labor, land ownership, subsidies and net returns per farm household. Although we considered both subsidies and net income in this model simultaneously, the interpretation of the effects of these factors should be done with care, since they might be a causality problem due to an econometric simultaneity issue. The results showed that age, whether or not farmers have laborers and ownership over their farmland, and net farm income were not significantly related to any of the three farming techniques.

However, as expected, education level of farmers was positively correlated to PCF and EFF. This result is hardly surprising as more educated farmers would have acquired the knowledge and would adopt advanced techniques relatively easily. This implied that the higher the education of the farmers, the greater the likelihood that farmers choose to adopt PCF and EFF, by 1.42 times. This finding confirms that of Weir and Knight [48], and Lapar and Ehui [49] who argue that an increase in farmers' education level increases the likelihood of adopting advanced farming techniques.

Moreover, farm size had a negative and significant relationship with EFF. This implies that the farm size decreases the tendency of adopting EFF by 0.80. Our finding supports the previous study by Khaledi et al. [29] who found that farmers with smaller farmland can more easily manage their fields to certified regulations. In addition, relatively small farmlands could be easier to manage within the regulations and standards of organic farming. This is inconsistent with the results of Karki et al. [50], showing that larger farm size is likely to adopt organic farming. This means the larger farm size has the potential for higher costs in labor and inevitable larger income loss during their transition period after they adopt EFF. In addition, according to Padel [65], the conventional and partially converted farmers could adopt organic farming later. The result is in line with Läpple and Rensburg [5] suggesting that larger farms are less likely to adopt organic farming which causes more intensive labor and is associated with higher costs and relatively higher risks.

The variable indicating whether or not farmers receive subsidies had a highly positive influence on the probability of the farmers' adoption of PCF and EFF. As a result of marginal effects of subsidies for PCF and EFF, the relative risk ratio for PCF and EFF relative to CF would be expected to increase by a factor of 2.73 and 5.20, respectively. The result demonstrates that receiving subsidies is the most significant positive influence on farmers' decisions. Moreover, similar studies found a positive relationship between the conversion process as an institutional factor [66,67]. This revealed that the subsidy can be considered as a key factor to encourage farmers to convert to EFF and expand arable land area of EFF [68]. Considering the importance of the subsidy, it should be noted that the direct payment program for EFF in South Korea is important to stimulate the farmers to change their farming techniques to EFF. In order to extend the EFF, the improvement of direct payment program for EFF is required as an incentive for compensating the income loss of environmentally friendly farmers during their transition period. The improvement measure to enhance the program of direct payment could be the unit price adjustment, changes in the payment period and the compensation by crop types [69].

### 2.5.4. Partially Converted Farming PCF in our Study

The results of the characteristics of PCF indicated that the partially converted farmers had the largest farm size and the highest number of crops. Although some PCF farmers went through the transition period in order to adopt EFF and the higher costs for implementing PCF, they continued to practice the PCF. This can play an important role in extending agricultural land of EFF. Therefore, viewed this way, the partially converted farmers in the districts might be considered as a bottleneck in promotion of EFF. Monitoring the developments of the agricultural sector among different types of farming techniques could be a key issue in the promotion policy of the local and national government.

Furthermore, throughout the interviews with farmers in the field survey conducted for this research, we found that partially converted farmers exist. The PCF is not officially recorded by the government as PCF farmers might be normally grouped in CF or in EFF under official data of the government. Therefore, extra studies related with PCF might be needed. Specifically, regarding the PCF, there is still little research on how PCF has developed, how they affect the market and how they influence the decision of other farmers. Accordingly, several questions occur: Can they be considered as a potential barrier to promote EFF, or are they in a transition period towards EFF? How high is the possibility that they return to CF or persevere with PCF? In this respect, PCF is especially important, as these farmers have the potential to compare both farming techniques and output of the sectors.

## 2.6. Conclusions and Policy Recommendations

The process of moving toward sustainability through organic farming has led to the emergence of partially converted farming in South Korea. These new partially converted farmers are not officially recorded and not investigated in South Korea. Partially converted farms could be a potential barrier for promotion of organic farming. Therefore, to extend organic agricultural land area, an up-to-date official database for partially converted farmers including production costs and revenues should be established in each district. In addition, while environmentally friendly farming is more profitable in our study area, the probability of higher costs is still remaining and could be one of the obstacles to extending organic agricultural land. Therefore, the government should provide more detailed support for reducing production costs. In particular, higher fertilizer costs are required in order to invest in improvement of the quality and investigation of the appropriate quality for organic fertilizers. Ultimately, in order to promote compliance with international standards of organic farming, improved measures for enhancing fertilizer management should be implemented by the government. Farmers' choice behavior can be driven by the utility perceived and net benefit from farming techniques. This is beyond the aim of the current study, which has focused on financial profitability and determinants affecting their decisions. Further research would be necessary to investigate farmers' perception and behavior reflecting different local conditions. Considering varying socio-economic characteristics and different factors affecting farming techniques in different regions, research projects on promotion of organic farming would be beneficial to design more targeted policy for sustainable agriculture.

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## 2.8. References

1. Stanhill, G. The comparative productivity of organic agriculture. *Agric. Ecosyst. Environ.* **1990**, *30*, 1–26.
2. Aldanondo-Ochoa, A.M.; Casasnovas-Oliva, V.L.; Arandia-Miura, A. Environmental efficiency and the impact of regulation in dryland organic vine production. *Land Use Policy* **2014**, *36*, 275–284.
3. Argyropoulos, C.; Tsiafouli, M.A.; Sgardelis, S.P.; Pantis, J.D. Organic farming without organic products. *Land Use Policy* **2013**, *32*, 324–328.

4. Stolze, M.; Lampkin, N. Policy for organic farming: Rationale and concepts. *Food Policy* **2009**, *34*, 237–244.
5. Läpple, D.; Rensburg, T.V. Adoption of organic farming: Are there differences between early and late adoption? *Ecol. Econ.* **2011**, *70*, 1406–1414.
6. Leifeld, J. How sustainable is organic farming? *Agric. Ecosyst. Environ.* **2012**, *150*, 121–122.
7. Patil, S.; Reidsma, P.; Shah, P.; Purushothaman, S.; Wolf, J. Comparing conventional and organic agriculture in Karnataka, India: Where and when can organic farming be sustainable? *Land Use Policy* **2014**, 37, 40–51.
8. Uematsu, H.; Mishra, A.K. Organic farmers or conventional farmers: Where's the money? *Ecol. Econ.* **2012**, *78*, 55–62.
9. Lobley, M.; Butler, A.; Reed, M. The contribution of organic farming to rural development: An exploration of the socio-economic linkages of organic and non-organic farms in England. . *Land Use Policy* **2009**, *26*, 723–735.
10. Scialabba, N.E.-H. *Organic Agriculture and Food Security*; FAO: Rome, Italy, 2007.
11. Jeong, H.-K.; Moon, D.-H. *Response Strategy to the Abolishment of Low-Pesticide Agricultural Product Certification*; Korea Rural Economic Institute (KREI) Report; Korea Rural Economic Institute: Seoul, Korea, 2013. (In Korean)
12. Ministry of Agriculture, Food and Rural Affairs (MAFRA). *The 3rd Environment-Friendly Agriculture Promotion 5-Year Plan*; Environment-Friendly Agriculture Division: Sejong-si, Korea, 2013. (In Korean)
13. The World of Organic Agriculture–Statistics and Emerging Trends 2016. Available online: https://shop.fibl.org/en/article/c/statistics/p/1698-organic-world-2016.html (accessed on 1 March 2016).
14. Rattanasuteerakul, K.; Thapa, G.B. Status and financial performance of organic vegetable farming in northeast Thailand. *Land Use Policy* **2012**, *29*, 456–463.

15. Acs, S.; Berentsen, P.; Huirne, R.; Van Asseldonk, M. Effect of yield and price risk on conversion from conventional to organic farming. *Aust. J. Agric. Resour. Econ.* **2009**, *53*, 393–411.
16. Delbridge, T.A.; Coulter, J.A.; King, R.P.; Sheaffer, C.C. A Profitability and risk analysis of organic and high-input cropping systems in Southwestern Minnesota. In Proceedings of the Agricultural and Applied Economics Association, Annual Meeting, Denver, CO, USA, 25–27 July 2010.
17. Offermann, F.; Nieberg, H. *Economic Performance of Organic Farms in Europe*; Organic Farming in Europe: Economics and Policy, Volume 5; University of Hohenheim: Stuttgart, Germany, 2000.
18. Mahoney, P.R.; Olson, K.D; Porter, P.M; Huggins, D.R.; Perillo, C.A.; Kent Crookston, R. Profitability of organic cropping systems In Southwestern Minnesota. *Renew. Agric. Food Syst.* **2004**, *19*, 35–46.
19. Oude Lansink, A.; Jensma, K. Analysing profits and economic behaviour of organic and conventional dutch arable farms. *Agric. Econ. Rev.* **2003**, *4*, 19–31.
20. Padel, S. Conversion to Organic Farming: A typical example of the diffusion of an innovation? *Sociol. Ruralis* **2001**, *41*, 40–61.
21. Sarker, M.A.; Itohara, Y.; Hoque, M. Determinants of adoption decisions: The case of organic farming in Bangladesh. *Ext. Farming Syst. J.* **2010**, *5*, 39–46.
22. Mabuza, M.L.; Sithole, M.M.; Wale, E.; Ortmann, G.F.; Darroch, M.A.G. Factors influencing the use of alternative land cultivation technologies in Swaziland: Implications for smallholder farming on customary Swazi Nation Land. *Land Use Policy* **2013**, *33*, 71–80.
23. Ullah, A.; Shah, S.N.M.; Ali, A.; Naz, R.; Mahar, A.; Kalhoro, S.A. Factors affecting the adoption of organic farming in Peshawar-Pakistan. *Agric. Sci.* **2015**, *6*, 587–593.
24. Hwang, J.-H. A Study on the marketing strategy of environment-friendly agricultural products. *Korean J. Org. Agric.* **2009**, *17*, 327–345.

25. Kim, H.-J. The Features of eco-agricultural producers, producers' organization and the potentialities of alternative agro-food system: A case study of the Pulmu Life Cooperative. *Korean Soc. Sci. Res. Rev.* **2008**, *24*, 185–212.
26. Kim, C.-G.; Jeong, H.-K.; Moon, D.-H. *Production and Consumption Status and Market Prospects for Environment-Friendly Agri-foods*; Korea Rural Economic Institute (KREI): Seoul, Korea, 2012. (In Korean)
27. Nieberg, H.; Offermann, F.; Zander, K. *Organic Farms in a Changing Policy Environment: Impacts of Support Payments*; EU-Enlargement and Luxembourg Reform; University of Hohenheim: Stuttgart, Germany, 2007.
28. Salvioni, C.; Aguglia, L.; Borsotto, P. The sustainability for an organic sector under transition: An empirical evaluation for Italy. In Proceedings of the 10th European IFSA Symposium, Aarhus, Denmark, 1–4 July 2012.
29. Khaledi, M.; Weseen, S.; Sawyer, E.; Ferguson, S.; Gray, R. Factors influencing partial and complete adoption of organic farming practices in Saskatchewan, Canada. *Can. J. Agric. Econ.* **2010**, *58*, 37–56.
30. Thapa, G.B.; Rattanasuteerakul, K. Adoption and extent of organic vegetable farming in Mahasarakham province, Thailand. *Appl. Geogr.* **2011**, *31*, 201–209.
31. Mondal, S.; Haitook, T.; Simaraks, S. Farmers' knowledge, attitude and practice toward organic vegetables cultivation in Northeast Thailand. *Kasetsart J. Soc. Sci.* **2014**, *35*, 158–166.
32. Province, Gangwon Statistical Yearbook, Gangwon Province, 2013. Available online: http://stat.gwd.go.kr/sub/sub03_10.asp# (accessed on 12 December 2015). (In Korean)
33. Jeon, M. *Device for Reducing Muddy Water in the Watershed of Soyang Dam*; Research Institute for Gangwon: Gangwon Province, Korea, 2008. (In Korean)
34. Jeon, M. *An Institutional Plan to Manage Areas in Gangwon Province that Are Vulnerable to Nonpoint Source Pollution*; Research Institute for Gangwon: Gangwon Province, Korea, 2015. (In Korean)

35. Poppenborg, P.; Koellner, T. Do attitudes toward ecosystem services determine agricultural land use practices? An analysis of farmers' decision-making in a South Korean watershed. *Land Use Policy* **2013**, *31*, 422–429.

36. Arnhold, S.; Lindner, S.; Lee, B.; Martin, E.; Kettering, J.; Nguyen, T.T.; Koellner, T.; Ok, Y.S.; Huwe, B. Conventional and organic farming: Soil erosion and conservation potential for row crop cultivation. *Geoderma* **2014**, *219–220*, 89–105.

37. Nguyen, T.T.; Ruidisch, M.; Koellner, T.; Tenhunen, J. Synergies and tradeoffs between nitrate leaching and net farm income: The case of nitrogen best management practices in South Korea. *Agric. Ecosyst. Environ.* **2014**, *186*, 160–169.

38. Hoang, V.-N.; Nguyen, T.T. Analysis of environmental efficiency variations: A nutrient balance approach. *Ecol. Econ.* **2013**, *86*, 37–46.

39. Long, J.S. *Regression Models for Categorical and Limited Dependent Variables*; Sage Publications: Thousand Oaks, CA, USA, 1997.

40. Tse, Y.K. A diagnostic test for the multinomial logit model. *J. Bus. Econ. Stat.* **1987**, *5*, 283–286.

41. Hausman, J.; McFadden, D. Specification tests for the multinomial logit model. *Econometrica* **1984**, *52*, 1219–1240.

42. Cheng, S.; Long, J.S. Testing for IIA in the multinomial logit model. *Sociol. Method. Res.* **2007**, *35*, 583–600.

43. Long, J.S.; Freese, J. *Regression Models for Categorical Dependent Variables Using Stata*, 2nd ed.; Stata Press: College Station, TX, USA, 2006.

44. Amemiya, T. Qualitative response models: A survey. *J. Econ. Lit.* **1981**, *14*, 1483–1536.

45. Greene, W.H. *Econometric Analysis*, 6th ed.; Prentice-Hall: Upper Saddle River, NJ, USA, 2008.

46. Goktolga, Z.G.; Bal, S.G.; Karkacier, O. Factors effecting primary choice of consumers in food purchasing: The Turkey case. *Food Control* **2005**, *17*, 884–889.

47. Bullock, R.; Mithöfer, D.; Vihemäki, H. Sustainable agricultural intensification: The role of cardamom agroforestry in the East Usambaras, Tanzania. *Int. J. Agric. Sustain.* **2013**, *12*, 109–129.
48. Weir, S.; Knight, J. *Adoption and Diffusion of Agricultural Innovations in Ethiopia: The Role of Education*; Oxford University: Oxford, UK, 2000.
49. Lapar, M.L.A.; Ehui, S.K. Factors affecting adoption of dual-purpose forages in the Philippine uplands. *Agric. Syst.* **2004**, *81*, 95–114.
50. Karki, L.; Schleenbecker, R.; Hamm, U. Factors influencing a conversion to organic farming in Nepalese tea farms. *J. Agric. Rural Dev. Trop. Subtrop.* **2011**, *112*, 113–123.
51. Adesina, A.A.; Mbila, D.; Nkamleu, G.B.; Endamana, D. Econometric analysis of the determinants of adoption of alley farming by farmers in the forest zone of southwest Cameroon. *Agric. Ecosyst. Environ.* **2000**, *80*, 255–265.
52. Ayuya, O.A.; Waluse, S.K.; Gido, O.E. Multinomial logit analysis of small-scale farmers' choice of organic soil management practices in Bungoma county, Kenya. *Curr. Res. J. Soc. Sci.* **2012**, *4*, 314–322.
53. Flaten, O.; Lien, G.; Ebbesvik, M.; Koesling, M.; Valle, P.S. Do the new organic producers differ from the 'old guard'? Empirical results from Norwegian dairy farming. *Renew. Agric. Food Syst.* **2006**, *21*, 174–182.
54. Isin, F.; Cukur, T.; Armagan, G. Factors affecting the adoption of the organic dried fig agriculture system in Turkey. *J. Appl. Sci.* **2007**, *7*, 748–754.
55. Bowman, M.S.; Zilberman, D. Economic factors affecting diversified farming systems. *Ecol. Soc.* **2013**, doi:10.5751/ES-05574-180133.
56. Koesling, M.; Flaten, O.; Lien, G. Factors influencing the conversion to organic farming in Norway. International Journal of Agricultural Resources. *Gov. Ecol.* **2008**, *7*, 78–95.
57. Pietola, K.; Lansink, A. Farmer response to policies promoting organic farming technologies in Finland. *Eur. Rev. Agric. Econ.* **2001**, *28*, 1–15.

58. Lampkin, N.H; Padel, S. *Conversion to Organic Farming: An International Perspective*; Cab International: Wallingford, UK, 1994; pp. 295–313.
59. Sgroi, F.; Candela, M.; Trapani, A.; Foderà, M.; Squatrito, R.; Testa, R.; Tudisca, S. Economic and financial comparison between organic and conventional farming in sicilian lemon orchards. *Sustainability* **2015**, *7*, 947–961.
60. Bernal, M.P.; Alburquerque, J.A.; Moral, R. Composting of animal manures and chemical criteria for compost maturity assessment. A Review. *Bioresour. Technol.* **2009**, *100*, 5444–5453.
61. Kristiansen, P.; Merfield, C.H. Overview of organic agriculture. In *Organic agriculture: A global perspective*; Kristiansen, P., Ed.; CSIRO: Clayton South, Australia, 2006; pp. 1–19.
62. Halpin, D.; Brueckner, M. The retail pricing, labelling and promotion of organic food in Australia. In *The Australian organic industry: A profile*; Department of Agriculture, Fisheries, and Forestry: Canberra, Australia, 2004.
63. Characteristics of Conventional and Organic Apple Production in the United States. Available online: http://www.ers.usda.gov/publications/fts-fruit-and-tree-nuts-outlook/fts34701.aspx (accessed on 22 February 2016).
64. The World of Organic Agriculture-Statistics and Emerging Trends 2007. Available online: http://orgprints.org/10506/ (accessed on 12 March 2015).
65. Padel, S. Conversion to Organic Milk Production: The Change Process and Farmers Information Needs. Ph.D. Thesis, University of Wales, Aberystwyth, UK, 2001.
66. Tzouramani, I.; Liontakis, A.; Sintori, A.; Alexopoulos, G. Assessing organic cherry farmers' strategies under different policy options. *Mod. Econ.* **2014**, *5*, 313–323.
67. Lohr, L.; Salomonsson, L. Conversion subsidies for organic production: Results from Sweden and lessons for the United States. *Agric. Econ.* **2000**, *22*, 133–146.
68. Jánský, J.; Živělová, I. Subsidies for the organic agriculture. *Agric. Econ. Czech* **2007**, *53*, 393–402.

69. Kim, C.-G.; Jeong, H.-K.; Jang, J.-G.; Kwon, H.-M.; Moon, D.-H. *Improving Direct Payment Systems for Environment-Friendly Agriculture and Introducing Environmental Cross Compliance Program*; Korea Rural Economic Institute: Seoul, Korea, 2010. (In Korean)

## 2.9. Appendix

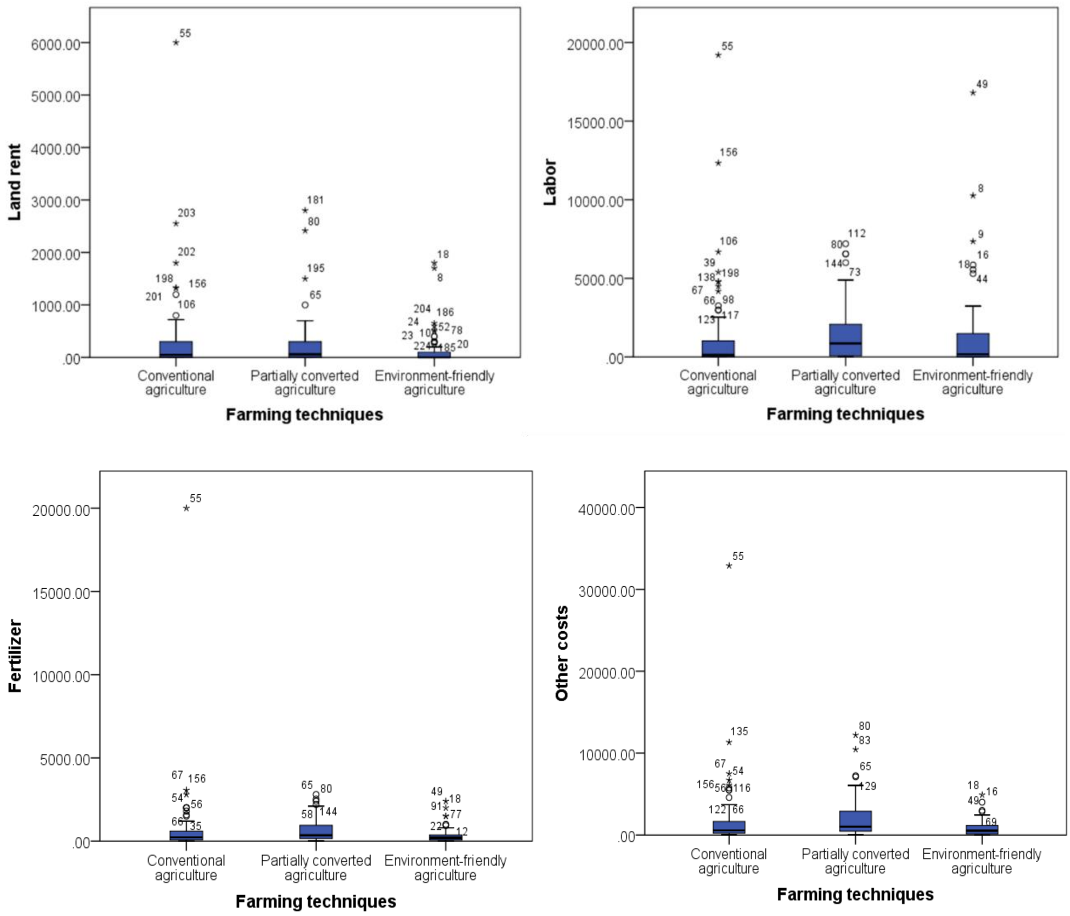


Figure S2.1: Distribution of costs per farm including outliers (N: 224).

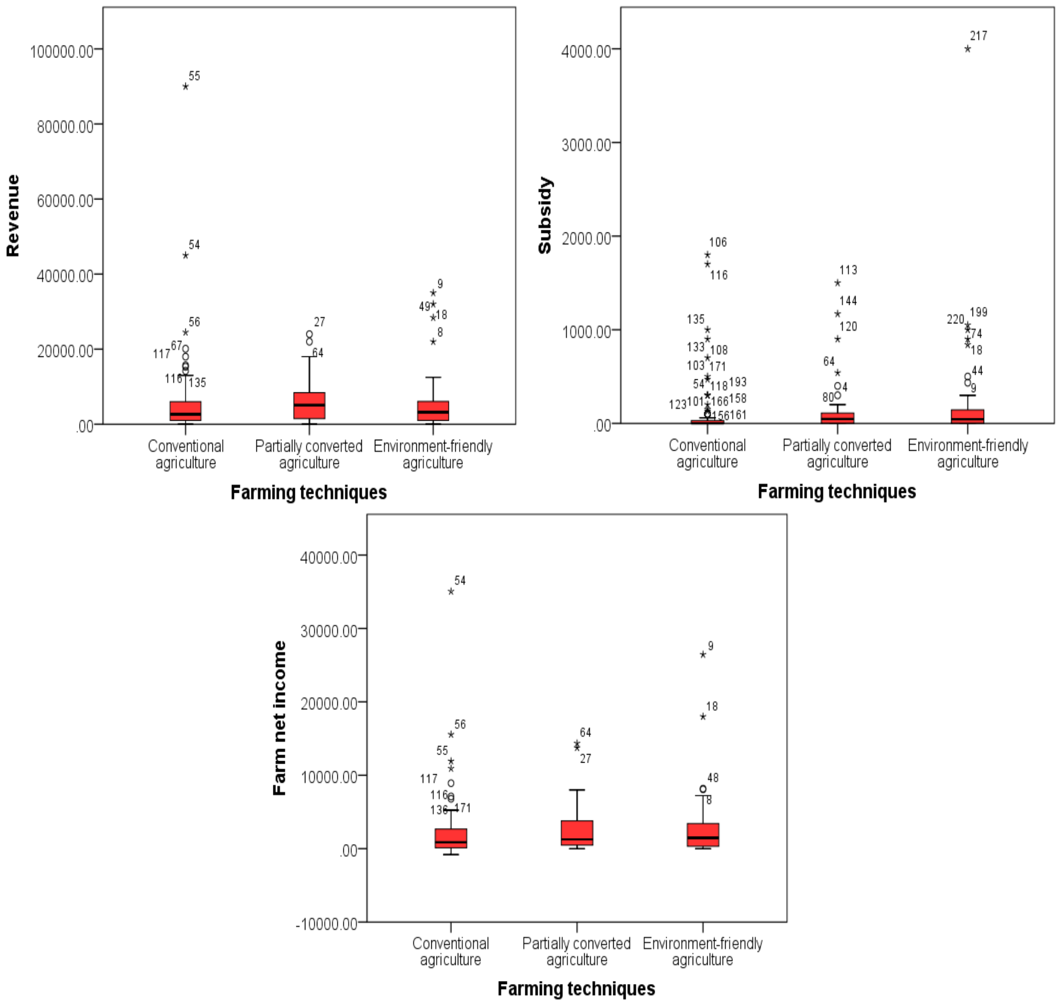


Figure S2.2: Distribution of benefits (red) per farm including outliers (N: 224).

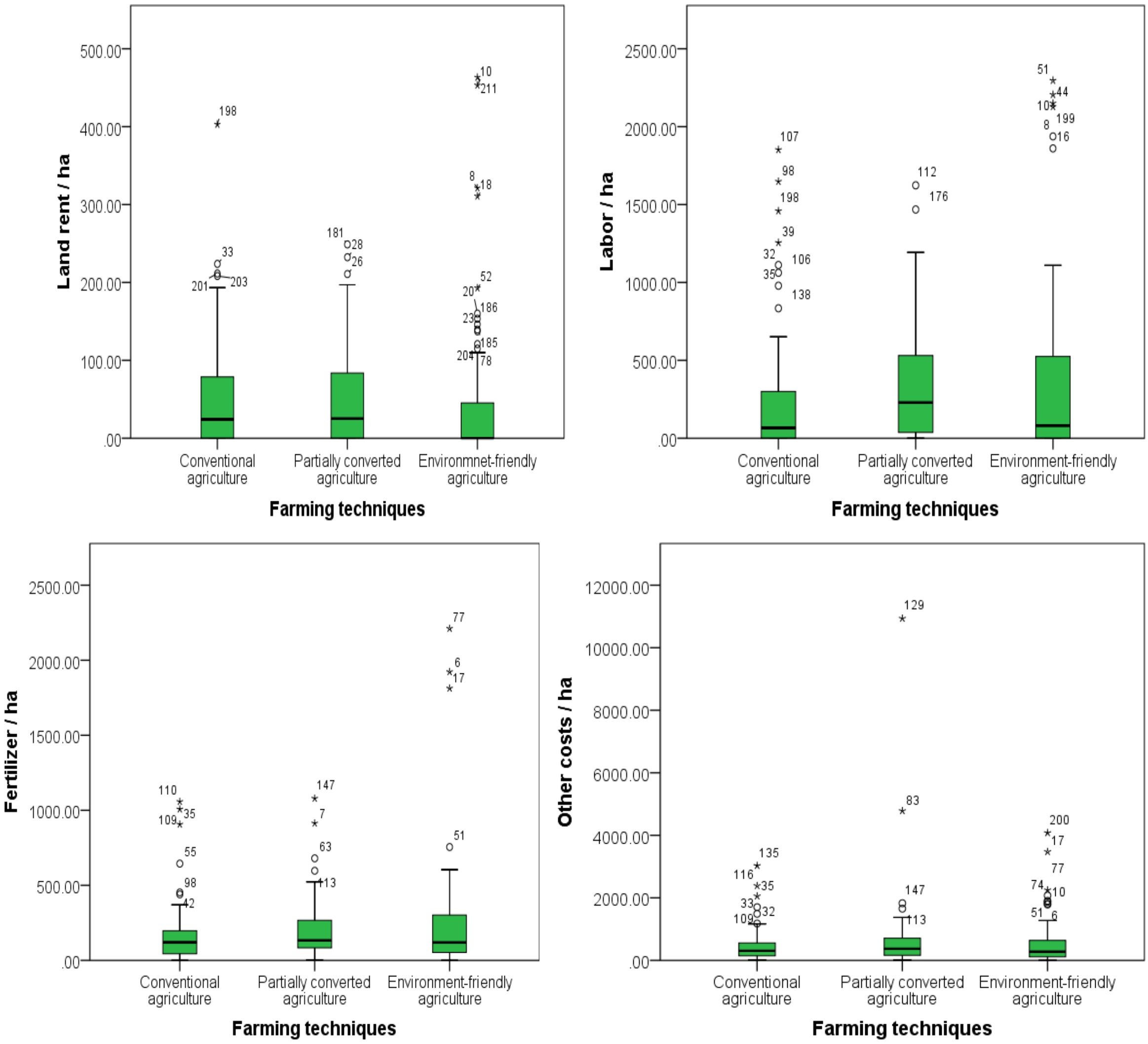


Figure S2.3: Distribution of costs per ha including outliers (N: 224).

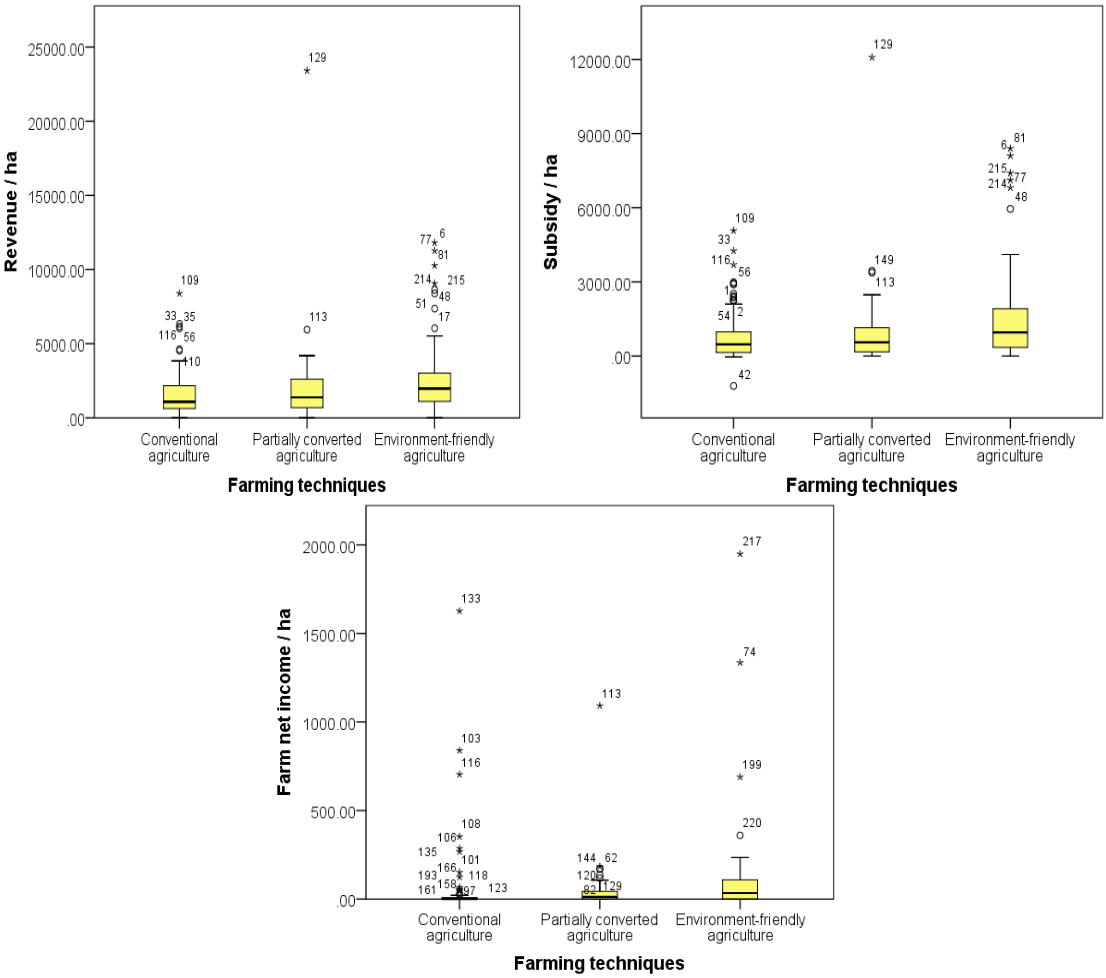


Figure S2.4: Distribution of benefits (yellow) per ha including outliers (N: 224).

Table S2.1: Total and organic cultivated area and the consumed quantity per ha of chemical fertilizers and pesticide in South Korea.

| | | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|
| Total cultivated areas (1000 ha) | | 1795 | 1773 | 1756 | 1788 | 1769 |
| Organic cultivated area (1000 ha) | | 13.3 | 15.5 | 19.3 | 25.5 | 21.2 |
| Rate of organic cultivated area (%) | | 0.7 | 0.8 | 1.1 | 1.4 | 1.2 |
| Chemical fertilizers | Total quantity consumed (1000 ton) | 500 | 423 | 447 | 472 | 459 |
| | The quantity consumed per ha (kg) | 267 | 233 | 249 | 267 | 262 |
| Pesticides | Total quantity consumed(1000 ton) | 22.8 | 20.4 | 19.1 | 17.4 | 18.7 |
| | The quantity consumed per ha (kg) | 12.2 | 11.2 | 10.6 | 9.9 | 10.7 |

Table S2.2: Main crops in percentage of farmers cultivating it and its average farm size split by farming techniques (Conventional farming CF, Partially Converted farming PCF and Environment-Friendly Farming EFF).

| Main Crops | CF (N:85) | | PCF (N:65) | | EFF (N:67) | |
|---|---|---|---|---|---|---|
| | Farmers Cultivating Crop (%) | Average Farm Size (ha) (Std. Dev.) | Farmers Cultivating Crop (%) | Average Farm Size (ha) (Std. Dev.) | Farmers Cultivating Crop (%) | Average Farm Size (ha) (Std. Dev.) |
| Chili | 20.3 | 0.5 (0.6) | 11.2 | 0.7 (0.7) | 13.9 | 0.5 (0.5) |
| Chinese cabbage | 4.1 | 1.4(1.1) | 4.6 | 0.9 (0.6) | 5.4 | 0.5 (0.4) |
| Chinese radish | 6.5 | 1.6 (1.5) | 6.0 | 1.2 (1.1) | 3.9 | 0.6 (0.6) |
| Codonopsis lanceolata | 1.0 | 0.6(0.3) | 4.3 | 0.8 (0.6) | 5.8 | 0.9(1.1) |
| Crown Daisy | 1.0 | 0.2 (0.2) | 9.7 | 0.2 (0.2) | 9.3 | 0.2 (0.3) |
| Potato | 14.8 | 1.3 (1.5) | 14.6 | 0.9(1.0) | 9.3 | 0.7 (0.7) |
| Rice | 11.3 | 2.2 (3.8) | 6.0 | 1.0 (0.7) | 2.3 | 3.0 (2.3) |
| Soybean | 14.4 | 1.0 (1.1) | 9.5 | 1.8 (3.6) | 5.0 | 1.0 (1.0) |

# Chapter 3: Do Consumers of Environmentally Friendly Farming Products in Downstream Areas Have a WTP for Water Quality Protection in Upstream Areas?

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## 3.1. Abstract

In South Korea, the Soyang Lake is an important source of drinking water to the metropolitan areas including Seoul. However, water quality problems in the Soyang Lake have still remained due to chemical contaminations attributed to conventional farming practices in the upstream areas. Based on a downstream consumer survey using a contingent valuation method, this study estimated the expected willingness to pays (WTPs) for water quality improvement through the conversion to environmentally friendly farming (EFF). The results showed that the estimated annual mean WTP is KRW 36,115 per household. The aggregated WTPs of downstream respondents in the Soyang Lake are sufficient to compensate for the income losses of upstream EFF farmers in highland farming areas. In addition, we found that the downstream citizens who recognize the label for EFF products and who intend to purchase EFF products in the future have a significant impact on WTPs for water quality improvement.

**Keywords:** water quality improvement; willingness to pay; compensation scheme; conversion to environmentally friendly farming

## 3.2. Introduction

The Soyang Lake is the largest artificial lake created by the construction of the Soyang Dam and is located at the upper reaches of the North-Han River in South Korea. This lake is an important source of drinking water to downstream metropolitan areas [1]. The maintenance of clean water quality in the upstream areas of this lake has been one of the most critical issues for several years to ensure healthy aquatic ecosystem services which provide many benefits to the society. However, conventional farming practices which overuse chemical fertilizers and pesticides have dominated especially in the highland areas of the upstream regions, which have caused soil erosion into the water and consequently resulted in deterioration of water quality. The decrease in water quality levels is problematic not only for drinking water but also for the aquatic ecosystem health and the management [2].

In an attempt to improve water quality, the government has proposed the conversion from conventional farming to environmentally friendly farming (EFF) in the upland areas as one of the alternative measures for the water quality improvement. However, despite the continued efforts to promote EFF, the proportion of conversion to EFF by upstream farmers has been low [1]. The main reason is that conversion to EFF would lead to loss of income for upstream farmers. Obviously, both ecosystem service providers in upstream areas and its users in downstream areas play an important role for sustainable water resources management. In this context, it is important to make systematic efforts helpful to find practical solutions that can satisfy both stakeholders.

A contingent valuation method (CVM) is utilized to measure the non-market values of change in environmental and natural resources in a stated preference approach [3]. Compared to the revealed preference approach, such as travel cost methods and hedonic price methods, which are based on actual behaviors revealed by decision-makers to estimate the value of goods and services, the CVM is more flexible and useful to estimate non-use values associated with change in conditions of environmental resources based on hypothetical scenarios [4]. With respect to water-related services, a number of existing literatures using CVM have provided empirical estimates of willingness to pay (WTP) for water quality improvement [5] combined with an agricultural policy [6,7], irrigation water use [8] and waste management improvement [9].

In connection with organic agricultural practices, previous studies estimated and analyzed the WTP for price premium of organic agricultural products due to environmental and health concerns [10,11]. Some studies identified the determinants of organic food purchase such as knowledge, attitudes and price consciousness towards organic products [12,13]. In addition, many studies showed the conversion to organic farming can have a potential to improve the water quality dominated by agricultural land use [14–16]. Other studies have emphasized that sustainable agricultural management practices such as organic farming and EFF can have positive effects on water quality improvement by reducing agricultural nonpoint source pollution [17,18]. In South Korea, several studies focused on an estimation of the WTP for improving water quality using CVM [19,20]. However, with respect to water quality conservation combined with a change in farming practices, less attention has been paid to assess the expected WTP for water quality improvement through the conversion to EFF.

Furthermore, payments for environmental services (PES) have been given much attention as a policy instrument to improve water-related ecosystem services in connection with farming practices. This aims to reduce/support negative/positive environmental externalities by transferring financial resources from downstream water users (beneficiaries) who benefit from clean water quality, to upstream farmers (service providers) who receive compensation by changing their farming practices [21]. Many PES schemes have been established and implemented in developed countries, such as the European Union and the United States, to motivate farmers to change their farming practices [22–25]. However, such attention on water-related ecosystem service valuation is currently much less in Asia in general and in South Korea in particular.

In terms of changes in farm management practices, many studies focused on key factors determining the adoption of conservation practices and on its accompanying challenges [26–30]. Several studies reported that decreased yields and increased farming costs during the transition periods are main barriers to the adoption [31–33]. In order to overcome the barriers, providing an incentive for the conversion would be helpful for farmers to offset their income losses and to increase the probability of the adoption. A financial incentive would encourage farmers to adopt the conservation practices.

In this context, our study aims to estimate the downstream households' WTPs (benefits) for water quality improvement by implementing EFF and to compare these benefits to the costs required for compensation for lost income of upstream farmers. Moreover, in the current literature, most studies focused on only one perspective, either benefits or costs, which might not provide sufficient information for successful policy-making [34]. Thus, our study considered both aspects with respect to water quality improvement, which is different from previous studies. In detail, this study estimates the expected WTP of downstream water users for water quality improvement through the conversion to EFF in the Soyang Lake of South Korea, and examines whether the WTP would be sufficient to cover the costs required to compensate for the loss of earnings that can occur for upstream farm households due to the shift to EFF practices.

## 3.3. Method

The method of our study is organized in the following way. Based on the downstream households' survey, the annual expected WTP for water quality improvement were estimated by a bivariate probit model. Additionally, an ordinary least squares (OLS) analysis was used to identify the factors affecting the WTPs with respect to policy implication. Furthermore, based on the survey of upstream farm households in mountainous areas, we calculated the average income loss during the EFF transition periods. Finally, the aggregate WTPs for downstream households were compared with the upstream farmers' mean income loss during the transition period, in order to identify whether the benefits are sufficient to cover the required costs.

### 3.3.1. Study area

The Soyang Lake is an important drinking water source to Seoul. It is the 1st tributary to the North-Han River in the Han River basin. The length of the Soyang watershed is 169.75 km and its catchment areas are about 1852 $km^2$. In terms of aquatic ecosystem services, this watershed is home to threatened and endangered species and provides recreational functions along the river basin. To maintain good water quality, the government of South Korea implemented the water management policy, which has been running since the 1970s. Although clean water quality has been maintained in the river basin, potential deterioration of the water quality caused by intensive agricultural practices in the upstream areas of the river basin is still remaining, especially during the monsoon season under climate change.

One of the beneficiaries among downstream areas along the river basin that this study considers is Seoul (latitude 37°33′ N, longitude 126°58′ E), which is the capital and the largest city (25 districts, 605.25 $km^2$) of South Korea, with a population of approximately 10 million people. This city is one of the representative downstream beneficiaries, being provided with clean water as well as aquatic ecosystem services from the upstream areas where economic activities are restricted to some extent to sustain water quality conditions [1]. Among upstream regions along the river basin, this study considers Gangwon Province which is located in the mountainous northeastern side of South Korea (latitude 37°02′ N–38°37′ N and longitudes 127°05′ E–129°22′ E). This province consists of 18 counties and its total area is about 16,874 $km^2$. Total cultivated areas of farmland in this province were 112,007 ha and more than 90% of farms in this region used conventional farming practices in 2012. The main crops cultivated in this province are Chinese cabbages and radishes, which use a large amount of chemical fertilizers and pesticides. In this province, three districts including Hongcheon, Inje, and Yanggu are the main districts where most farming is activated in the mountainous areas, which resulted in soil erosion into the river having negative impacts on water quality. These districts can be regarded as hot spots of non-point source pollution in monsoon climate (See Lee et al. [1] for more details). The conventional farming in these districts has been blamed for one of the main factors which cause degradation of water quality during the monsoon period. Such water pollution has been long debated between upstream and downstream areas with respect to water management issues (See Lee et al. [1] for more details).

### 3.3.2. Downstream consumers survey: Data and study design

The survey was administered from 4th to 28th of March 2013 by a professional survey company with trained interviewers. A face-to-face survey was carried out at the Nonghyup supermarket, one of the biggest supermarkets selling both conventional agricultural products and EFF products in Seoul to collect heterogeneous consumers. Prior to implementing the questionnaire to final survey samples, we held a focus group discussion to optimize responses and ensure accuracy by adjusting question wording and format of the questions. For incentives to respond to the survey, a gift was provided only to those who completed the survey. Before starting the survey, we randomly selected respondents and asked whether they are Seoul residents or not. Using this procedure, we collected 210 completed responses, which included 105 consumers who purchased EFF products and 105 consumers who had not. The sample size of Seoul population is in the 7% sampling error. Note that the incomplete survey cases were excluded for the analysis. The profile of survey respondents is presented in Table S3.1 in the Supplementary Materials. In addition, Table S9 provides standardized mean differences (SMD) of households' characteristics regarding their annual income. This shows that there are no significant differences between the survey dataset and the dataset including Seoul households in 2013, despite the fact that there is a large difference in the total number of observations and surveyed samples. Thus, it means that our survey sample is a representative sample of Seoul households in their income mean comparisons.

The survey questionnaire was divided into three sections. In the first section, respondents were asked about their environmental perception and attitude towards the water quality and their expenditure on EFF products. In the second section, respondents were first provided the information about the past decrease in water quality of the river basin with high levels of turbidity (328NTU (Number of Transfer Units)) in South Korea. Subsequently, the respondents are told that the water quality degradation means dirty water from an influx of the muddy water and that the main reason for the degradation is an overuse of the chemical fertilizers and pesticides used by conventional agricultural practices. Next, the questionnaire informed the respondents of certain details that the water quality could be improved through the conversion to EFF from muddy water to potable water. Based on the description, the WTP questions were included in the questionnaire. Finally, in the third section, socio-economic characteristics of respondents were included such as age, education, income. The WTP question presented in the second section is as following:

"Suppose that this proposal will improve the water quality through the adoption of EFF from muddy water to fresh water along the Soyang watershed, if you would make a payment of KRW A in a tax. The proposal would reduce runoff from heavy rains during the monsoon period in the mountainous agricultural farmland area and would ensure more sustainable clean water supply. Remember that if this would be implemented, the water quality will be improved as a result of EFF practices from muddy water (grade 2) to fresh water (grade 1)".

The WTP question for the water quality improvement followed a dichotomous choice framework. The bid values presented were KRW 2000, KRW 4000, KRW 6000, or KRW 8000 and these values were randomly distributed. We used a tax referendum format because this is a compulsory contribution to avoid free-riding which might happen in voluntary contributions. Before presenting bid amounts in the WTP question, we asked if respondents agree with the presented scenario regarding the role of the watershed and information on the water quality, habitats and recreation functions that have negative impacts as a result of agricultural practices in the upstream area. The 25 respondents who disagreed with the offered scenario were excluded in the analysis.

### 3.3.3. Downstream consumers survey: WTP elicitation formats

A CVM is the most common stated-preference technique in non-market valuation that does not depend on observed market behavior. This method is commonly used to elicit environmental values based on a hypothetical situation for policy contribution. Individuals are directly asked for their WTP based on hypothetical scenarios for a proposed policy [35–37]. In this study, the double bounded dichotomous choice (DBDC) elicitation method was used for deriving the WTP. Although the National Oceanic Atmospheric Administration (NOAA) emphasizes the single bounded referendum method for eliciting WTP in non-market goods and services [36], the single bounded model has a disadvantage, providing inefficient welfare measures due to limited information gained from individual respondents. The DBDC model is more information intensive and asymptotically more efficient than the single bounded method [38,39]. The DBDC model is a close-ended format consisting of a binary response of a yes or no answer to initial values ($B_1$) and follow-up values ($B_2$). The follow-up WTP values depend on the respondents' response to the first WTP value that was proposed; if the first value is accepted, the second value is doubled, whereas if the first value is refused, the second value is half of the value as much. Thus, the DBDC method can directly offer an economic measure of individual welfare relevant to a discrete change in water quality [40]. In the dichotomous choice question format, the probability that individual's WTP is equal to or larger than presented bids ($B$) can be written as:

$$\Pr(\text{yes}) = \Pr\,(WTP \geq B) \equiv 1 - F_c(B), \tag{1}$$

where $F_c(B)$ indicates the cumulative distribution function of WTP. According to Hanemann [41], all components of the indirect utility function are not observable. The error terms are random variables in the random utility model, the probability of the "yes" answer can be written as:

$\Pr(\text{yes}) = \Pr\{C(Q^0, Q^1, Y, P, Z, \varepsilon \geq B) = \Pr\{V\left(Q^1, Y - B, P, Z, \varepsilon\right) \geq V(Q^0, Y\, P, Z, \varepsilon)\} \equiv 1 - F_C(B),$ (2)

where (Q) indicates the scalar for being valued in environmental quality, (P) is the vector of the prices for the market goods, (Z) is the socio-demographic information, and (Y) is the income of interviewed respondents. Accounting for the current situation, the utility function is considered as V $(Q^0, Y, P, Z, \varepsilon)$. When a change in the environmental quality, such as water quality, happens to the offered alternative scenario, the utility function is changed into $V\,(Q^1, Y - B, P, Z, \varepsilon)$. In this regard, the compensation variation (C) indicates the expected WTP for the environmental quality. It produces the maximum WTP of respondents for the change from the initial status quo $(Q^0)$ to changed situation $(Q^1)$. If $\mu_{WTP}$ is equal to $E[WTP(Q^0, Q^1, Y, P, Z, \varepsilon)]$, $\delta^2_{WTP}$ is equal to $Var[WTP(Q^0, Q^1, Y, P, Z, \varepsilon)]$ and F(•) can be the cumulative distribution function of the standardized variate $\omega = (WTP - \mu_{WTP})/\delta_{WTP}$, the probability function can be indicated as:

$$\Pr(\text{yes}) = 1 - F\left[\frac{B - \mu_{WTP}}{\delta_{WTP}}\right] \equiv 1 - F(-\alpha + \beta B), \tag{3}$$

where $\alpha = \mu_{WTP}/\delta_{WTP}$ and $\beta = 1/\delta_{WTP}$. In this dichotomous choice, the model for estimating WTP is determined by cumulative distribution function of WTP (C), $F_c(B)$ and distribution assumption of the random component in the utility function. If $F_c(B)$ follows a probit standard distribution and linear model, the expected average WTP is:

$$E\varepsilon\ (WTP/\alpha, \beta, Z) = \frac{\alpha Z}{\beta} \tag{4}$$

where $\alpha$ denotes the vector of parameters of the coefficient on the bid level, $\beta$ indicates the estimated marginal utility of income and Z means the vector of characteristics of the respondents.

A respondent (*j*) is proposed with the first and the second bid amount for the water quality improvement in our study. The response patterns to the DBDC WTP questions were as follows: No–No (NN) responses ($WTP_j < B_2$), No–Yes (NY) responses ($B_1 \geq WTP_j > B_2$), Yes–No (YN) responses ($B_1 \leq WTP_j < B_2$) and Yes–Yes (YY) responses ($WTP_j \geq B_2$). In a bivariate probit model, the dependent variable takes the value of 1 if the respondent accepts the proposed value and of 0 otherwise, depending on the response to the double-bounded values. Haab and McConnell [40] illustrated that 'YN' and 'NY' answers provide a relative clear bound of WTP and obtains 'NN' and 'YY' estimate efficiency. This has an advantage of reducing variance of the WTP estimates, as compared to single bounded question.

### 3.3.4. Downstream consumer's survey: Empirical model

In DBDC format, a bivariate probit model was employed in order to calculate the mean WTP for water quality improvement. The randomly assigned initial bids for the WTP ranged from KRW 2000 to KRW 8000 per month in the four sub-samples to avoid initial bid biases (Table S3). In accordance with a bivariate Probit model equation, the dependent variable takes 1 if the respondents are willing to pay for the conversion to EFF to improve water quality, and 0 otherwise. The *bid* variable was a bid amount in KRW. The variable *buyer* which takes the value 1 if respondent bought EFF products, 0 otherwise. The estimates for the model are obtained through maximum likelihood techniques. The average willingness to pay is calculated with the corresponding 95% confidence intervals following the 5000 boot-strapping procedures of Krinsky and Robb [42].

Furthermore, we analyzed an OLS regression in the log formation as a way to explain the points raised in this discussion. In the OLS regression model, explanatory variables such as socio-economic variables and environmental awareness were included. It is assumed that *Age*, *Education*, *Income* and *Children* could be significant factors affecting the WTP for the water quality through the adoption of EFF. Moreover, it is expected that the respondents who have knowledge about the labels of EFF products and the future willingness to purchase have a significant effect on the WTP. The OLS model can be written as follows:

$$\ln(Y)_i = \alpha_0 + \sum \beta_i x_i + \varepsilon_i \tag{5}$$

where $Y$ is the expected WTP calculated from a bivariate probit model, $\alpha_0$ and $\beta_i$ are parameters to be estimated, $x_i$ means explanatory variables and $\varepsilon_i$ is the stochastic error term. Based on Equation (5), the marginal effect for the continuous variables can be indicated as:

$$\frac{\partial Y}{\partial x_i} = \beta_i * \bar{Y} \text{ for continuous variables,} \tag{6}$$

where $\bar{Y}$ is the mean of WTP. According to Kennedy [43], the marginal effect for dummy variables can be written in the below equation:

$$\Delta \mathrm{D} = \left\{\exp\left(\beta_i - 0.5 * V(\beta_i)\right) - 1\right\} * Y_{mean} \tag{7}$$

where $\Delta$D means the marginal effect for dummy variables, $V(\beta_i)$ is an estimates of the variance. $Y_{mean}$ is the average WTP. Based on Equations (6) and (7), we calculated the marginal effects for the explanatory variables (Table S3.6).

### 3.3.5. Upstream farmers' data collection and study design

Face-to-face interviews were conducted with upstream farm households of the watershed. The sample size is 218 farm households including 85 conventional farms, 68 EFF farms, and 65 partially converted farms who are using both conventional and EFF practices in their own choices (see Lee et al. [1] using the same data). The farmer's list was obtained from local leaders and government staff in Gangwon Province in 2012. Due to the time and budget constraints, stratified random sampling was applied, with 7% sample size based on the total number of farm households. After a pilot-test, the final survey was implemented from March to April of 2012 with trained interviewers. The questionnaire comprised of three sections. The three types of farm households had in common the first and third sections. The second section had different questions according to their farming techniques. The first section contained their benefits including revenues and subsidies and costs including land rent, labor fertilizer, pesticides and extra costs for their cultivation among the three groups [1]. The second included conventional and partially converted farmers' response for the adoption of EFF and reasons not to adopt the EFF. Regarding the two groups, we asked if they were willing to adopt the EFF for environmental protection, when their income loss is fully compensated during the transition period. The reasons not to adopt the EFF were investigated, when they did not want to change their farming techniques under the compensation. In addition, in the case of partially converted farming and EFF, we asked different questions about their yield reduction during the transition period in the second section. On the other hand, targeting partially converted and EFF farmers, we asked about how much yield reduction occurred during the transition period from the first to the fifth year. The final section was to identify the social, economic and demographic characteristics of interviewed farm households such as age, income, education level and farming experience, farm size of farmland.

### 3.3.6. Calculation of income loss of environmentally friendly farmers during transition period

We calculated the income loss of EFF during the transition period as a proxy for the financial incentive in upstream areas. Given the revenue of farmers is obtained by multiplying the quantity with the price of their cultivated crops, the price can be affected by various factors such as other crops' prices, seasonal variability and weather. While price variability for each crop is challenging, changes in crop productivity and quantity can be easily detected by farmers. Thus, regarding the revenues obtained from price and crop yields, price fluctuation was not considered, since the price is influenced by various factors. The price was fixed when calculating farmers' net income loss. Only output changes were considered as their income loss by their yield reduction. In the case of no output change during the transition period, the farmers' interview data was excluded.

Regarding farm households' survey data and information, the results of Lee et al. [1] were used to calculate the income loss of EFF in our study. In order to calculate the income loss during the transition period, only quantity change in EFF practices and annual net income per ha of conventional farmers were considered in the mountainous area. Current conventional farmers are potential EFF farmers in the future who are compensated in case they convert their farming method to EFF. Thus, based on the interviews of conventional farmers, their annual net income per ha was confirmed by their revenue minus total costs in farm management practices. Targeting EFF farmers who faced the problem of yield decrease, we investigated the level of their yield reduction during the transition period in a relative term (percentage). In addition, with respect to partially converted farmers who are implementing both conventional farming and EFF, we investigated both their output reduction during the transition period and whether they were willing to adopt EFF.

If the conversion to EFF in total highland areas affecting the water quality is implemented, the current conventional farm households would be compensated for their income reduction by the conversion. Thus, the average annual net income per ha of the conventional farmers was multiplied with the average crop yield reduction rate in EFF per ha (Table S3.7). The decreased annual income was then multiplied with the total highland areas. The total highland upland areas affecting the water quality problem were 3925 ha reported by the Ministry of the Interior of South Korea. As the total compensation required for the conversion of the total highland areas, the calculated income loss is shown in Table 3.5.

## 3.4. Results

### 3.4.1. Downstream citizens' WTP for water quality improvement through EFF

The descriptive statistics for downstream respondents are presented in Table S3.1. The distribution of the respondents' response to the corresponding first and follow-up bids is shown in Tables S3.2 and S3.3. The basic description of the variables used in a bivariate probit model is included in Table S3.4. These tables are in the Supplementary Materials. Table 3.1 presents the estimation results of the bivariate probit model for the water quality improvement. We implemented a Wald test with the 95% confidence interval to test the relative efficiency measures between the single bounded and the double bounded models. The result shows that the double bounded model is more efficient than the single bounded model with a low ratio of confidence level. The *Bid* variable in logarithmic form was included in the model. With respect to the presented WTP, as expected, the coefficient of ln *(Bid)* is found to be negative and statistically significant. The variable *Buyers* is positively and statistically significantly correlated with the WTP decision. It means that the purchase amounts of EFF products rarely affect the WTP decision since the coefficient value of *Buyers* is close to zero, but are positively related with the likelihood of a yes response for the WTP.

Table 3.1: Estimation results of a bivariate probit regression for the improved water quality.

| Explanatory Variable | Coefficient | Std. Err. |
|---|---|---|
| WTP (Yes 1) | | |
| ln *(Bid 1)* | −0.838217 *** | 0.164895 |
| *Buyers* | 0.000004 *** | 0.000002 |
| *Constant* | 6.109605 *** | 1.371691 |
| WTP (Yes 2) | | |
| ln *(Bid 2)* | −0.783377 *** | 0.111559 |
| *Buyers* | 0.000004 *** | 0.000002 |
| *Constant* | 5.497683 *** | 0.908565 |
| *Athrho* | 3.30 | 1.56 |
| *rho(ρ)* | 0.99 | 0.01 |

Note: *** $p < 0.01$; Number of observation = 185; Log pseudo likelihood = −140.46; Wald chi-square(4) = 54.42; Likelihood-ratio test of rho = 0; chi-square(1) = 73.73; Prob > Chi-square = 0.0000.

Table 3.2 shows the annual mean WTPs for improving water quality by adopting EFF. The expected value of annual mean WTP is KRW 36,115 while the estimated median WTP is approximately a half of that. The lower bounded estimate is approximately KRW 27,471/year/household, assuming that respondents have a WTP of KRW 0, if they do not want to pay for it. The upper bounded estimate is KRW 58,975/year/household on the survey. The aggregate average WTPs are about KRW 15,104,594.

Table 3.2: An annual mean Willingness to Pays (WTPs) and aggregate Willingness to Pay (WTP) values.

| Mean WTP [KRW /Year] (A) | Lower Bound WTP [KRW /Year] (B) | Upper Bound WTP [KRW /Year] (C) | CI [a] /Mean | Total Number of Households (D) | Aggregate Mean WTPs [b] (E) = (A) × (D) | Aggregate Lower Bound WTPs [b] [KRW 10,000/Year] (F) = (B) × (D) | Aggregate Upper Bound WTPs [b] [KRW 10,000/Year] (G) = (C) × (D) |
|---|---|---|---|---|---|---|---|
| 36,115 | 27,471 | 58,975 | 0.87 | 4,182,351 | 15,104,594 | 11,488,918 | 24,664,997 |

Note: The number of households is obtained from the Statistics Korea (http://stat.seoul.go.kr/jsp3/stat.book.jsp?link=6&cot=009, accessed on 31 January 2017) in 2013.
a CI: Confidence Interval for WTP measures of Krinsky and Robb (95%); b Unit US$ 1.00 = KRW 1055.4, at the time of the survey (2013).

### 3.4.2. Key factors affecting downstream willingness to pay for the water quality improvement through the adoption of EFF

The OLS regression was implemented to investigate the factors affecting the WTP of downstream citizens and the results are shown in Table 3.3. The F-value was significant at 1% level, meaning that this OLS model was well fitted. To check for the perfect multicollinearity between the variables, the VIF test was implemented and the null hypothesis was rejected. The result of OLS model shows that the two out of six explanatory variables are found to be significant on the dependent variable lnWTP.

Table 3.3: Coefficient estimates and standard errors of ordinary least squares (OLS) regression.

| Variable | Coefficient | Standard Error |
|---|---|---|
| *Future purchase intention of current consumers with EFF products* | 0.0257 *** | 0.0050 |
| *Label* | 0.0840 * | 0.0503 |
| *Children* | 0.0155 | 0.0634 |
| Age | −0.0002 | 0.0024 |
| *Income* | −0.0067 | 0.0177 |
| *Education* | 0.0021 | 0.0118 |
| *Constant* | 8.0861 *** | 0.2446 |
| *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ | | |
| N | | 185 |
| $F$-value | | 5.53 *** |
| Adjusted-$R^2$ | | 0.13 |
| Mean VIF | | 1.26 |

Among the six variables, the *Children*, *Age*, *Income* and *Education* variable have a statistically insignificant relationship with the lnWTP. The coefficients of *Future purchase intension of current consumers with EFF products and Label* are statistically significant with positive signs. It demonstrates that as the current and future purchase intensions of EFF products increases, the probability of paying WTP for the water quality improvement through the adoption of EFF increases. The result also implies that consumers' awareness for labels is positively related with the lnWTP. Moreover, the higher the awareness for labels of EFF products, the higher the probability of accepting the value of the WTP.

### 3.4.3. Upstream farmers' response and reasons to change farming technique to EFF

Table 3.4 shows the response of upstream farmers for the willingness to adopt EFF when their income loss during the transition period is compensated. With respect to the yes response for the conversion to EFF, the conventional farmers account for 47.1%, while partially converted farmers who are implementing both conventional farming and EFF account for 60.0%. The result shows that about half of total farmers (52.7%) are willing to convert their farming techniques to EFF, if their income loss is offset. In addition, the crucial reasons for the reluctance to adopt EFF are presented in Table S5. The main reasons not to adopt EFF in total are the farm profitability and aging problem in conventional and partially converted farmers.

Table 3.4: The response of upstream farmers for willingness to convert farming method to Environmentally Friendly Farming (EFF).

| Farming Techniques | Conventional Farmer (*N* = 85) | Partially Converted Farmer (*N* = 65) | Total (*N* = 150) |
|---|---|---|---|
| Yes | 40 (47.1) | 39 (60.0) | 79 (52.7) |
| No | 45 (52.9) | 26 (40.0) | 71 (47.3) |
| Total | 85 (100) | 65 (100) | 150 (100) |

Note: The numbers in parentheses are the proportions of surveyed farmers respectively.

### 3.4.4. A comparison between income loss of upstream farmer and aggregate WTP of downstream consumer

The result of the aggregate estimated WTP of downstream respondents is shown in Table 3.5. Based on the total population of Seoul city obtained from the Statistics Korea in 2013, the estimated result was calculated with the above annual mean WTP of the respondents. The compensation for each farm was obtained from multiplying the calculated mean income loss during the transition period with total highland area of farm. The calculated compensation costs (KRW 60 billion) turns out to be about 40% less than the downstream consumers' annual WTP (KRW 151 billion). This shows that the aggregate WTPs estimated from consumers' interview might be sufficient to compensate the income loss of farmers during the transition period.

Table 3.5: The calculated compensation costs based on highland farm size, compared with annual WTP.

| (A) Total Highland Farm Area (ha) | (B) Annual Income Loss of EFF per ha [KRW 10,000/ha] | (C = A * B) Total Annual Compensation [KRW 10,000] | Annual Aggregate WTP [KRW 10,000] |
|---|---|---|---|
| 3925 | 1534 | 6,020,950 | 15,104,594 |

Note: Source: (A)—Ministry of the Interior of South Korea; (B)—Our farmers' survey data.

## 3.5. Discussion

### 3.5.1. Willingness to pay estimates for water quality through the adoption of EFF Practices

Most of the respondents, 88.1%, interestingly, are willing to pay a tax to improve the water quality along Soyang Lake (Table S3.2). This might be attributed to several discussions in the mass media with environmental policy makers and scientists of South Korea about maintaining potable water quality during the summer season. It means that the clean water availability from the river basin has been deemed important to respondents in downstream areas. In the bivariate probit model, the result shows that the presented bid values have a negative and statistically significant effect on the respondents' probability of accepting the bid. This indicates that the higher the bid values respondents have, the lower the willingness to pay is in the study area. In addition, *Buyers* is considered as a hypothesis-specific variable, assuming that it would appear to have an influence on the WTP for the water quality improvement through conversion to EFF, since the respondents who have bought EFF products can have more environmental and health concerns. The result shows that the variable *Buyers* has a positive and statistically significant effect on the household's probability of accepting the bid. This means that the consumers of EFF products would have more interests in the WTP, while its coefficient appears to have minimal effects on the WTP.

Based on the bivariate probit model, the expected mean and median WTPs were calculated in 95% confidence interval for the WTP measures of Krinsky and Robb. The expected mean WTP for water improvement by converting to EFF is KRW 36,115 per household per year. The estimated mean WTP accounts for about 0.08% of the average annual income per household of Seoul citizens reported by Statistic Korea in 2013 [44]. To the best of our knowledge, none of the previous studies in South Korea revealed WTP estimation for water quality improvement through the conversion to EFF, as a way to reduce the negative externality from intensively managed farmlands causing water turbidity problem. Our findings are consistent with the current literature on the WTP for improving water quality in South Korea [19] and in line with Choi et al. [20], who report that the mean annual WTP for a land use restriction policy in the upstream areas was KRW 34,320 per household.

### 3.5.2. Key factors influencing the willingness to pay for water quality improvement combined with EFF practices

In an OLS model, our findings indicate that the predicted probability of the WTP for the water quality increases as future purchase intention for EFF products increases. This is in line with previous studies, showing that EFF products' consumption is connected with consumers' attitude towards environment and their behavior toward environmental conservation [45,46]. In addition, our result implies that the higher awareness for labels of EFF products increases the probability of accepting the WTP for water quality improvement through the adoption of EFF. These results are in line with existing findings, implying that the awareness of labels for EFF products would have a positive impact on the WTP for the price premium towards organic products [47–49]. Regarding the marginal effects for the statistically significant variables, the calculated values in Future purchase intension of current consumers with EFF products and Label are on average KRW 3120 and KRW 924 per year for households respectively. These results are consistent with previous researches which emphasized Seoul citizens' preferences for environment improvement and food security and the expected WTP for the water quality conservation in South Korea [19,50].

### 3.5.3. Upstream farmers' response for their farming practices and income loss of EFF farmers during transition period

In upstream farm household survey targeting conventional and partially converted farmers, we found that about a half of the farmers are not willing to convert to EFF. One of the main reasons not to adopt the EFF came from the low profitability of EFF. This is consistent with several studies that show that this is a crucial determinant for adopting conservation practices in watersheds [26–30] and barrier for adopting organic farming in agricultural land use management [31–33]. Moreover, the result is also in line with the previous studies [51–55], which report that economic and institutional barriers such as unstable production and lack of financial support from governments for the adoption of organic farming.

Finally, the aggregate monetary WTPs by the number of total downstream citizens are KRW 151 billion with a range from KRW 114 billion to KRW 246 billion. The total benefits from the water quality improvement resulting from changes in EFF practices can be compared with the costs that upstream farmers can incur through the conversion. Thus, our result implies that the aggregate WTPs might be enough to cover the required costs in the conversion, as the average income loss accounts for about 40% of the aggregate WTPs.

## 3.6. Conclusions

Our study estimated the average annual WTP for water quality improvement of the Soyang Lake targeting to the downstream households. The expected WTP for the water quality through the adoption of EFF was calculated to be about KRW 36,115 per household per year. The total aggregate WTPs in the downstream areas were enough to cover the costs required through the conversion to EFF in the upstream area. The estimated values imply downstream citizens can assign the benefit from the water-related services to the investment for water quality conservation related to agriculture. This paper provides valuable information for sustainable water resource management as provided an importance for water quality protection combined with agricultural practices.

It should be noted that there are still several limitations of our study. The calculated income loss in the farmer survey is not likely to be equal to the exact reduced costs of the each farm households during their transition period. In addition, we did not consider several other factors affecting the price fluctuation such as which crops cultivated and seasonal effects. With a small sample size of farmers, our study investigated only a fixed profit in the survey year. We suggest further investigations for farmers' willingness to accept for water quality that consider various socio-economic characteristics in valuation statements. Further research should be needed to extend the sample and to improve the estimation of the willingness to accept for water quality improvement.

Regarding the downstream household survey, the targeted downstream households at the market might have potentially biased outcomes due to the difference in socio-economic characteristics of each group. Thus, future studies should be done by extending the scope at multiple stakeholders to investigate the various characteristics. Moreover, methodologically, attempts to use other payment vehicles should be made to explore heterogeneous consumers' preferences using CVM.

In the PES scheme, future research needs to compare local impacts of abolishing direct payments and on the analysis based on different policy instruments. Moreover, evaluation of the economic benefits and costs by emphasizing dual role relationships between upstream farmers and downstream consumers is recommended. In terms of their effectiveness and efficiency to facilitate the conversion to EFF for sustainable water services, an integrated management policy should be strengthened. Our analysis obtained by an empirical case study could be extended with spatial modeling studies such as invest, GIS, agent based modeling in integrated water resource management.

With respect to environmental problems with excessively abundant nutrients, many previous studies focused on water pollution treatment for water quality improvement and treatment plants for efficient diffuse sources management [56–59]. Some research has considered the relationships between abatement measures and an impact on nutrient loads in water basin [60–62]. As our paper focused on the WTP analysis for water pollution abatement through the adoption of EFF using CVM, further studies associated with water pollution treatment are essential for water quality improvements.

Furthermore, in our study, there is still insufficient information that concerns trading costs in the river basin. A recent review of the literatures shows a focus on the emerging water quality trading markets which are crucial for water quality improvement [63,64]. Several literatures have taken into account cost-effective solutions for combating eutrophication of coastal ecosystem in spatial and dynamic management [65–67]. In order to determine a more proper policy programs for the cost-effective conservation practices, several studies suggest the applications of transaction costs, trading costs and imposed trading ratios in emerging water quality trading markets. Thus, further studies for cost-effective conservation practices need to be developed in our study area as well.

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## 3.8. References

1. Lee, S.; Nguyen, T.T.; Poppenborg, P.; Shin, H.J.; Koellner, T. Conventional, Partially Converted and Environmentally Friendly Farming in South Korea: Profitability and

Factors Affecting Farmers' Choice. *Sustainability* **2016**, *8*, 704, doi:10.3390/su8080704.
2. Nguyen, T.T.; Ruidisch, M.; Koellner, T.; Tenhunen, J. Synergies and tradeoffs between nitrate leaching and net farm income: The case of nitrogen best management practices in South Korea. *Agric. Ecosyst. Environ.* **2014**, *186*, 160–169.
3. Hanemann, W.M. Valuing the environment through contingent valuation. *J. Econ. Perspect.* **1994**, *8*, 19–43.
4. Bateman, I.J.; Carson, R.T.; Day, B.; Hanemann, M.; Hanleys, N. Hett, T.; Jones-Lee, M.; Loomes, G.; Mourato, S.; Özdemiroglu, E.; et al. *Economic Valuation with Stated Preference Techniques: A Manual*; Edward Elgar: Cheltenham, UK, 2002; ISBN 1840649194.
5. Shah, S.A.; Hoag, D.L.K.; Davies, S. Household preferences and willingness to pay (WTP) for freshwater quality improvement in Pakistan's Swat River Valley. *Environ. Dev. Sustain.* **2016**, *18*, 1081–1093.
6. Aref, F. Farmers' Participation in Agricultural Development: The Case of Fars Province, Iran. *Indian J. Sci. Technol.* **2011**, *4*, 155–158.
7. Zheng, S.; Wang, Z.; Awokuse, T.O. Determinants of Producers' Participation in Agricultural Cooperatives: Evidence from Northern China. *Appl. Econ. Perspect. Policy* **2012**, *34*, 167–186.
8. Chandrasekaran, K.; Devarajulu, S.; Kuppannan, P. Farmers' Willingness to Pay for Irrigation Water: A Case of Tank Irrigation Systems in South India. *Water* **2009**, *1*, 5–18.
9. Afroz, R.; Hanaki, K.; Hasegawa-Kurisu, K. Willingness to pay for waste management improvement in Dhaka city, Bangladesh. *J. Environ. Manag.* **2009**, *90*, 492–503.
10. Basha, M.B.; Mason, C.; Shamsudin, M.F.; Hussain, H.I.; Salem, M.A. Consumers Attitude towards Organic Food. *Procedia Econ. Financ.* **2015**, *31*, 444–452, doi:10.1016/S2212-5671(15)01219-8.
11. Khai, H.V. Assessing Consumer Preferences for Organic Vegetables: A Case Study in the Mekong Delta, Vietnam. *Inf. Manag. Bus. Rev.* **2015**, *7*, 41–47.
12. Sivathanu, B. Factors Affecting Consumer Preference towards the Organic Food Purchases. *Indian J. Sci. Technol.* **2015**, *8*, 1–6, doi:10.17485/ijst/2015/v8i1/78261.
13. Hsu, S.-Y.; Chang, C.-C.; Lin, T.T. An analysis of purchase intentions toward organic food on health consciousness and food safety with/under structural equation modeling. *Br. Food J.* **2016**, *118*, 200–216, doi:10.1108/bfj-11-2014-0376.
14. Rigby, D.; Cáceres, D. Organic farming and the sustainability of agricultural systems.

*Agric. Syst.* **2001**, *68*, 21–40, doi:10.1016/S0308-521X(00)00060-3.

15. Hass, R.; Canavari, M.; Slee, B.; Tong, C.; Anurugsa, B. *Looking East, Looking West: Organic and Quality Food Marketing in Asia and Europe*; Academic Publishers: Wageningen, The Netherlands, 2010.
16. Barataud, F.; Aubry, C.; Wezel, A.; Mundler, P. Management of drinking water catchment areas in cooperation with agriculture and the specific role of organic farming. Experiences from Germany and France. *Land Use Policy* **2014**, *36*, 585–594, doi:10.1016/j.landusepol.2013.10.010.
17. Schoumans, O.F.; Chardon, W.J.; Bechmann, M.E.; Gascuel-Odoux, C.; Hofman, G.; Kronvang, B.; Rubæk, G.H.; Ulén, B.; Dorioz, J.-M. Mitigation options to reduce phosphorus losses from the agricultural sector and improve surface water quality: A review. *Sci. Total Environ.* **2014**, *468–469*, 1255–1266.
18. Sun, W.-X.; Huang, B.; Qu, M.-K.; Tian, K.; Yao, L.-P.; Fu, M.-M.; Yin, L.-P. Effect of Farming Practices on the Variability of Phosphorus Status in Intensively Managed Soils. *Pedosphere* **2015**, *25*, 438–449.
19. Shin, H.-J.; Jeon, C.-H.; Choi, I.-C.; Yeon, I.-C. Estimation of Beneficiary's Willingness to Pay in Mid.Down-Stream Area to the Water Quality Improvements in Upper Bukhan River Basin. *Seoul Stud.* **2009**, *10*, 91–106. (In Korean)
20. Choi, I.-C.; Kim, H.-N.; Shin, H.-J.; Tenhunen, J.; Nguyen, T.T. Willingness to Pay for a Highland Agricultural Restriction Policy to Improve Water Quality in South Korea: Correcting Anomalous Preference in Contingent Valuation Method. *Water* **2016**, *8*, 547.
21. Fripp, E.; Shantiko, B. *Payment for Ecosystem Services (PES): Assessment of PES Potential in Kapuas Hulu*; Working Paper 165; Center for International Forestry Research (CIFOR): Bogor, Indonesia, 2014.
22. Organisation for Economic Co-operation and Development (OECD). *The Environmental Effects of Agricultural Land Diversion Programs*; OECD: Paris, France, 1997.
23. Baylis, K.; Peplow, S., Rausser, G., Simon, L. Agri-environmental policies in the EU and United States: A comparison. *Ecol. Econ.* **2008**, *65*, 753–764.
24. Gómez-Baggethun, E.; de Groot, R.; Lomas, P.L.; Montes, C. The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes. *Ecol. Econ.* **2010**, *69*, 1209–1218.
25. Boisvert, V.; Méral, P.; Froger, G. Market-Based Instruments for Ecosystem Services: Institutional Innovation or Renovation? *Soc. Nat. Resour.* **2013**, *26*, 1122–1136.

26. Lamba, P.; Filson, G.; Adekunle, B. Factors affecting the adoption of best management practices in southern Ontario. *Environmentalist* **2009**, *29*, 64, doi:10.1007/s10669-008-9183-3.
27. Ullah, A.; Shah, S.N.M.; Ali, A.; Naz, R.; Mahar, A.; Kalhoro, S.A. Factors affecting the adoption of organic farming in Peshawar-Pakistan. *Agric. Sci*. **2015**, *6*, 587–593.
28. Patil, S.; Reidsma, P.; Shah, P.; Purushothaman, S.; Wolf, J. Comparing conventional and organic agriculture in Karnataka, India: Where and when can organic farming be sustainable? *Land Use Policy* **2014**, *37*, 40–51.
29. Sarker, M.A.; Itohara, Y.; Hoque, M. Determinants of adoption decisions: The case of organic farming in Bangladesh. *Ext. Farming Syst. J.* **2010**, *5*, 39–46.
30. Mabuza, M.L.; Sithole, M.M.; Wale, E.; Ortmann, G.F.; Darroch, M.A.G. Factors influencing the use of alternative land cultivation technologies in Swaziland: Implications for smallholder farming on customary Swazi Nation Land. *Land Use Policy* **2013**, *33*, 71–80.
31. Constance, D.-H.; Choi, J.-Y. Overcoming the Barriers to Organic Adoption in the United States: A Look at Pragmatic Conventional Producers in Texas. *Sustainability* **2010**, *2*, 163–188, doi:10.3390/su2010163.
32. Mahoney, P.R.; Olson, K.D.; Porter, P.M.; Huggins, D.R.; Perillo, C.A.; Kent Crookston, R. Profitability of organic cropping systems In Southwestern Minnesota. *Renew. Agric. Food Syst.* **2004**, *19*, 35–46.
33. Delbridge, T.-A.; King, R.P. Transitioning to Organic Crop Production: A Dynamic Programming Approach. *J. Agric. Resour. Econ*. **2016**, *41*, 481–498.
34. Nyongesa, J.M.; Bett, H.K.; Lagat, J.K.; Ayuya, O.I. Estimating farmers' stated willingness to accept pay for ecosystem services: Case of Lake Naivasha watershed Payment for Ecosystem Services scheme-Kenya. *Ecol. Process.* **2016**, *5*, 15, doi:10.1186/s13717-016-0059-z.
35. Cummings, R.G.; Brookshire, D.S.; Schulze, W.D. *Valuing Environmental Goods: A State of the Arts Assessment of the Contingent Valuation Method*; Roweman and Allanhelds: Totowa, NJ, USA, 1986.
36. Mitchell, R.C.; Carson, R.T. *Using Surveys to Value Public Goods: The Contingent Valuation Method*; Resource for the Future: Washington, DC, USA, 1989.
37. Freeman, A.M. *The Benefits of Environmental Improvement: Theory and Practice*; Johns Hopkins University Press: Baltimore, MD, USA, 1979.

38. Arrow, K.J.; Solow, R.M.; Portney, P.R.; Leamer, E.E.; Radner, R.; Schuman, H. Report of the NOAA-Panel on Contingent Valuation. *Fed. Regist.* **1993**, *58*, 4601–4614.
39. Hanemann, W.M.; Loomis, J.; Kanninen, B. Statistical efficiency of double bounded dichotomous choice contingent valuation. *Am. J. Agric. Econ.* **1991**, *73*, 1255–1263.
40. Haab, T.C.; McConnell, K.E. *Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation*; Edward Elgar Publishing: Cheltenham, UK, 2002.
41. Hanemann, W.M. Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses. *Am. J. Agric. Econ.* **1984**, *66*, 332–341.
42. Cameron, T.A. Interval Estimates of Non-Market Resource Values from Referendum Contingent valuation Surveys. *Land Econ.* **1991**, *67*, 413–421.
43. Kennedy, P.E. Estimation with Correctly Interpreted Dummy Variables in Semilogarithmic Equations. *Am. Econ. Rev.* **1981**, *71*, 801.
44. Seoul, Seoul Statistical Yearbook, Seoul Metropolitan Government. 2014. Available onlin e: http://ebook.seoul.go.kr/Viewer/ZV975O62TBCW (accessed on 31 January 2017).
45. Hughner, R.S.; Mcdonagh, P.; Prothero, A.; Shultz, C.J.; Stanton, J. Who are organic food consumers? A compilation and review of why people purchase organic food. *J. Consum. Behav.* **2007**, *6*, 1479–1838, doi:10.1002/cb.210.
46. Owusu, V.; Anifori, M.O. Consumer Willingness to Pay a Premium for Organic Fruit and Vegetable in Ghana. *Int. Food Agribus. Manag.* **2013**, *16*, 67–86.
47. Aryal, K.P.; Chaudhary, P.; Pandit, S.; Sharma, G. Consumers' Willingness to Pay for Organic Products: A Case from Kathmandu Valley. *J. Agric. Environ.* **2009**, *10*, 15–26, doi:10.3126/aej.v10i0.2126.
48. Haghiri, M.; Hobbs, J.E.; McNamara, M.L. Assessing consumer preferences for organically grown fresh fruit and vegetables in Eastern New Brunswick. *Int. Food Agribus. Manag.* **2009**, *12*, 81–99.
49. Janssen, M.; Hamm, U. The mandatory EU logo for organic food: Consumer perceptions. *J. Consum. Behav.* **2012**, *114*, 335–352.
50. Kim, H.; Heo, S.W.; Lee, J.Y. *An Analysis of Social and Economic Effects on the Certification for Environment-Friendly Agricultural Products Dankook University Report*; National Agricultural Products Quality Management Service (NAQS): Seoul, Korea, 2009. (In Korean).
51. Stevenson, J.R.; Serraj, R.; Cassman, K.G. Evaluating conservation agriculture for small-scale farmers in Sub-Saharan Africa and South Asia. *Agric. Ecosyst. Environ.* **2014**, *187*,

1–10.

52. Tiwari, K.R.; Sitaula, B.K.; Nyborg, I.L.; Paudel, G.S. Determinants of Farmers' Adoption of Improved Soil Conservation Technology in a Middle Mountain Watershed of Central Nepal. *Environ. Manag.* **2008**, *42*, 210–222, doi:10.1007/s00267-008-9137-z.
53. Menozzi, D.; Martina F.; Michele, D. Farmer's motivation to adopt sustainable agricultural practices. *BAE* **2015**, *4*, 125–147, doi:10.13128/BAE-14776.
54. Nguyen, T.T.; Hoang, V.-N.; Seo, B. Cost and environmental efficiency of rice farms in South Korea. *Agric. Econ.* **2012**, 43, 369–378.
55. Ryan, R.; Erickson, D.; De Young R. Farmers' Motivations for Adopting Conservation Practices along Riparian Zones in a Mid-western Agricultural Watershed. *J. Environ. Plan. Manag.* **2003**, *46*, 19–37, doi:10.1080/713676702.
56. Roebeling, P.C.; Cunha, M.C.; Arroja, L.; van Grieken, M.E. Abatement vs. treatment for efficient diffuse source water pollution management in terrestrial-marine systems. *Water Sci. Technol.* **2015**, *72*, 730–737, doi:10.2166/wst.2015.259.
57. Gren, I.-M. Resilience value of constructed coastal wetlands for combating eutrophication. *Ocean Coast Manag.* **2010**, *53*, 358–365.
58. Laukkanen, M.; Huhtala, A. Optimal Management of a Eutrophied Coastal Ecosystem: Balancing Agricultural and Municipal Abatement Measures. *Environ. Resour. Econ.* **2008**, *39*, 139–159, doi:10.1007/s10640-007-9099-2.
59. Roebeling, P.C.; Van Grieken, M.E.; Webster, A.J.; Biggs, J.; Thorburn, P. Cost-effective water quality improvement in linked terrestrial and marine ecosystems: A spatial environmental–economic modelling approach. *Mar. Freshw. Res.* **2009**, *60*, 1150–1158.
60. Gren, I.M. Adaptation and mitigation strategies for controlling stochastic water pollution: An application to the Baltic Sea. *Ecol. Econ.* **2008**, *66*, 337–347.
61. Söderqvist, T. Constructed wetlands as nitrogen sinks in southern Sweden: An empirical analysis of cost determinants. *Ecol. Eng.* **2002**, *19*, 161–173.
62. Motallebi, M.; Hoag, D.L.; Tasdighi, A.; Arabi, M.; Osmond, D.L. An economic inquisition of water quality trading programs, with a case study of Jordan Lake, NC. *J. Environ. Manag.* **2017**, *193*, 483–490.
63. Corrales, J.; Naja, G.M.; Bhat, M.G.; Miralles-Wilhelm, F. Water quality trading opportunities in two sub-watersheds in the northern Lake Okeechobee watershed. *J. Environ. Manag.* **2017**, *196*, 544–559.
64. Elofsson, K. Cost-effective reductions of stochastic agricultural loads to the Baltic Sea.

*Ecol. Econ.* **2003**, *47*, 13–31.

65. Gren, I.M.; Savchuk, O.P.; Jansson, T. Cost-Effective Spatial and Dynamic Management of a Eutrophied Baltic Sea. *Mar. Resour. Econ.* **2013**, *28*, 263–284, doi:10.5950/0738-1360-28.3.263.
66. Lescot, J.M.; Bordenave, P.; Petit, K.; Leccia, O.A. spatially distributed cost-effectiveness analysis framework for controlling water pollution. *Environ. Model. Softw.* **2013**, *41*, 107–122.
67. Laukkanen, M.; Ekholm, P.; Huhtala, A.; Pitkänen, H.; Kiirikki, M.; Rantanen, P.; Inkala, A. Integrating ecological and economic modeling of eutrophication: Toward optimal solutions for a coastal area suffering from sediment release of phosphorus. *Ambio* **2009,** *38*, 225–235.

## 3.9. Supplementary materials

Table S3.1: Profile of downstream survey respondents.

| Characteristics | Description | Buyers (N: 105) | Non-buyers (N: 105) | Total (N: 210) |
|---|---|---|---|---|
| | | Mean (Std. Dev.) | | |
| Age | Years | 46.6 (10.5) | 47.1 (10.9) | 46.9 (10.7) |
| Number of Children | N | 2.5 (1.2) | 2.5 (1.1) | 2.5 (1.1) |
| | | Percentage (%) | | |
| Education | Primary | 0.0 | 1.9 | 1.0 |
| | Secondary | 4.8 | 4.8 | 4.8 |
| | High | 51.4 | 46.7 | 49.0 |
| | University | 43.8 | 46.7 | 45.2 |
| Income [a] | 10–20 | 3.8 | 1.9 | 2.9 |
| | 21–30 | 17.1 | 19.0 | 18.1 |
| | 31–40 | 21.0 | 22.9 | 21.9 |
| | 41–50 | 36.2 | 35.2 | 35.7 |
| | 51–60 | 16.2 | 17.1 | 16.7 |
| | >61 | 5.7 | 3.8 | 4.8 |

[a] Unit = million in KRW.

Table S3.2: Summary for the yes response regarding the WTP of downstream respondents.

| | Yes Response Rate for the willIngness to Pay for the Water Quality Improvement |
|---|---|
| Buyers | 90.5% ($N$ = 95) |
| Non-Buyers | 85.7% ($N$ = 90) |
| Total respondents | 88.1% ($N$ = 185) |

Table S3.3: Response results for bid values and proportion of downstream respondents.

| 1st bid | 2nd bid (upper) | 2nd bid (lower) | Yes/Yes response | Yes/No response | No/Yes response | N/N response | Total Response |
|---|---|---|---|---|---|---|---|
| Bids (KRW [a]) | | | N | | | | |
| 2000 | 3000 | 1000 | 10 | 10 | 7 | 17 | 44 |
| 4000 | 5000 | 3000 | 6 | 3 | 0 | 38 | 47 |
| 6000 | 7000 | 5000 | 9 | 1 | 1 | 36 | 47 |
| 8000 | 9000 | 7000 | 2 | 3 | 0 | 42 | 47 |

[a] KRW means the currency of South Korea and US$1.00 = KRW 1055.4, at the time of the survey (2013).

Table S3.4: Description of the variables used in the bivariate Probit model.

| Variables | Description | Type of Measure | Expected Sign |
|---|---|---|---|
| WTP | Whether a consumer has a willingness to pay or not | Dummy (1 if yes, 0 if no) | N.A. |
| Bid | Bid amount in KRW [a] as a tax paid for water quality improvement per month | Bid | negative |
| Buyer | 1 if respondent bought environmentally friendly farming products, 0 otherwise | Dummy (1 if yes, 0 if no) | positive |

Table S3.5: Reasons for the no response regarding WTP of downstream respondents.

| Reasons | N (%) |
|---|---|
| I can not afford it financially | 15 (60) |
| The central government should be responsible for the payment for the water quality improvement | 2 (8) |
| The local government should be responsible for the payment for the water quality improvement | 3 (12) |
| No response | 5 (20) |
| Total | 25 (100) |

Table S3.6: Descriptions of variables used in OLS model and their marginal effects.

| Variables | Description | Mean (s.e) | Calculated Values by Marginal Effect (KRW [a]) |
|---|---|---|---|
| *Age* | Age of respondents (years) | 46.9 (10.7) | N.A |
| *Edu* [b] | Education level | 3.4 (0.6) | N.A |
| *Income* [c] | Household income (10000 KRW) | 4.6 (1.2) | N.A |
| *Children* | Whether respondent households have children (1: yes, 0: no) | 0.9 (0.3) | N.A |
| *Label* | Whether respondents know EFA-labels (1: yes, 0: no) | 0.8 (0.4) | 924 |
| *Future purchase intension of EFF products* | Whether respondents want to purchase environmentally friendly products in future (1: yes, 0: no) | 0.5 (0.5) | N.A |
| *Average expenditure of EFF products* | Whether there is a dollar amount that respondents are going to spend on purchasing environment-friendly agricultural products (10,000KRW) | 0.5 (0.5) | N.A |
| *Future purchase willingness of current consumers with EFF products* | Interaction between *Future purchase intension of EFF products* and *Average expenditure of EFF products* | 0.3 (0.4) | 3120 |

[a] KRW means the currency of South Korea and US$1.00 = KRW 1055.4, at the time of the survey (2013); [b] 0 = no formal education; 1 = primary education; 2 = secondary education; 3 = high school; 4 = college and university; [c] 1 = less than 10,000,000 KRW, 2 = 1~2,000,000 KRW, 3 = 2~30,000,000 KRW, 4 = 3~40,000,000 KRW, 5 = 4~50,000,000 KRW, 6 = 5~60,000,000 KRW, 7 = 6~70,000,000 KRW, 8 = 7~80,000,000 KRW.

Table S3.7: Average income loss during transition periods from conventional farming to environmentally friendly farming.

| Year | N | Average Annual Income Loss [KRW [a] 10,000/ha] |
|---|---|---|
| 1 | 48 | 1357 |
| 2 | 48 | 1519 |
| 3 | 46 | 1549 |
| 4 | 41 | 1612 |
| 5 | 38 | 1635 |

[a] Unit: US$1.00 = KRW 1055.4, at the time of the survey (2013).

Table S3.8: The reasons not to adopt environmentally friendly farming of upstream farmers.

| Reasons | Conventional Farmers ($N$ = 45) | Partially Converted Farmers ($N$ = 26) | Total ($N$ = 71) |
|---|---|---|---|
| Higher profitability in conventional farming | 10 (22.2) | 13 (50.0) | 23 (32.4) |
| Old age (aging) | 17 (37.8) | 6 (23.1) | 23 (32.4) |
| Lack of labors | 5 (11.1) | 1 (3.8) | 6 (8.5) |
| Lack of skills utilizing advanced technology for EFF | 3 (6.7) | NA | 3 (4.2) |
| Large farmland size | 1 (2.2) | 2 (7.7) | 3 (4.2) |
| Other reasons | 9 (20.0) | 4 (15.4) | 13 (18.3) |

Table S3.9: The comparison of mean values between survey sample and Seoul samples.

| Variable | Seoul Sample | | Survey Sample | | |
|---|---|---|---|---|---|
| | Mean | SD. | Mean | SD. | Standardized mean difference (SMD) [a] |
| Income of households (KRW 10,000 in 2013) | 4394 | 4129 | 4149 | 1198 | 0.08 |
| N | 3798 | | 210 | | |

[a] SMD calculated using Cohen's d procedures.

# Chapter 4: Farmers and consumers' preferences for drinking water quality improvement through land management practices: The case study of Soyang watershed in South Korea

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## 4.1. Abstract

Drinking water quality along Soyang watershed has been affected negatively by intensive agricultural practices in the upstream area. Our study used a choice experiment method to estimate the values that upstream water providers (i.e. farmers) and downstream water users (i.e. consumers) attach to the following attributes: agricultural profits, water quality and biodiversity level of the Soyang watershed in South Korea. The preferences of upstream water providers and downstream water users were presented by conditional logit model and with interactions. Results from the conditional logit model specifications revealed that water quality is the most important attribute preferred by downstream water users and upstream farmers. Both upstream farmers and downstream water users put substantial values on the protection of water bodies of Soyang watershed, and are concerned about the consequences of water use on the environment and human health. The respondents in each income group and different local communities with income levels seemed to have different implicit costs for water quality improvement of the Soyang watershed. This paper provides the valuable information to water management policy makers with the importance of the water quality-related services associated with different stakeholders and income levels.

**Key words**: choice experiment, stated preference, conditional logit model, water quality improvement

## 4.2. Introduction

Sustainable water resource management is important to support human life and agricultural production processes as well as to provide water-related ecosystem services [1-2]. As water quality degradation is becoming more serious in some parts of the world, particular attention has been increasingly paid to protecting the water quality of watershed at multiple scales. In a upstream watershed, improper farm management can lead to land degradation, soil depletion and water pollution in a river basin [3]. Given harmful effects of water quality degradation through inappropriate land use management, it is imperative that we consider relevant options for improved land use management and sustainable water management [4]. For example, changes in farm management such as adoption of advanced farming methods can have the potential to mitigate negative impacts on and to gain various benefits from the environment.

In South Korea, Soyang watershed is facing a serious water pollution caused by intensive farming activities in upstream mountainous area [5]. The upstream watershed in Gangwon Province is surrounded by intensively managed highland farming which cultivates Chinese cabbage and radish with overuse of chemical fertilizers and pesticides. The watershed has water pollution problems due to soil erosion and influx of the chemicals by heavy rainfalls during monsoon season. The reduction of water pollution is relevant for upstream and downstream households for ensuring access to clean water in the watershed.

Identifying the trade-offs between human activities and environmental protection is important. However, the trade-offs often face challenges due to lacking information about monetary values of the public and private goods and services. The information on monetary values of environmental resources can be produced by using nonmarket valuation techniques such as stated preferences [6]. Stated preference techniques are mainly applied to estimate their non-use values of nonmarket goods and services with no price tag. Within stated preference techniques, choice experiment (CE) method easily demonstrates respondents' choices among the presented alternatives. It offers a flexible design with respect to hypothetical scenarios through surveys. Moreover, it derives welfare estimates via marginal willingness to pay (WTP) or to accept (WTA) estimation for policy implication. In stated preference techniques, CE method can estimate various benefits that might be produced by several governmental interventions and their trade-offs.

The number of existing studies using CE method have shown an importance of improving water quality in diverse geographical scales. The previous research focused on reduction of eutrophication [7-8], on individuals' WTP for reducing environmental health risks related with water quality [9], and biodiversity levels for water quality improvement with the existence of preference heterogeneity[10]. Several studies examined the households' preferences of the heterogeneous water attributes [11] and estimated their marginal WTP using CE [12]. Some studies elicited WTA compensation for the conversion to environment-friendly agricultural practices and compared this with WTP for water quality [13]. However, few studies have investigated the willingness to pay for water quality improvement by providing hypothetical scenarios with several choice sets simultaneously to both upstream resource managers and downstream water users.

Accordingly, in valuing environmental changes in water quality and biodiversity levels through different agricultural practices, their preferences between upstream farmers and downstream water users might be different, even though they both perceive the importance of safe drinking water resources. Therefore, our study focused on the questions: what do the upstream and downstream respondents prefer given the trade-offs between agricultural practices with different agricultural profits and environmental conservation involved? Is there a difference in their preferences? Moreover, we estimate the marginal WTP for the water quality by both respondents, based on three selected attributes of the options – their impacts on water quality, on biodiversity in the Soyang watershed and on agricultural profits through different land use practices. We explore the application of CE method at both upstream and downstream within the study area.

Therefore, the first purpose of this study was to analyze upstream and downstream respondents' preferences in the Soyang watershed of South Korea, providing for the agricultural profit options with different environmental attributes including water quality and biodiversity levels. Its second purpose was to examine upstream and downstream households' WTP by eliciting their preferences using conditional logit model (CLM) and CLM with interactions in CE method.

## 4.3. Method

### 4.3.1. Study region

The study regions were selected in both the upstream area of Soyang lake, Gangwon Province (latitude 37°02'N–38°37'N and longitudes 127°05'E–129°22'E) and the downstream area, Seoul (latitude 37° 33' N, longitude 126° 58' E) in South Korea. The watershed has an considerable importance with respect to the drinking water resources and endangered species in South Korea. The Soyang Lake flows mainly from three districts, Inje, Hongcheon and Yanggu in Gangwon Province into the metropolitan areas of South Korea, in particular, Seoul. The Soyang watershed (2,694.35 $km^2$) is the largest tributary located North of the Han River in South Korea. The watershed is used as a major drinking water source for the downstream area with a population of about 10 million people. In the upstream area of Soyang watershed, the selected three districts in the Province were initial nonpoint pollution source management areas due to inappropriate land use activities which result in water degradation along the watershed [5].

The water quality of the watershed is generally in good conditions. However, when heavy rains occurred in monsoon periods, high levels of turbidity with sediment yields had an significant influence on and decreased water quality in the downstream watershed [14]. In particular, a crucial contributor affecting the muddy water is the highland agricultural land use in mountainous area. The mainly cultivated crops such as Chinese cabbage and radish, are dependent on heavy use of chemical fertilizers and pesticides in the upstream area. The muddy water led to eutrophication and pollution of the watershed. Due to the excessive inputs of N and P from intensively managed conventional farming in the mountainous area, the watershed quality degradation occurred from the most clean drinking water quality, grade 1, used in South Korea to seriously bad water quality, grade 3, which is not for tap water use. This led to the reduction of biodiversity and posed a serious threat to aquatic ecosystem. Therefore, issues on water quality protection of Soyang watershed have been emerged in local and national scales for water quality improvement in South Korea.

### 4.3.2. Choice experiment method

The CE method weights individual behaviors through statistically estimating the parameters of models derived from the random utility theory (RUT) [15]. It is consistent with RUT in an econometric basis [16-18]. According to Lancaster [15], consumers obtained their utility from their attributes, not from goods themselves. This is identified by asking respondents to state their own preferences for alternative choice sets including different attribute levels. The choice sets with various attribute levels are produced by systematic combinations of the levels. Consequently, based on RUT, the selected sequence in offered choice sets is employed in the maximum likelihood estimation among the alternatives, which can present the probability of a chosen alternative by econometric analysis. In random utility models, welfare measures can be estimated with individual WTP compensation for a change in offered attributed levels. The welfare measurements estimations are gained from applying a conditional logit model [19-20].

In CE method, a basic conditional logit model rooted on the Independence on Irrelevant Alternatives (IIA) property, deriving from the independently and identically distributed (i.i.d.) of error terms. It is assumed that utility rely on their choice sets made from *C*, which means a choice set with possible alternatives. The indirect utility function ($U_i$) for each respondent *i* can be composed into additive and independent parts: a deterministic component (V) which is determined by the attributes of the alternatives in the choice experiment and characteristics of the respondent, and a stochastic component (e) which means unobservable influences on individual choice. The assumed utility function *U* is:

$$U_{ij} = V(Z_{ij} + \varepsilon_i), \tag{1}$$

where for any respondents *i*, a given level of utility is linked with any option $j$. $Z_{ij}$ denotes its attributes from the option *j* for respondent *i.* Based on RUT, the utility levels of respondents have a deterministic component V-vector, $V(\bullet)$,indicating the goods has an influence on respondents' preferences, and stochastic error variables $\varepsilon_i$ which means all other unobservable components affecting the decision process of respondents. Individuals are assumed to compare all of the alternatives j in each of the choice cards and select the alternative which have the highest utility. A conditional logit model is formulated as below:

$$P(y_i = j) = P_{ij} = \frac{\exp\left(\mu V(Z_{ij})\right)}{\sum_{h=1}^{C} \exp(\mu V(Z_{ih}))} \tag{2}$$

The probability of individual i choosing alternative i out of J alternatives. $\mu$ is a scale parameter which is inversely proportional to the standard deviation of the error distribution. This parameter cannot be separately identified and is therefore typically assumed to be one, implying a constant error variance. The indirect utility function can be generally produced by taking a linear functional form. In order to show an explicit expression for this probability, it is essential to know the distribution of the error terms. A typical assumption is that they are i.i.d. with an extreme-value (Weibull) distribution. This distribution for the error term means that the probability of any particular alternative being chosen as the most preferred can be expressed in terms of the logistic distribution, which lead to a specification known as conditional logit model (CLM) [19]:

$$V_{ij} = \mu(\beta + \beta_1 Z_1 + \beta_2 Z_2 + \cdots\cdots\cdots + \beta_n Z_n) \tag{3}$$

where $\beta$ denotes the alternative specific constant (ASC), indicating utility of any attributes not included in choice of presented attributes and capturing the effects on the utility of any attributes not contained in choice specific attributes. $n$ is the number of considered attributes. The vector of attributes for options are indicated by coefficients $\beta_1$ to $\beta_n$. $\mu$ is assumed to be greater than 0 as a scale parameter. It is inversely proportional to error terms' standard deviation [21-22].

After parameter estimation, an economic value measure can be calculated via the following equation:

$$\text{CS} = \frac{\ln\sum_k \exp(V_{ki}) - \ln\sum_k \exp(V_{k0})}{\alpha} \tag{4}$$

where CS is a welfare estimate of the compensating surplus, α is the marginal utility of income, which indicates the coefficient of monetary attributes in CE. $V_{ki}$ and $V_{k0}$ are indirect utility functions as the change under the considered scenarios. Based on above CS equation, the reduced form, the substitution rate (SR) by Hanemann [23] can be written as follows:

$$\text{SR} = -1\left(\frac{\beta_{attribute}}{\beta_{monetaryattribute}}\right) \tag{5}$$

In econometric analysis, this basic CLM was used in the initial stage of CE method. The recent frontier of the analysis tends to utilize the econometric models relaxing strict assumption of the conditional model which reflects the heterogeneity such as CLM with interactions [24-27]. This is because the classic CLM imposes the i.i.d assumption including homogeneous preferences across alternatives with strict IIA property. This property indicates the relative probabilities of two options being selected have no influence on the suggestion or removal of other alternatives. This property derives from the independence of the error terms across the different options included in the choice set. The CLM with interactions can account for heterogamous preference and does not have the IIA property as improved welfare estimates reflecting accuracy and reliability.

The calculation of the marginal willingness to pay (MWTP) is based on an interpretation of the parameter of the price/profit attribute being equal to the marginal utility of income [28]. If 'X' is composed of '$X_1$, $X_2$, ., $X_n$' attributes the implicit price/profit (or willingness-to-pay/accept) relevant to any individual attribute. The specific formula can be written as follows:

$$P_n = -\beta_n/\alpha, \tag{6}$$

where'α' is the parameter estimate of the price/profit variable 'P' and '$\beta_n$' is the parameter estimate of the specific attribute 'Xn'. Standard errors and confidence intervals can also be calculated for these implicit prices, although there is still significant argument about which method is the most appropriate to use [29].

Thus, estimation results of the main effects models are presented with a conditional indirect utility function. A basic conditional logit model refers to the main effect model, only considering the direct effects of the characteristics of the choice, as our baseline model specification. The conditional logit models with interactions incorporating socio-economic variables are estimated to show systematic and random preference heterogeneity. In our study, considering the socio-economic variables, interaction terms regarding income levels (low/middle/high income) and districts (upstream/downstream) are included. In a two-way interaction, the basic attribute variables (agricultural profit, water quality and biodiversity) are interacted with three income levels. For example, the interaction term, low income level*agricultural profit, was used based on the income percentiles in the total sample. These interactions imply the effect of different characteristics according to each income level on the probability that a respondent will select their presented options. This means that how the basic variables modify the effects of income and district on the probability of choice in choice sets.

Moreover, in order to identify different preferences of local communities in three income levels, upstream and downstream variables were used with three-way interactions by districts and income levels. For instance, the three-way interaction term, upstream*low income level*agricultural profit, was used based on the income percentiles in the total sample. Associated with hypothetical changes in the attributes in Soyang watershed calculated by low, middle, and high income groups, the MWTP for individual attribute, *k* can be estimated as below:

Low income level: $\mathrm{MWTP}_k^{low} = -\beta_{low*k} / \beta_{low*price}$

Middle income level: $\mathrm{MWTP}_k^{med} = -\beta_{med*k} / \beta_{mid*price}$

High income level: $\mathrm{MWTP}_k^{high} = -\beta_{high*k} / \beta_{high*price}$ (7)

Regarding three-way interactions, this included the MWTP for individual attribute, *k* and this can be written as below:

Upstream: $\mathrm{MWTP}_k^{upstream} = -\beta_{upstream*k} / \beta_{upstream*profit}$

Downstream: $\mathrm{MWTP}_k^{downstream} = -\beta_{downstream*k} / \beta_{downstream*profit}$ (8)

This is related with hypothetical changes in the attributes in Soyang watershed calculated by low/middle/high income groups and different upstream/downstream districts. The MWTPs for the water quality are calculated based on parameter estimates from Table 4.5, showing the water quality is a significant factor in each income level.

### 4.3.3. Survey design and data collection

One consistent set of questionnaires was designed for both upstream farmers in Gangwon Province and downstream water users in Seoul. The farm household's' survey was administrated in between March and April, 2011. The downstream households' survey was administrated in March, 2012. The surveys were undertaken through face-to-face interviews by a professional survey company with trained interviewers in order to avoid any misunderstanding about questions. The questionnaire described the choice set in order to ask respondents to read an information sheet easily with main characteristics of the options. Before the main questions, guidelines for attribute levels, alternative in choice sets and the number of choice questions were represented. Three attributes are described as agricultural profits, water quality levels and biodiversity levels. The questionnaire provided the information regarding a status quo or baseline option in Soyang watershed and two alternatives (Table 4.1). One option is the level of the status quo that we mentioned above. Other options are two alternatives showing adverse relationships between agricultural profits and environmental benefits such as lower water quality/biodiversity with offered higher agricultural profits. The socio-economic information and water quality change history of upstream area in Soyang watershed were included in the questionnaire. The total sample size of the respondents was 240 including 125 upstream farmers and 115 downstream consumers. The socio-economic background characteristics of the sample were provided in S4.1.

An orthogonal fractional factorial design was utilized by SPSS conjoint software [30]. This was randomly blocked and one choice card was comprised of three choice options. Twenty-seven choice sets were initially developed with three levels of each of three attributes. Each respondent was presented with 9 choice sets, each with two alternatives to the status quo. The detailed information about attributes was developed based on officially investigated data in South Korea. For example, the standard agricultural profit was the average agricultural income of Gangwon Province in 2011. The agricultural profit options had financial implications for farmers. Water quality levels were classified in accordance with the current grades issued by South Korea government. The biodiversity assessment focused on scarcity of endangered species that have an influence on the water quality options. Biodiversity levels were shown with the figures investigated in the upstream area and included the current number of amphibian, reptile and fish species.

The current level in the base option was agricultural profit KRW 15.60 million, level 2 of water quality and 0% of biodiversity. Based on this, we deleted the choice sets not showing rational trade-offs between agricultural profits and the other two environmental quality levels. This is because they would prefer both positive economic and environmental benefits if there is a situation with the higher profits and the better environment. Moreover, we informed the respondents that higher agricultural profits mean that it would be more costly to compensate for the reduced income loss. Three key attributes and levels for different agricultural profits through land use management regarding water quality and biodiversity were identified in Table 4.1. The data was coded according to the levels of attributes in conditional models. The models included socio-economic variables such as age, education level and income as interaction with the alternative-specific constant (ASC).

Table 4.1: Definition and levels of attributes

| Attribute | Definition | Level |
|---|---|---|
| ASC | Alternative specific constant for the choice between status quo or change options | 1 for the change options, otherwise 0 |
| Agricultural profit | Based on average agricultural profit per farm household in 2011, the level of farmers' profit was increased. | 13.56 (0%), *15.60 (15%),* 17.64 (30%) |
| Water quality level | Grade 1 for the 1st level of drinking water source, the cleanest level; Grade 2 for tap water source, swimming and recreational use; Grade 3 for not for tap water use, turbid color | level 1, *level 2,* level 3 |
| Biodiversity level | Basic biodiversity level according to districts-Hongcheon: 6 amphibian, 3 reptile, 22 fish species<br>Inje: 10 amphibian, 6 reptile, 22 fish species<br>Yanggu: 7 amphibian, 5 reptile, 22 fish species | *0 %,* 5 %, 10 % |

Note: Attribute levels in italics indicate the status quo level.

The CE application included the evaluation of multiple agricultural land use options in Soyang watershed, in terms of increases in attributes such as water quality and biodiversity level. The agricultural profits reflected official data for annual profit of conventional farming in 2011 in Gangwon Province, upstream areas of Soyang watershed in South Korea. Three water quality levels (Grade 1, 2 and 3) were provided to upstream farmers and downstream water users of the Soyang watershed. The biodiversity level included three levels. Three choice sets were included with one fixed attribute choice in each set and no duplicated choices in other two attributes. Unlike previous studies providing the costs or prices for estimation of the WTP in choice sets [31-32], our study included agricultural profit as proxy variable meaning increase in potential compensation costs from water users to farmers for changing agricultural practices.

As our study assessed upstream farmers and downstream water users' preferences for alternative scenarios of different agricultural profits that would lead to change in the environment, it provided the status quo level referred to the Soyang watershed situation happened in heavy rainy season with bad water quality problems to upstream farmers and downstream water users. We assumed that farmers might prefer higher agricultural profit even though their farming activities would have negative effects on the environments. We also assumed that downstream water users might prefer better environment than higher agriculture profits because they do not undertake substantial economic activities through agriculture and they receive the environmental benefits from the watershed. Contrary to other studies which considered environmental attributes and payment vehicles for the WTP experiments, this study used agricultural profits substituted for offered directed payments in the alternative scenario. The coefficients from the conditional models were used to calculate the implicit costs.

The definition of the variables used in the conditional logit models are shown in Table 4.2. These three dummy variables for each income category were interacted with the presented attributes using a two-way interaction. The variables of low, middle and high income levels represent income levels obtained from the face-to-face interviews. The three variables were used as the explanatory variables to understand differences in respondents' preferences by each income category. Farmers' income was calculated by annual costs and revenues of farm households. The consumers' income was investigated by their household annual income.

Table 4.2: Definition of the variables used in conditional logit models

| Variable | Definition |
|---|---|
| *ASC* | Alternative specific constant; 1 for current situation, 0 otherwise |
| *Agricultural profit* | Agricultural profit (KRW 100,000) in year 2011; Gangwon Province statistics applied (13.56, *15.60,* 17.64) |
| *Water quality* | 1 for bad water quality level, 2 for tap water quality level, 3 for clean water quality level |
| *Biodiversity* | Rate of biodiversity level; 0%, 15%, 30% |

| | |
|---|---|
| *Low income level* | 1 for low income level (less than 33rd centiles of real income), 0 otherwise |
| *Middle income level* | 1 for middle income level (between 33rd and 66th centiles), 0 otherwise |
| *High income level* | 1 for high income level (more than 66th centiles), 0 otherwise |
| *Low income level *Agricultural profit* | Interaction between low income level and *agricultural profit* |
| *Middle income level*Agricultural profit* | Interaction between middle income level and *agricultural profit* |
| *High income level*Agricultural profit* | Interaction between high income level and *agricultural profit* |
| *Low income level*Water quality* | Interaction between low income level and *water quality* |
| *Middle income level*Water quality* | Interaction between middle income level and *water quality* |
| *High income level* Water quality* | Interaction between high income level and *water quality* |
| *Low income level*Biodiversity* | Interaction between low income level and *biodiversity* |
| *Middle income level* Biodiversity* | Interaction between middle income level and *biodiversity* |
| *High income level* Biodiversity* | Interaction between high income level and *biodiversity* |
| *Upstream* | 1 for upstream districts in Gangwon Province (Inje, Yanggu, Hongcheon), 0 otherwise |
| *Downstream* | 1 for upstream districts in Seoul, 0 otherwise |
| *Upstream*Low/middle/high income level*Agricultural profit/water quality/biodiversity* | Interaction among *upstream, low/middle/high income level* and each attribute; *agricultural profit/water quality/biodiversity* |
| *Downstream*Low income level*Agricultural profit/water quality/biodiversity* | Interaction among *downstream, low/middle/high income level* and each attribute; *agricultural profit/water quality/biodiversity* |

## 4.4. Results

We presented three models with different forms. This included the basic model showing respondent's choices affected by the level of attributes. Moreover, additional two models were contained in two-way interactions with three income levels and three-way interactions with upstream and downstream households in three different income groups. All models have a good statistical model fit with McFadden' pseudo $R^2$ equal to about 0.3.

### 4.4.1. A basic conditional logit model

Table 4.3 shows the conditional logit results for a basic model (Model 1) including ASC and attributes. Variable ASC is positive and statistically significant, implying the respondents prefer their current situation to hypothetical scenario. Both agricultural profit and water quality coefficients are statistically significant at the 1% significance level, while the biodiversity level is statistically insignificant. This suggests that agricultural profit and water quality variables play important roles in respondents' decisions for the choice. The signs on the attributes are, in general, shown as expected. With respect to environmental attributes, it is interesting to observe that both agricultural profit and water quality level are positively affected, with the latter having much higher impact on their decisions than the former.

Table 4.3: The conditional logit result for a basic model regarding estimates of the determinants of option in choice.

| Variables | Model 1 |
|---|---|
| ASC | 0.270 (0.117)*** |
| Agricultural profit | 0.056 (0.005)*** |
| Water quality | 1.847 (0.158)*** |
| Biodiversity | 0.005 (0.017) |
| logL | -588.32 |
| N | 2160 |
| Pseudo $R^2$ | 0.256 |

Note: standard errors are presented in brackets; *** indicates statistical significance at the 1% level

### 4.4.2. Conditional logit model with interactions

Table 4.4 contains three income levels to be interacted with attributes in Model 2. Their coefficients were investigated as explanatory variables for respondents' monetary valuation. The ASC is statistically significant. The interaction terms with each income and water quality are significant explanatory variables meaning that the respondents with each income level present higher values for the water quality improvement of Soyang watershed. As expected, the coefficients on these variables are positive and highly statistically significant. It is interesting to observe that the interaction terms with biodiversity do not influence on the choice of respondents. The interaction terms, *Low income level*Agricultural profit*, *Middle income level*Agricultural profit* and *High income level*Agricultural profit*, represent the marginal utility of income for each level. Unlike the general assumption of negative relationship in the marginal utility of income, however, agricultural profits applied in our study show a positive relationship with the marginal utility.

Table 4.4: The conditional logit model for interactions with income levels.

| Variables | Model 2 |
|---|---|
| ASC | 0.300 (0.122)*** |
| Low income level*Agricultural profit | 0.062 (0.007)*** |
| Middle income level*Agricultural profit | 0.070 (0.008)*** |
| High income level*Agricultural profit | 0.019 (0.009)** |
| Low income level*Water quality | 1.922 (0.247)*** |
| Middle income level*Water quality | 2.014 (0.243)*** |
| High income level* Water quality | 1.404 (0.303)*** |
| Low income level*Biodiversity | -0.019 (0.025) |
| Middle income level*Biodiversity | 0.030 (0.027) |
| High income level*Biodiversity | 0.017 (0.034) |
| logL | -574.30 |
| N | 2160 |
| Pseudo $R^2$ | 0.274 |

Note: standard errors are presented in brackets; *** indicates statistical significance at the 1% level; ** indicates statistical significance at the 5% level.

Table 4.5 shows the result for upstream and downstream households with three income groups which includes the three-way interaction terms, upstream and downstream areas, low/middle/high income and three attributes (agricultural profit, water quality and biodiversity). The three-way interaction presents $R^2$ 0.298 among three models, meaning this model is better in explanation than other models that mentioned above. The model fit is improved by adding income and districts through three-way interactions. The log likelihood gets the better fit from -574.30 in model 1 to -556.16. The Pseudo $R^2$ increases from 0.256 to 0.298. This means that the model 3 is improved and has a more accurate model specification.

The parameter estimates in the model follow their expected signs, except the variables on the interactions with biodiversity. Regarding the agricultural profit variable, upstream and downstream respondents to be interacted with low and middle income levels are positive and highly statistically significant. Since all coefficients of interactions related to water quality are positive and highly statistically significant, it may be considered to be a substantial determinant of all respondents. The interaction term, *upstream*high income level*agricultural profi*t is, however, statistically significant at the 10% significance level, while the interaction term, *downstream*high income level*agricultural profit* is statistically insignificant.

Table 4.5: The conditional logit result for upstream farmers and downstream consumers regarding estimates of the determinants of option in choice.

| Variables | Coefficient | Std. Err. |
|---|---|---|
| ASC | 0.288*** | 0.132 |
| Upstream*Low income level*Agricultural profit | 0.060*** | 0.008 |
| Upstream*Middle income level*Agricultural profit | 0.116*** | 0.026 |
| Upstream*High income level*Agricultural profit | 0.024* | 0.015 |
| Downstream*Low income level*Agricultural profit | 0.068*** | 0.013 |
| Downstream*Middle income level*Agricultural profit | 0.063*** | 0.008 |
| Downstream*High income level*Agricultural profit | 0.019 | 0.012 |
| Upstream*Low income level*Water quality | 2.010*** | 0.295 |

| | | |
|---|---|---|
| Upstream*Middle income level*Water quality | 4.345*** | 0.954 |
| Upstream*High income level* Water quality | 2.344*** | 0.579 |
| Downstream*Low income level*Water quality | 1.203*** | 0.438 |
| Downstream*Middle income level*Water quality | 1.604*** | 0.243 |
| Downstream*High income level* Water quality | 1.009*** | 0.361 |
| Upstream*Low income level*Biodiversity | -0.035 | 0.030 |
| Upstream*Middle income level* Biodiversity | 0.031 | 0.075 |
| Upstream*High income level* Biodiversity | 0.071 | 0.057 |
| Downstream*Low income level*Biodiversity | 0.006 | 0.046 |
| Downstream*Middle income level* Biodiversity | 0.035 | 0.031 |
| Downstream*High income level* Biodiversity | -0.010 | 0.041 |
| logL | -556.16 | |
| N | 2163 | |
| Pseudo $R^2$ | 0.298 | |

Note: standard errors are presented in brackets; *** indicates statistical significance at the 1% level; * indicates statistical significance at the 10% level.

### 4.4.3. Marginal willingness to pay results for attributes in three income levels

Table 4.6 shows the MWTP results for the water quality in different income levels. The results of the MWTP show a change in each of the attribute values with the interactions. They indicate the monetary trade-offs between the two attributes, agricultural profits and water quality according to two-way interactions with income levels and three-way interactions including different districts and income levels.

The calculated value of middle income level is the lowest while the estimated MWTP of high income level is the highest. The calculated results for the water quality are significantly influenced by districts and income levels. The annual MWTPs for the upstream respondents range from KRW 3,484,673 to KRW 9,616,920. Regarding the upstream, the difference between low and middle income levels is relatively small. With respect to high income level, however, its MWTP is about 2.6 ~ 2.8 times higher than those of the other two levels. In the downstream respondents, the MWTP of high income level respondents is about

3 times as high as that of low income level group while the MWTP of the latter is about 1.4 times higher than that of the middle income level. With respect to the comparison between upstream and downstream, the difference in low income levels was about 2 times which was the highest compared to middle and high income level. Regarding the difference between upstream and downstream, upstream respondents with high income level is higher than those in downstream area about 1.8 times and upstream respondents with middle level is about 1.5 times higher than the downstream respondents.

Table 4.6: MWTP results in KRW for attributes in three income levels

| | Attribute | Low income level | Middle income level | High income level |
|---|---|---|---|---|
| | Water quality | 3,078,392 | 2,874,638 | 7,415,775 |
| Upstream | Water quality | 3,484,673 | 3,746,120 | 9,616,920 |
| Downstream | Water quality | 1,773,511 | 2,532,524 | 5,420,074 |

Unit = KRW

## 4.5. Discussion

The basic conditional logit model was used in its classic form due to the characteristics having homogeneity based on IIA assumption. The CLM with interactions incorporated socio-economic characteristics was applied to relax the assumption of homogeneity [25-26]. That is, this model with interactions improves model fit by allowing more heterogeneity removing IIA violations [33-34]. Thus, we compared a basic CLM and CLM with interactions to measure more accurate MWTP and to examine their preferences of the upstream farmers and downstream water users. The three conditional logit models were applied with containing an alternative specific constant (ASC), the attributes and interaction terms with income levels and different stakeholders (upstream and downstream housholds). A basic model included three attributes and ASC. To test if different income level households influence the presented choice option [29, 35], low and middle and high income levels of interviewed respondents are included in Table 4. Moreover, we added interaction terms with attributes, the income levels and different districts of the respondents in three-way interactions.

### 4.5.1. A basic conditional logit model

In a basic attribute specification, the coefficients of two attributes are statistically significant, except the attribute of biodiversity level. In the basic attribute specification model, the ASC is statistically significant. The coefficients of agricultural profit and water quality are positively and statistically significant at the 1% significance level in Table 3. The three variables, agricultural profits, water quality and biodiversity levels have positive signs. All coefficients of the choice attributes how the expected signs. Interestingly, the variable biodiversity is, however, not statistically significant. This is inconsistent with the result showing the importance of biodiversity [9,38]. It seemed that the upstream and downstream respondents have higher concerns about the conservation of the drinking water quality than that of biodiversity level.

### 4.5.2. A conditional logit model with two-way interactions

The result of model 2 could give further insight for how income level affects option choice. The signs of agricultural profit to be interacted with all income levels are positive. The variables *Low income level*Agricultural profit* and *Middle income level*Agricultural profit* are highly statistically significant at the 1% significance level. The *High income level*Agricultural profit* is statistically significant at the 5% significance level. It implies that low and middle income households are sensitive to agricultural profits. The variable ASC is positive and statistically significant meaning that respondents prefer current status to hypothetical scenarios. The biodiversity attribute for each income group is not statistically significant. This means that biodiversity in interaction with income levels is not a significant determinant of option choice. This is in contrast to results showing that economic value regarding biodiversity attribute could offer reliable information to estimate welfare losses by the reduction of biodiversity levels [38-39]. However, the interaction terms, *Low/Middle/High income level*Water quality* are highly statistically significant. It implies that the *water quality* in all income levels is an important factor on the choice option of respondents. This can be drawn that respondents weighted importance to increase in water quality levels to the Soyang watershed. This is in line with the previous studies showing customer places a high value on maintaining a clean water supply [36, 40-41].

Furthermore, the coefficients for water quality with the interactions of upstream farm and downstream households with income levels are highly statistically significant with a positive sign. It implies that the respondents are prone to significantly concern about the water quality in economic characteristics and districts affecting the water quality of Soyang watershed. This result can be explained by the fact that even though the role of respondents are different along the Soyang watershed, they are especially concerned about water quality level in Soyang watershed. This is in line with the result showing importance of socio-economic determinants in heterogeneous choice of respondents [42-44].

We further consider estimation results by the MWTP in order to identify the preference for water quality differentiated by each income range, the implicit costs were calculated using the coefficient of the agricultural profits. In the case of the Soyang watershed, the MWTP values for the water quality imply a change from one water quality level to another, meaning increase in one unit of water quality improvement through a change from reduction of fertilizers and pesticides leading to reduction in agricultural production. With respect to low, middle and high income level, the calculated annual MWTPs of the respondents range from KRW 2,874,638 to KRW 7,415,775 for reducing the water pollution from advanced agricultural farming practices. The result implies the MWTP for the water quality is significantly different between low/middle and high income levels. They suggest that the water quality improvement is considerably important in each income level and district in South Korea.

### 4.5.3. A conditional logit model with three-way interactions

The results with three-way interactions show the parameters of *Upstream/Downstream*Low/Middle income level*Agricultural profi*t are statistically significant at the 1% significance level. The parameter of *Upstream*High income level*Agricultural profit* is statistically significant at the 10% significance level. The coefficient of *Downstream*High income level*Agricultural profit*, is, however, not statistically significant. It implies that upstream and downstream respondents in low and middle income levels tend to prefer increases in water quality of the Soyang watershed. This means that the water quality improvement is not a significant determinants of the downstream high income respondents on the choice. Moreover, the parameters related with the biodiversity level with three way interactions are not a significant determinant on the choice of upstream and downstream respondents with each income group. This might be explained that different local communities have less perception about biodiversity conservation.

Moreover, we estimated the implicit costs, or MWTPs, for each of water quality attribute in different income levels by interaction with different stakeholders. When the two respondent groups are compared, it can be seen that the marginal values of the attributes are different at different income levels. The annual MWTPs of the upstream respondents for water quality range from KRW 3,484,673 (low), KRW 3,746,120 (middle) to KRW 9,616,920 (high) while those for the downstream respondents for the water quality vary from 1,773,511 (low), KRW 2,532,524 (middle) to KRW 5,420,074 (high). Regarding result from the upstream respondents, the difference of implicit costs between low and middle income levels is relatively small. The upstream respondents with high income level have the highest costs for improving water quality. With respect to downstream respondents, however, the implicit costs of upstream respondents are shown about 3 times differences in between low and high income levels while the implicit cost of low income level is differentiated with that of the middle income level by about 1.4 times. Overall, the difference of the implicit costs between low and middle income levels is relatively small in upstream and downstream respondents. With respect to high income level, the result of MWTP shows a big difference. Their disparity is larger in the interaction terms associated with districts and income levels. It implies that estimated marginal values are different in each income level and each stakeholder. The MWTP disparity between upstream and downstream householders in each income group is based on the fact that the downstream citizens have higher annual income than upstream farmers' annual net income.

With a relatively small sample size, it might be statistically limited to fully explain the heterogeneous existence in income and districts differences, which suggest a sample size enough to have statistical justification for their heterogeneity. Moreover, in South Korea, less studies focused on the use of CE method and researches related with biodiversity in stated preferences should be needed to enhance the perception of public. Further researches can be investigate the non-market benefits of biodiversity conservation and elicit the WTP for biodiversity attributes using CE method, as considering income and district effects among different stakeholders.

Estimating the social benefits of improving water quality can be interpreted as the opportunity costs for upstream farmers' forgone profits by change in their agricultural practices. Given that compensation for the income loss would imply forging the water quality improvements, we assumed that the agricultural profits mean farmers' income including their implicit compensation costs. This might be hypothesized that upstream and downstream households are willing to easily adopt for the options with the agricultural profits since they would compare their benefits and costs on the provision of ecosystem services as an actual actor for their farming activity. Subsequently, this results can provide meaningful insights for policy makers, with the importance of income-specific and district-specific differences associated with environment protection through agriculture in further researches.

Methodologically, there is a limitation that our study considered only CLM and CLM with interactions. In order to compare the results with advanced models, we recommend advanced models such as multinomial logit and random parameter logit models which allow control for heteroscedasticity over the choice sets should be utilized. This suggests, therefore, to use different model specifications accounting for heterogeneous preferences with careful construction of the choice sets and effective data collection. More importantly, the incorporated preferences differences between the districts at different income levels should be investigated in decision-making for the sustainable water management.

Once specific costs and WTP in the CE model have been provided to policy decision makers, the specific monetary values for environment can be the reference points for sustainable water management planning and designing. Thus, we suggest that inclusion of a cost attribute such as direct payments or agricultural program participation should be done with care in choice experiment to elicit monetary values for the environmental improvement. Further studies should focus on how choice experiment can be used to provide both welfare estimates corresponding to policy changes involving one or more attributes with offered direct payments and community ranking of multiple policy options.

## 4.6. Conclusions

Our study focused on understanding upstream farm and downstream households' preferences for water quality improvements in Soyang watershed of South Korea. We used the choice experiment as stated preference elicitation approaches to assess environmental benefits associated with water quality improvement of the watershed. This study attempted to estimate the value of water quality changes providing economic and geographical characteristics of upstream farmers and downstream households related to income levels.

With preferences of farmers and consumers associated with the environmental attributes, this study assessed the relative importance of three attributes (agricultural profits, water quality and biodiversity) and estimating the values related with various attribute levels. The most important attribute in upstream and downstream local communities was the same in water quality of the watershed. This provided important implications for different estimates of marginal willingness to pay for the water quality with farmers' the advanced farming management using less fertilizers and pesticides. Moreover, this study highlights the influence of both upstream farmer-based and downstream consumer-based decision-making approaches under the same hypothetical scenario as identified the upstream and downstream preferences for the same scenario. In the context of policy, estimating economic valuation of the benefits from water improvement can be a fundamental input for aiding the designing and productive sustainable water management policies.

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## 4.8. References

1. OECD. 1989. Water resource management: integrated policies. Paris, OECD.
2. Bruce, P.; Hooper. 2003. Integrated Water Resources Management and River Basin Governance. Universities Council on Water Resources Water Resources Update, issue 126, 12-20, November **2003.**
3. Holden, J.; Haygarth, P.M.; MacDonald, J.; Jenkins, A.;Sapiets, A.; Orr, H.G.; Dunn, N.; Harris, B.; Pearson, P.L.; McGonigle, D.; Humble, A.; Ross, M.; Harris, J.; Meacham, T.; Benton, T. *Agriculture's impacts on water quality*. Global Food Security, 2015, 21,.
4. Dabrowski, J.M.; Murray, K.; Ashton, P.J.; Leaner, J.J. Agricultural impacts on water quality and implications for virtual water trading decisions. *Ecol. Econ.*, *Volume* 68, Issue 4, 15 February **2009**, 1074-1082, ISSN 0921-8009, doi:10.1016/j.ecolecon.2008.07.016.
5. Lee, S.; Nguyen, T.T.; Poppenborg, P.; Shin, H.J.; Koellner, T. Conventional, Partially Converted and Environmentally Friendly Farming in South Korea: Profitability and Factors Affecting Farmers' Choice. *Sustainability* **2016**, *8*, 8, 704. doi:10.3390/su8080704.
6. Bateman, Ian J.; Carson, R. T., Day, B.; Hanemann, M.; Hanleys, N.H.T.; Jones-Lee, M.; Loomes, G.; Mourato, S.; Ozdemiroglu, E.; Pearce, D.; Sugden, R.; Swanson, J. Ec onomic valuation with stated preference techniques: a manual. 2002 Edward Elgar, Che

ltenham, UK. ISBN 1840649194.

7. Kosensius A.K. Heterogeneous preferences for water quality attributes: the case of eutrophication in the Gulf of Finland. *Ecol. Econ.,* 2010, *69*, 528-538, doi: 10.1016/j.ecolecon.2009.08.030.

8. Shrestha, R.K,; Alavalapati, J.R.R. Valuing environmental benefits of silvopasture practice: a case study of the Lake Okeechobee watershed in Florida.*Ecol. Econ.,* **2004**, *49*, 3,pp. 349-359.

9. Georgiou, S.; Langford, I.; Bateman, I.; Turner, K. Determinants of individuals' willingness to pay for perceived reductions in environmental health risks: A case study of bathing water quality. *Environ. Plann.,* **1998,** *30*, 577-594**.**

10. Eggert, H.; Olsson, B. Valuing multi-attribute marine water quality. *Mar. Policy*. **2009**, *33*, 201– 206.

11. Lee, DE.; Hosking, SG.; du Preez, M. A choice experiment application to estimate willingness to pay for controlling excessive recreational fishing demand at the Sundays River Estuary. South Africa. *Water SA*, **2014**, *40(1)*, 39-40.

12. Dauda, S.A.; Yacob, M.R.;Radam, A.Household’s willingness to pay for heterogeneous attributes of drinking water quality and services improvement: an application of choice experiment. *Appl Water Sci*, **2015,** *5*, 253, doi:10.1007/s13201-014-0186-6.

13. Yacob, M.R.; Radam A.; Samdin, Z. Willingness to Pay for Domestic Water Service Improvements in Selangor, Malaysia: A Choice Modeling Approach, *International Business and Management*, **2011**, *2*, pp. 30-39.

14. Sangkapitux, C.; Neef, A.;Polkongkaew, W. Willingness of upstream and downstream resource managers to engage in compensation schemes for environmental services. *International Journal of the Commons*, **2009,** *3(1)*, pp. 41-63.

15. Jeon, M. Device for Reducing Muddy Water in the Watershed of Soyang Dam (In Korean); Research Institute for Gangwon: Gangwon Province, Korea, **2008**.

16. Lancaster, K. A New Approach to Consumer Theory, *J Polit. Econ.*, **1966**, *74(2)*, 132-157.

17. Luce, R. D. *Individual Choice Behavior: A Theoretical Analysis*. New York: Wiley, 1959.

18. Luce, R. D.; Suppes P. Preference, Utility, and Subjective Probability, in Handbook of Mathematical Psychology, Vol. 3, ed. by R. D. Luce, R. R. Bush, and E. H. Galanter. New York: Wiley, **1965,** Chapter 19, 249–410.

19. McFadden, D. *Conditional logit analysis of qualitative choice behaviour, in Frontiers of Econometrics,* P. Zarembka, ed., Academic Press, London, U.K., 1974. pp. 105-142.

20. Greene, William H. *Econometric Analysis*, Forth Edition. New Jersey, USA: Prentice Hall. 2003.

21. Freeman, A.M., III. *The measurement of environmental and resource values: theory and methods*. 2nd ed. Washington, DC: Resources for the Future, 2003.

22. Ben-Akiva, M.;Lerman, S. *Discrete Choice Analysis: Theory and application to travel demand*, 2 edn, The MIT Press, Cambridge, Massachusetts, 1985.

23. Bateman, I. J.; Carson, R. T.; Day, B.; Hanemann, M.; Hanley, N.; Hett, T.; Jones-Lee, M.; Loomes. G. 2002. Economic Valuation with Stated Preferences Techniques: a Manual. Edward Elgar Publishing Ltd., Cheltenham, UK.

24. Hanemann, W. M. Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses, *Am J Agr Econ.*, **1984**, *66*, 3, pp. 332-341.

25. Hanley, N.; Wright, R. E.;Adamowicz, V. Using choice experiments to value the environment - Design issues, current experience and future prospects, *Environ Resour Econ,* **1998,** *11*, 3-4, pp. 413-428.

26. Train, K. *Discrete Choice Methods with Simulation*, Cambridge University Press, U.K.. 2003.

27. Kaffashi, S;Shamsudin, MN;Radam, A;Yacob, M.R;Abdulrahim, K;Yazid, M. Economic valuation and conservation: do people vote for better conservation of Shedegan International Wetland? *BiolConserv,* **2012**, *150*, 150–158.

28. Adamowicz,W.; Louviere,J.; Williams, M. Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities, *J. Environ. Econ. Manage*. **1994**, 26, 271-292, http://dx.doi.org/10.1006/jeem.1994.1017.

29. Poe, G.L., Welsh, M.P, Champ, P.A. Measuring the difference in mean willingness to pay when dichotomous choice contingent valuation responses are not independent. *Land Economics* **1997**, 73, 255–267.

30. Morey, E.; Rossmann, K.G. Calculating, With Income Effects, the Compensating Variation for a State Change. *Environ Resour Econ,* **2008**, 39, 283-90.

31. Eggert, H.; Olsson, B. Valuing multi-attribute marine water quality, Marine Policy, 2009, 33, 201–206.

32. Sangkapitux, C. Willingness of upstream and downstream resource managers to engage in compensation schemes for environmental services, International Journal of the Commons, 2009, 3, 41–63.

33. Louviere, J.J.; Hensher, D.A.; Swait, J.D *Stated choice methods*, Cambridge University Press, Cambridge, 2000.

34. Manzini, P.; Mariotti, M.; MittoneL. Choosing Monetary Sequences: Theory and Experimental Evidence, *TheorDecis.*, **2010**, *69*, 327–354.

35. Adamowicz, W.; Boxall, P.; Williams, M.; Louviere, J. Stated Preference Approaches for Measuring Passive Use Values: Choice Experiments and Contingent Valuation, *Am J Agr Econ.*, **1998**, *80*, 1, pp. 64-75.

36. Rolfe, J.; Bennett, J.; Louviere, J. Choice Modelling and its Potential Application to Tropical Rainforest Preservation, *Ecol. Econ.*, **2000**, *35*, pp. 289-302.

37. Morrison, M.; Blamey, R.; Bennett, J.; Louviere, J. *A Review of Conjoint Techniques for Estimating Environmental Values*, University of New south Wales, **1999**.

38. Khai, H.V.; Yabe, M. Choice modeling: assessing the non-market environmental values of the biodiversity conservation of swamp forest in Vietnam. *Int J Energy Environ Eng*, **2014,** *5*, 77, doi:10.1007/s40095-014-0077-5.

39. Atkinson, G.; Bateman, I.; Mourato, S. Recent advances in the valuation of ecosystem services and biodiversity. Oxf Rev *Econ Policy*, **2012**, *28 (1)*, 22–47, doi:10.1093/oxrep/grs007.

40. Willis, K.G.; Scarpa R.; AcuttM. Assessing water company customer preferences and willingness to pay for service improvements: A stated choice analysis, *Water Resources* Research, **2005**, *41*, 2, doi: 10.1029/2004WR003277.

41. Kragt M.E.; Bennett, J.W. Using Choice Experiments to value River and Estuary Health in Tasmania with Individual Preference Heterogeneity, Research Report No. 16, **2009**, https://crawford.anu.edu.au/research_units/eerh/pdf/EERH_RR16.pdf.

42. Blazy, J.M.; Alain C.; Alban T. The willingness to adopt agro-ecological innovations: Application of choice modelling to Caribbean banana planters, *Ecol. Econ.*, **2011**, *72*(15), 140-150, ISSN 0921-8009, doi:10.1016/j.ecolecon.2011.09.021.

43. Yamada, K.; Sato, M.; Nakamoto, Y. Measurement of Social Preference from Utility-Based Choice Experiments, Discussion Paper. No. 759, 2009, http://www.iser.osaka-u.ac.jp/library/dp/2009/DP0759.pdf.

44. Lee, S.; Nguyen, T.T.; Kim, H.N.; Koellner, T.; Shin, H.J. Do Consumers of Environmentally Friendly Farming Products in Downstream Areas Have a WTP for Water Quality Protection in Upstream Areas?, *Water*, 2017, 9(7), 511; doi:10.3390/w9070511.

## 4.9. Appendix

Table S4.1: Descriptive statistics of characteristics

| | | Upstream (N : 125) | Downstream(N : 115) |
|---|---|---|---|
| Characteristics | Description | N (%) | N (%) |
| Age | 1 : 20s | 9 (0.67) | 81 (5.18) |
| | 2 : 30s | 15 (1.11) | 342 (21.85) |
| | 3 : 40s | 267 (19.78) | 438 (27.99) |
| | 4 : 50s | 597 (44.22) | 405 (25.88) |
| | 5 : > 60s | 462 (34.22) | 299 (19.11) |
| Education | Primary | 282 (20.89) | 18 (1.15) |
| | Secondary | 483 (35.78) | 75 (4.79) |
| | High | 444 (32.89) | 746 (47.67) |
| | University | 141 (10.44) | 726 (46.39) |
| Income[a] | 1 : < 10 | 552 (40.89) | NA |
| | 2 : 10-20 | 171 (12.67) | 54 (3.45) |
| | 3 : 21-30 | 192 (14.22) | 303 (19.36) |
| | 4 : 31-40 | 132 (9.78) | 342 (21.85) |
| | 5 : 41-50 | 138 (10.22) | 537 (34.31) |
| | 6 : 51-60 | 48 (3.56) | 254 (16.23) |
| | 7 : 61-70 | 18 (1.33) | 57 (3.64) |
| | 8 : 71-80 | 15 (1.11) | 18 (1.15) |
| | 9 : 81-90 | 21 (1.56) | NA |
| | 10 : 91-100 | 9 (0.67) | NA |
| | 11 : > 1000 | 54 (4.00) | NA |

[a] Unit = Million in KRW

## 4.10. Supporting information

### 4.10.1. Farmers questionnaire I

SQ1. Where do you live?

1. Hongcheon
2. Inje
3. Yanggu

SQ2. Do you live in the same regions where your main crops are cultivated?

1 Yes ☞ Go to A1

2 No ☞ Go to SQ2-1

SQ2-1 Where do you cultivate your main crops?

1. The areas located in Soyang watershed (inside) with an influence on water quality

2. The areas located in Soyang watershed (inside) with no influence on water quality

3. The areas located in Soyang watershed (outside) with an influence on water quality

4. The areas located in Soyang watershed (outside) with no influence on water quality.

SQ2-2. Which administrative district does your farmland belong to?

1. Yanggu Yanggu-eup
2. Yanggu Nam-myeon
3. Yanggu Dong-myeon
4. Yanggu Bangsan-myeon
5. Yanggu Haean-myeon
6. Inje-gun Inje-eup
7. Inje-gun Nam-myeon
8. Inje-gun Buk-myeon
9. Inje-gun Girin-myeon
10. Inje-gun Seohwa-myeon
11. Inje-gun Sangnam-myeon
12. Hongcheon-gun Hongcheon-eup
13. Hongcheon-gun Hwacheon-myeon
14. Hongcheon-gun Duchon-myeon
15. Hongcheon-gun Naechon-myeon
16. Hongcheon-gun Seosuk-myeon
17. Hongcheon-gun Dong-myeon
18. Hongcheon-gun Nam-myeon
19. Hongcheon-gun Seo-myeon
20. Hongcheon-gun Bukbang-myeon
21. Hongcheon-gun Nae-myeon
22. Other

Part A. Current state of farmhouse

A1. How many years of farming experience do you have? (            ) years

A2. Do you have designated distributors or markets to sell your products? (Multiple responses)

1. No designated markets
2. Farmer related national group
3. Nonghyup
4. Wholesale market
5. Large-scale distributors
6. Consumer organization
7. Direct sales
8. Electronic commerce
9. Contracted cultivation
10. Others (            )

A3. What are the main crops you cultivated **in 2011**? (Please circle the number; multiple response)

1. Rice paddy
2. Annual crops
3. Perennial crops
4. Vinyl greenhouse crops
5. Others

A4. Please write down the main cultivated crops, areas under cultivations and circle the farming technique that you applied **in 2011**.

| Land category | Main crops | Cultivated area (Unit : Peong) | Farming techniques | |
|---|---|---|---|---|
| Rice paddy | | | Conventional farming | Environmentally Friendly Farming |
| Annual crops | | | Conventional farming | Environmentally Friendly Farming |
| Perennial crops | | | Conventional farming | Environmentally Friendly Farming |
| Vinyl greenhouse | | | Conventional farming | Environmentally Friendly Farming |
| Others | | | Conventional farming | Environmentally Friendly Farming |

A5. Do you have any crops that were cultivated **in 2010**, but not in 2011?

1. Yes ☞ Go to A5-1 2. No ☞ Go to A6

A5-1. What was the reason not to cultivate these crops?

1. Low profit
2. Increased number of imported agriculture products
3. Because of affecting areas causing agricultural pesticide contamination
4. Low quality
5. Difficulties with finding market places
6. Other reasons ( )

A6. Do you ever had experience using personal land, renting land, or leasing land **in 2011**?

(Multiple response)

1. Private land
2. Land to be rented
3. Land to be leased

A6-1. Please, indicate the cultivated land areas **in 2011**.

| Land category | Owned land (unit: pyeong) | Leased land (unit: pyeong) | Lease fee (unit: 10 thu. won) | Rental land (unit: pyeong) | Rental income (unit: 10 thu. won) |
|---|---|---|---|---|---|
| Rice paddy | | | | | |
| Annual crops | | | | | |
| Perennial crops | | | | | |
| Vinyl Greenhouse | | | | | |
| Others | | | | | |
| Total | | | | | |

A7. Please indicate your income **in 2011.**

(Unit: 10 thou.KRW)

| Agricultural income | | | | | Transferred income | | Non-agricultural income | |
|---|---|---|---|---|---|---|---|---|
| Rice paddy | Annual crops | Perennial crops | Vinyl greenhouse | Others | Government subsidies | Others | wage | Self-employed |
| | | | | | | | | |

A8. Did you have employed workers for cultivation **in 2011**?

1. Yes ☞ Go to A8-1
2. No ☞ Go to A9

A8-1. Please write down the daily wage of the workers, number of employed workers and number of days of employment of the workers **in 2011**?

| Land category | Male (unit: 1,000 won) | | | | Female (unit: 1,000 won) | | | |
|---|---|---|---|---|---|---|---|---|
| | No. of workers | Daily wage | No. of days | Wage/ Year | No. of workers | Daily wage | No. of days | Wage/Y ear |
| Rice paddy | | won | | | | won | | |
| Annual crops | | won | | | | won | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Perennial crops | | won | | | | won | | |
| Vinyl greenhouse | | won | | | | won | | |
| Others | | won | | | | won | | |

A9. Did you have seed purchase expenditures **in 2011**?

1. Yes ☞ Go to A9-1
2. No ☞ Go to A10

A9-1. How much was the expenditure for seed **in 2011**?

| Land category | Conventional farming | Environmentally Friendly Farming |
|---|---|---|
| Rice paddy | Won | Won |
| Annual crops | Won | Won |
| Perennial crops | Won | Won |
| Vinyl greenhouse | Won | Won |
| Others | Won | Won |

A10. Did you have fertilizer purchase expenditures **in 2011**?

1. Yes ☞ Go to A10-1
2. No ☞ Go to A11

A10-1. How much was the expenditure for fertilizers **in 2011?**

| Land category | Conventional farming | Environmentally friendly farming |
|---|---|---|
| Rice paddy | Won | Won |
| Annual crops | Won | Won |
| Perennial crops | Won | Won |
| Vinyl greenhouse | Won | Won |

A11. Did you rent agricultural machines **in 2011**?

1. Yes ☞ Go to A11-1
2. No ☞ Go to A12

A11-1. Please indicate the cost of agricultural machine rentals **in 2011.**

| Land category | Conventional farming | Environmentally friendly farming |
|---|---|---|
| Rice paddy | Won | Won |
| Annual crops | Won | Won |
| Perennial crops | Won | Won |
| Vinyl greenhouse | Won | Won |
| Others | Won | Won |

A12. Did you have any vinyl greenhouse installation and management expenditures **in 2011**?

1. Yes ☞ Go to A12-1
2. No ☞ Go to A13

A12-1. Please indicate greenhouse installation and management expenditures **in 2011.**

| Land category | Conventional farming | | Environmentally friendly farming | |
|---|---|---|---|---|
| | Building Cost of GH | Energy Cost of GH | Building Cost of GH | Energy Cost of GH |
| Rice paddy | Won | Won | Won | Won |
| Annual crops | Won | Won | Won | Won |
| Perennial crops | Won | Won | Won | Won |
| Vinyl greenhouse | Won | Won | Won | Won |
| Others | Won | Won | Won | Won |

A13. Did you have agriculture pesticide purchase expenditures **in 2011**?

1. Yes ☞ Go to A13-1
2. No ☞ Go to A14

A13-1. Please indicate expenditure of agriculture pesticides **in 2011.**

| Land category | Conventional farming | Environmentally friendly farming |
|---|---|---|
| Rice paddy | Won | Won |
| Annual crops | Won | Won |
| Perennial crops | Won | Won |
| Vinyl greenhouse | Won | Won |
| Others | Won | Won |

A14. If you had any other expenditures **in 2011**, please write down the costs.

| Land category | Conventional farming | Environmentally friendly farming |
|---|---|---|
| Rice paddy | Won | Won |
| Annual crops | Won | Won |
| Perennial crops | Won | Won |
| Vinyl greenhouse | Won | Won |
| Others | Won | Won |

PART B. Awareness for farmers

B1. Are you familiar with environmentally friendly farming?

1. Yes ☞ Go to B1-1
2. No ☞ Go to B2

B1-1. What is the environmentally friendly farming you are familiar with?

1. Organic agriculture using organic fertilizers and chemicals
2. Natural agriculture using ducks or river snails
3. Agriculture using no chemical fertilizers or pesticides

4. Agriculture using less chemical fertilizers and pesticides
5. Agriculture maintained in the environment regardless of farming techniques
6. Other (                    )

B2. Are you aware of the direct payment program to be implemented from the government for environmentally friendly farming?

1. Yes ☞ Go to B2-1
2. No ☞ Go to B3

B2-1. How do you understand payment programs for environmentally friendly farming?

1. It is an appropriate policy program for the spread of environmentally friendly farming.
2. It is highly reliable to use payment programs in environmentally friendly farming
3. It is not an appropriate policy program to promote environmentally friendly farming due to the large financial burden to government.
4. Higher subsidies are required in order to spread environmentally friendly farming.
5. Other reasons (                         )

B3. Which farming method do you use?

1. Environmentally friendly farming ☞ Go to B3-1
2. Conventional farming ☞ Go to B4
3. Conventional farming and environmentally friendly farming ☞ Go to B3-1

B3-1. How many years of experience of environmentally friendly farming do you have?

(            ) years

B3-2. Do you have any certificates for environment-friendly agricultural products?

: Name of agricultural product – (                  )

B3-3. After conducting environmentally friendly framing, how many years did you require to recover the crop production amount? Please circle the figure.

| 1st Year | 2nd Year | 3rd Year | 4th Year | 5th Year | 6th Year |
|---|---|---|---|---|---|
| More than 40% | More than 40% | More than 40% | More than 40% | More than 40% | More than 40% |
| 31-40% | 31-40% | 31-40% | 31-40% | 31-40% | 31-40% |
| 21-30% | 21-30% | 21-30% | 21-30% | 21-30% | 21-30% |
| 11-20% | 11-20% | 11-20% | 11-20% | 11-20% | 11-20% |
| 1-10% | 1-10% | 1-10% | 1-10% | 1-10% | 1-10% |
| 0% | 0% | 0% | 0% | 0% | 0% |
| 1-10% | 1-10% | 1-10% | 1-10% | 1-10% | 1-10% |
| 11-20% | 11-20% | 11-20% | 11-20% | 11-20% | 11-20% |
| 21-30% | 21-30% | 21-30% | 21-30% | 21-30% | 21-30% |
| 31-40% | 31-40% | 31-40% | 31-40% | 31-40% | 31-40% |
| Less than 40% | Less than 40% | Less than 40% | Less than 40% | Less than 40% | Less than 40% |

▶ Only environmentally friendly farming ☞ Go to B3-5

▶ Both environmentally friendly farming and conventional farming ☞ Go to B3-4

B3-4. What kind of farming techniques were conducted before applying conventional farming and environmentally friendly farming together?

1. Environmentally friendly farming ☞ Go to B4-2
2. Conventional farming ☞ Go to B3-5-2
3. Conventional farming and environmentally friendly farming ☞ Go to B4-4

B3-5. Did you ever have experience with conventional farming before doing environmentally friendly farming?

1. Yes ☞ Go to B3-5-1
2. No ☞ Go to B6

B3-5-1. What was the most important reason for you to transition to environmentally friendly farming from conventional farming? ☞ Go to B6

Please write the numbers in order of importance ( 1st - , 2nd- )

1. To attain higher profit from environmentally friendly farming than conventional farming
2. To protect the environment by environmentally friendly farming

3. To maintain your health
4. To get direct payment from the government
5. Because of increased consumption of environmentally friendly farming
6. To attract agriculture tourists
7. Other reasons (                                        )

B3-5-2. What is the most important reason for you to transition to both environmentally friendly farming and conventional farming from conventional farming? ☞ Go to B5-1

Please, put the number with priority into appropriate factors ( 1st -     ,  2nd-          )

1. To attain higher profit from both farms than conventional farming
2. To protect the environment by environmentally friendly farming
3. To maintain your health
4. To get direct payment from the government by promotion policy of environmentally friendly farming
5. To reduce income losses during transition period
6. Because of increased consumption of environmentally friendly farming
7. Other reasons (                                        )

B4. Did you ever had experience with environmentally friendly farming before doing conventional farming?

1. Yes ☞ Go to B4-1
2. No ☞ Go to B4-3

B4-1. What is the most important reason for you to change to conventional farming from environmentally friendly farming? Please, write the numbers with an order of its importance ( 1st -          ,  2nd -          )

1. Due to difficulties applying production techniques of environmentally friendly farming (disease and pest management, weeding, etc.)
2. Due to difficulties with finding markets
3. Due to low income compared to higher cost
4. Due to more required labor for conventional farming than environmentally friendly farming
5. Due to lack of knowledge and information about environmentally friendly farming
6. Due to lack of government subsidies
7. Due to difficulties with manufacturing and securing the materials of environmentally

friendly farming
8. Due to complicated procedure of certification
9. Due to lack of neighbors sharing environmentally friendly farming together
10. Other reasons ( ) ☞ Go to B5

B4-2. What was the most important reason to transition to both environmentally friendly farming and conventional farming from environmentally friendly farming? ☞ Go to B5-1

Please put the numbers in order of appropriate factors ( 1st - , 2nd- )

1. Due to difficulties of applying production techniques of environmentally friendly farming (disease and pest, weeding, etc.)
2. Due to difficulties with finding markets
3. Due to low income compared to higher cost
4. Due to more required labor for conventional farming than environmentally friendly farming
5. Due to lack of knowledge and information about environmentally friendly farming
6. Due to lack of government subsidies
7. Due to difficulties with manufacturing and securing the materials of environmentally friendly farming
8. Due to complicated procedure of certification
9. Due to lack of neighbors sharing environmentally friendly farming together
10. Other reasons ( )

B4-3. What is the most important reason for you to have no experience with environmentally friendly farming? Please, put the numbers in order of appropriate factors. ( 1st - , 2nd- )

1. Because of the higher profit of conventional farming
2. Because of old age, the transition to environmentally friendly farming is too much burden
3. Because of the large scale of the farmland
4. Because of the lack of labor needed to change techniques from conventional farming to environmentally friendly farming
5. Because of lack of knowledge and skills about environmentally friendly farming
6. Because of lack of government subsidies
7. Due to lack of neighbors doing environmentally friendly farming together
8. Due to the gaps of period between conventional farming and environmentally friendly farming

9. Other reasons (                                        ) ☞ Go to B5

B4-4. What was the most important reason for you to have both environmentally friendly farming and conventional farming? Please, write the numbers in order of importance.

( 1st -      ,  2nd-       ) ☞ Go to B5-1

1. Because of higher profits than only conventional farming
2. Because of higher profit than only environmentally friendly farming
3. To compensate for losses during the period of transition by implementing conventional farming
4. Because of lack of confidence with getting a higher profit from environmentally friendly farming
5. To get subsidies from the government
6. To get higher profit from each crop by using different agricultural techniques
7. Other reasons (                                        )

B5. Do you have willingness to change your farming method from conventional farming to environmentally friendly farming?

1. Yes ☞ Go to B5-2
2. No ☞ Go to B5-1

B5-1. According to previous studies, if you convert from conventional farming to environmentally friendly farming, total output would decrease for the next 5 years. If income loss due to environmentally friendly farming could be fully (100%) offset by subsidies for next 5 years, would you be willing to accept EFA?

1. Yes ☞ Go to B5-2
2. No ☞ Go to B5-3

B5-2. What is the reason? Please put the number in order of appropriate factors.

(1st :                2nd :                ) ☞ Go to B5-2-1

1. To attain higher income from environmentally friendly farming
2. To protect environment by implementing environmentally friendly farming
3. To maintain health
4. To get subsidies from the government by promotion policy of environmentally friendly farming

5. Because of increase in consumption of environmentally friendly products
6. To attract agriculture tourists

B5-2-1. If you change the method from conventional farming to environmentally friendly farming, what is the main reason? ☞ Go to B5-2-2

1. Labor
2. Cost of production
3. Subsides
4. Sales prices
5. Income (profitability)
6. Other reasons (                    )

B5-2-2. What do you think about the profitability if you change agriculture method from conventional farming to environmentally friendly farming? ☞ Go to B6

1. It will be decreased compared with current profitability
2. It will be similar compared with current states
3. It will be increased than current states

B5-3. What is the reason if you don't want to change the method? Please write the numbers in order. (1st :          2nd :          ) ☞ Go to B6

1. Lower income of environmentally friendly farming
2. Old age (aging)
3. Land scale is too large
4. Lack of labor
5. Lack of knowledge about environmentally friendly farming technique
6. Lack of government subsidies
7. No neighbor to implement environmentally friendly farming together with
8. Other reasons (                    )

B6. Did you receive subsidies or payments from a direct payment program in 2011?

1. Yes ☞ Go to B6-1
2. No ☞ Go to B7

B6-1. If you received subsidies, how much did you receive?

1. Direct payment: (                    )
2. Subsidies: (                              ) ☞ Go to B7

B7. Do you think that environmentally friendly farming has positive impacts on improving the environment?

1. Yes ☞ Go to B8
2. No ☞ Go to B9

B8. If you answered "yes" in B7, what elements of the environment are being improved?

| Very little ☜ | ① | ② | ③ | ④ | ⑤ | ☞ Very much |
|---|---|---|---|---|---|---|
| Biodiversity protection | | | | | | |
| Water quality | | | | | | |
| Erosion control | | | | | | |
| Pollination | | | | | | |
| Crop production | | | | | | |
| Carbon sequestration | | | | | | |

Part C. Social Economic Background

C1. What is your gender?

1. Male
2. Female

C2. How old are you?

1. Twenties
2. Thirties
3. Forties

4. Fifties
5. Sixties
6. Seventies
7. More than eighties

C3. How many years have you lived in your current city? (                    ) years

C4. What is your highest level of academic education?

1. No schooling
2. Dropped out of elementary school
3. Elementary school graduation
4. Dropped out of junior high school
5. Middle school graduation
6. Dropped out of high school
7. High school graduation
8. Dropped out of college/university
9. College/university graduation
10. Master 's/doctoral graduation

C5. Which organizations do you belonging to?

1. Nonghyup
2. Farmer related national group
3. Crop cultivating group
4. NGO
5. None

C6. Please, mark ‘√’.

| Very little ☜ | ① | ② | ③ | ④ | ⑤ | ☞ Very much |
|---|---|---|---|---|---|---|
| Do you think that the given information in this questionnaire is sufficient to answer? | | | | | | |
| Do you think that the given information in this questionnaire is the same as what you know? | | | | | | |
| Do you think that the given information in this questionnaire is enough to be understood | | | | | | |

#### 4.10.2. Farmers questionnaire II (Korean)

SQ1. 현재 선생님께서 거주하고 계신 지역은 어디입니까?

1. 강원도 홍천군
2. 강원도 인제군
3. 강원도 양구군

SQ2. 선생님께서는 현재 거주하고 계신 지역과 주요 작물을 재배하는 지역이 동일하십니까?

1. 예 ☞ A1 로
2. 아니오 ☞ SQ2-1 로

SQ2-1. 그렇다면, 어느 지역에 주요 작물을 재배하십니까?

1. 소양호권역(양구, 인제, 홍천, 춘천)내 하천 수질에 영향을 미치는 지역
2. 소양호권역(양구, 인제, 홍천, 춘천)내 하천 수질에 영향을 미치지 않는 지역
3. 소양호권역(양구, 인제, 홍천, 춘천)밖 하천 수질에 영향을 미치는 지역
4. 소양호권역(양구, 인제, 홍천, 춘천)밖 하천 수질에 영향을 미치지 않는 지역

SQ2-2. 주요 작물을 재배하는 지역은 행정구역상 어디입니까?

1. 양구군 양구읍
2. 양구군 남면
3. 양구군 동면
4. 양구군 방산면
5. 양구군 해안면
6. 인제군 인제읍
7. 인제군 남면
8. 인제군 북면
9. 인제군 기린면
10. 인제군 서화면
11. 인제군 상남면
12. 홍천군 홍천읍
13. 홍천군 화촌면
14. 홍천군 두촌면
15. 홍천군 내촌면
16. 홍천군 서석면
17. 홍천군 동면
18. 홍천군 남면
19. 홍천군 서면
20. 홍천군 북방면
21. 홍천군 내면
22. 기타

PART A. 2011년도 경작 현황

A1. 선생님께서는 농사를 시작한지 얼마나 되셨습니까?

(　　　　)년

A2. 선생님께서 경작한 작물들의 판매처가 있다면, 판매처를 모두 말씀해 주십시오.

1. 판매처 없음
2. 작목반이나 영농조합법인
3. 농협
4. 대형유통업체
5. 대형물류센터 (도매시장)
6. 소비자 단체
7. 소비자 직판매 (농장직판, 택배)
8. 전자상거래
9. 계약재배
10. 기타 (　　　　　)

A3. 선생님께서 지난 <u>2011년</u> 한 해 동안 경작한 주요 작물을 모두 말씀해 주십시오.

1. 논 작물
2. 일년생 작물
3. 다년생 작물
4. 비닐하우스 작물
5. 기타 (　　　　　)

A4. 지난 <u>2011 년</u> 한 해 동안 경작한 주요 작물들의 종류와 경작 면적 및 영농 방법을 모두 말씀해 주십시오.

| 경 지 분류 | 주요작목 | 경작 면적 (단위 : 평) | 영농 방법 | |
|---|---|---|---|---|
| 논 작물 | | | 관행농업 | 친환경농업 |
| 일년생 작물 | | | 관행농업 | 친환경농업 |
| 다년생 작물 | | | 관행농업 | 친환경농업 |
| 비닐하우스 작물 | | | 관행농업 | 친환경농업 |
| 기타 | | | 관행농업 | 친환경농업 |

A5. 그렇다면 이번에는 2010년에는 경작했지만, <u>2011년</u>에는 경작하지 않은 작물이 있습니까?

1. 있다 ☞ A5-1 로
2. 없다 ☞ A6 으로

A5-1. 해당 작물을 경작하지 않은 이유는 무엇 입니까?

1. 이윤이 높지 않아서
2. 수입 농산물이 많아서
3. 농약 피해지역이 발생하여서
4. 품질이 떨어져서판매처를 찾기 힘들어서
5. 기타 (              )

A6. <u>2011년</u> 한 해 동안 경작을 위해 개인 토지를 사용하거나 임차 혹은 임대한 경험이 있습니까? 모두 말씀해 주십시오. (복수응답 가능)

1. 개인 소유 토지
2. 타인 소유 토지 임차
3. 개인 소유 토지 임대

A6-1. 선생님께서 <u>2011년</u> 한 해 동안 경작 또는 임대(차)한 토지의 면적과 가격/임대료를 말씀해 주십시오.

| 경 지<br>분 류 | 소유 토지<br>(단위 : 평) | 임차 토지<br>(단위 : 평) | 임차료<br>(단위 : 만원) | 임대 토지<br>(단위 : 평) | 임대료<br>(단위 : 만원) |
|---|---|---|---|---|---|
| 논 작물 | | | | | |
| 일년생 작물 | | | | | |
| 다년생 작물 | | | | | |
| 비닐 하우스 | | | | | |
| 기타 | | | | | |
| 합 계 | | | | | |

A7. 2011년 한 해 동안의 소득을 모두 적어주십시오

(단위 : 만원)

| 농업소득 | | | | | 이전 소득 | | 농업 외 소득 | | 기타 (임대료) |
|---|---|---|---|---|---|---|---|---|---|
| 논 작물 | 일년생 작물 | 다년생 작물 | 비닐 하우스 | 기타 | 정부 보조금 | 기타 | 임금 | 자영업 | |
| | | | | | | | | | |

A8. 선생님께서는 2011년 한 해 동안 경작을 위해 근로자를 고용하신 경험이 있습니까?

1. 있다 ☞ A8-1 로
2. 없다 ☞ A9 로

A8-1. 2011년 한 해 동안 고용한 근로자 수와 임금, 고용 일수를 말씀해 주십시오.

| 경지 분류 | 남 | | | | 여 | | | |
|---|---|---|---|---|---|---|---|---|
| | 근로자 수 | 일당 | 고용일수 | 임금/년 | 근로자 수 | 일당 | 임금/일 | 임금/년 |
| 논 작물 | | | | | | | | |
| 일년생 작물 | | | | | | | | |
| 다년생 작물 | | | | | | | | |
| 비닐 하우스 | | | | | | | | |
| 기타 | | | | | | | | |

* 점심 포함하지 않은 인건비

A9. 선생님께서는 2011년 한 해 동안 종자를 구입하기 위해 지출한 비용이 있습니까?

1. 예 ☞ A9-1 로
2. 아니오 ☞ A10 으로

A9-1. <u>2011년</u> 한 해 동안 구입한 종자 비용을 말씀해 주십시오.

| 경지분류 | 관행농업 | 친환경농업 |
|---|---|---|
| 논 작물 | | |
| 일년생 작물 | | |
| 다년생 작물 | | |
| 비닐 하우스 | | |
| 기타 | | |

A10. 선생님께서는 <u>2011년</u> 한 해 동안 비료를 구입하기 위해 지출한 비용이 있습니까?

1. 예 ☞ A10-1 로
2. 아니오 ☞ A11 로

A10-1. <u>2011년</u> 한 해 동안 구입한 비료 비용을 말씀해 주십시오.

| 경지분류 | 관행농업 | 친환경농업 |
|---|---|---|
| 논 작물 | | |
| 일년생 작물 | | |
| 다년생 작물 | | |
| 비닐 하우스 | | |
| 기타 | | |

A11. 선생님께서는 <u>2011년</u> 한 해 동안 농기계를 임대하여 사용한 경험이 있습니까?

1. 예 ☞ A11-1 로
2. 아니오 ☞ A12 로

A11-1. <u>2011년</u> 한 해 동안 사용된 농기계의 임대비용을 말씀해 주십시오.

| 경지 분류 | 관행농업 | 친환경농업 |
|---|---|---|
| 논 작물 | | |
| 일년생 작물 | | |
| 다년생 작물 | | |
| 비닐 하우스 | | |
| 기타 | | |

A12. 선생님께서는 2011년 한 해 동안 비닐하우스의 설치 및 관리를 위해 사용한 비용이 있습니까?

1. 예 ☞ A12-1 로
2. 아니오 ☞ A13 으로

A12-1. 선생님께서는 2011년 한 해 동안 비닐하우스의 설치 및 관리를 위해 사용한 비용은 얼마입니까?

| 경지 분류 | 관행농업 | | 친환경농업 | |
|---|---|---|---|---|
| | 설치비용 | 에너지<br>(냉/난방)<br>관리 비용 | 설치비용 | 에너지<br>(냉/난방)<br>관리 비용 |
| 논 작물 | | | | |
| 일년생 작물 | | | | |
| 다년생 작물 | | | | |
| 비닐 하우스 | | | | |
| 기타 | | | | |

A13. 선생님께서는 2011년 한 해 동안 농약을 구입하기 위해 지출한 비용이 있습니까?

1. 있다 ☞ A13-1 로
2. 없다 ☞ A14 로

A13-1. 2011년 한 해 동안 구입한 농약 비용을 말씀해 주십시오.

| 경지분류 | 관행농업 | 친환경농업 |
|---|---|---|
| 논 작물 | | |
| 일년생 작물 | | |
| 다년생 작물 | | |
| 비닐 하우스 | | |
| 기타 | | |

A14. 지금까지 말씀하신 것 이외에 2011년 동안 추가적인 사용 비용이 있다면 말씀해 주십시오.

| 경지분류 | 관행농업 | 친환경농업 |
|---|---|---|
| 논 작물 | | |
| 일년생 작물 | | |
| 다년생 작물 | | |
| 비닐 하우스 | | |
| 기타 | | |

PART B. 농가 인식도

B1. 선생님께서는 친환경농업에 대해 알고 계십니까?

1. 알고 있다 ☞ B1-1 로
2. 모른다 ☞ B2 로

B1-1. 그렇다면 친환경농업에 대해 어떻게 이해하고 계십니까?

1. 유기비료와 친환경 생물농약을 사용하는 유기농업
2. 오리, 우렁이 등을 사용하는 자연농업
3. 화학비료와 농약을 전혀 사용하지 않는 농업
4. 화학비료와 농약 사용량을 현재보다 줄여서 사용하는 농업
5. 어떤 농업을 적용하든 상관없이 환경을 건실하게 유지/보전하는 농업
6. 기타 (                    )

B2. 선생님께서는 친환경농업 직접지불제에 대해 알고 계십니까?

1. 알고 있다 ☞ B2-1 로
2. 모른다 ☞ B3 으로

B2-1. 그렇다면 친환경농업 직접지불제에 대해 어떻게 이해하고 계십니까?

1. 친환경농업을 실천하는 농가 확산에 매우 적절한 정책 수단
2. 친환경농업 육성을 위해 필요한 수단이나 실천 농가의 보조금에 대한 의존도가

높음

3. 많은 재정 부담이 수반되므로 친환경농업 육성을 위해 바람직하지 않은 정책 수단
4. 농가 확산을 위하여 더 높은 보조금이 필요한 정책
5. 기타 (                                        )

B3. 선생님께서는 어떤 방법으로 농사를 짓고 있습니까?

1. 친환경농업 ☞ B3-1 로
2. 관행농업 ☞ B4 로
3. 친환경농업과 관행농업 병행 ☞ B3-1 로

B3-1. 친환경농업을 시작한지 얼마나 되셨습니까? (          )년

B3-2. 친환경 농산물로 인증된 작목은 무엇입니까? 친환경 농산물 이름 모두를 말씀해 주십시오. (                    )

B3-3. 친환경농업을 실시한 이후에 연도별 생산량의 증/감 비율을 선택해 주십시오. 생산량의 변화는 직전 년도를 기준으로 작성해 주십시오. (친환경농업 실시 7년 이상인 자도 6차년도 까지만 작성)

| 1차년도 | 2차년도 | 3차년도 | 4차년도 | 5차년도 | 6차년도 |
|---|---|---|---|---|---|
| 40% 이상 | 40% 이상 | 40% 이상 | 40% 이상 | 40% 이상 | 40% 이상 |
| 31-40% | 31-40% | 31-40% | 31-40% | 31-40% | 31-40% |
| 21-30% | 21-30% | 21-30% | 21-30% | 21-30% | 21-30% |
| 11-20% | 11-20% | 11-20% | 11-20% | 11-20% | 11-20% |
| 1-10% | 1-10% | 1-10% | 1-10% | 1-10% | 1-10% |
| 0% | 0% | 0% | 0% | 0% | 0% |
| 1-10% | 1-10% | 1-10% | 1-10% | 1-10% | 1-10% |
| 11-20% | 11-20% | 11-20% | 11-20% | 11-20% | 11-20% |
| 21-30% | 21-30% | 21-30% | 21-30% | 21-30% | 21-30% |
| 31-40% | 31-40% | 31-40% | 31-40% | 31-40% | 31-40% |
| 40% 이상 | 40% 이상 | 40% 이상 | 40% 이상 | 40% 이상 | 40% 이상 |

▶ 친환경 농업만 실시 ☞ B3-5 로

▶ 친환경농업과 관행 농업 병행 ☞ B3-4 로

B3-4. 친환경농업과 관행농업을 병행 실시하기 이전에는 어떤 농업을 하셨습니까?

1. 친환경농업 ☞ B4-2로
2. 관행농업 ☞ B3-5-2 로
3. 친환경농업과 관행농업 병행 ☞ B4-4 로

B3-5. 현재 친환경농업으로 농사를 짓기 전 관행농업을 하신 경험이 있습니까?

1. 있다 ☞ B3-5-1 로
2. 없다 ☞ B6 으로

B3-5-1. 관행농업에서 친환경농업으로 전환한 이유는 무엇이십니까? 중요하다고 생각하시는 순서대로 번호를 적어주십시오. (1순위: , 2순위: )

1. 친환경농업이 관행농업보다 고소득을 얻을 수 있어서
2. 환경 친화적인 농사를 통해 환경을 보전하기 위해
3. 본인의 건강을 위하여
4. 친환경 농업 육성법에 의한 정부의 직불금 등을 받기 위해서
5. 친환경제품에 대한 소비가 증가하고 있는 추세여서
6. 농촌관광객(마을방문객)을 고객화하기 위하여
7. 기타 ( )

B3-5-2. 관행농업에서 친환경농업과 관행농업 병행으로 전환한 이유는 무엇이십니까? 중요하다고 생각하시는 순서대로 번호를 적어주십시오. (1순위: , 2순위: )
☞ B5-1 으로

1. 친환경농업과 관행농업 병행이 관행농업보다 고소득을 얻을 수 있어서
2. 환경 친화적인 농사를 통해 환경을 보전하기 위해
3. 본인의 건강을 위하여
4. 친환경 농업 육성법에 의한 정부의 직불금 등을 받기 위해서
5. 친환경 농업으로 바뀌는 단계의 소득 감소율을 적게 하기 위해
6. 친환경제품에 대한 소비가 증가하고 있는 추세여서

7. 기타 (                    )

B4. 관행농업 이전에 친환경농업을 하신 경험이 있으십니까?

1. 있다 ☞ B4-1 로
2. 없다 ☞ B4-3 로

B4-1. 친환경농업에서 관행농업으로 바꾼 이유는 무엇이십니까? 중요하다고 생각하시는 순서대로 번호를 적어주십시오. (1순위:          , 2순위:          ) ☞ B5 로

1. 친환경농산물 생산기술의 어려움이 있어서(병해충, 제초문제 등)
2. 친환경농산물 판로확보의 어려움이 있어서
3. 노력에 비해서 소득이 적어서(오히려 손해)
4. 관행농업이 친환경 농업에 비해 노동력이 적게 들어서
5. 친환경농업 교육.홍보 부족 및 정보획득이 어려워서
6. 정부의 친환경농업 지원금이 적어서
7. 적당한 친환경농자재의 제조 및 확보의 어려움이 있어서
8. 복잡한 인증절차 때문에
9. 친환경 농업을 같이 할 이웃 주민(농업인)이 없어서
10. 기타 (                                        )

B4-2. 친환경농업에서 친환경농업과 관행농업 병행으로 전환한 이유는 무엇이십니까? 중요하다고 생각하시는 순서대로 번호를 적어주십시오. (1순위:        , 2순위:        )

☞ B5-1 로

1. 친환경농산물 생산기술의 어려움이 있어서 (병해충, 제초문제 등)
2. 친환경농산물 판로확보의 어려움이 있어서
3. 노력에 비해서 소득이 적어서(오히려 손해)
4. 관행농업이 친환경 농업에 비해 노동력이 적게 들어서
5. 친환경농업 교육.홍보 부족 및 정보획득이 어려워서

6. 정부의 친환경농업 지원금이 적어서
7. 적당한 친환경농자재의 제조 및 확보의 어려움이 있어서
8. 복잡한 인증절차 때문에
9. 친환경 농업을 같이 할 이웃 주민(농업인)이 없어서
10. 기타 (                                        )

B4-3. 농사를 한 이후 한 번도 친환경농업을 하지 않은 이유는 무엇입니까?

(1순위:          , 2순위:              ) ☞ B5 로

1. 관행농업이 친환경농업보다 수익이 더 높기 때문에
2. 나이로 인해 친환경농업 전환에 대한 부담이 있어서
3. 농지규모가 커서 친환경농업을 하기 어려울까봐
4. 친환경농업으로 전환하기에는 노동력이 부족해서
5. 친환경농업 기술을 잘 알지 못해서
6. 정부의 친환경농업에 대한 보조금이 적어서
7. 친환경 농업을 같이 할 이웃 주민(농업인)이 없어서
8. 관행농업에서 친환경 농업 전환기간의 공백 기간 때문
9. 기타 (                                        )

B4-4. 친환경농업과 관행농업을 병행 하시는 이유는 무엇이십니까? 중요하다고 생각하시는 순서대로 번호를 적어주십시오. (1순위:          , 2순위:          ) ☞ B5-1 로

1. 관행농업만 실시할 때의 수익보다 높다고 생각하기 때문에
2. 친환경 농업만 실시할 때의 수익보다 높다고 생각하기 때문에
3. 친환경 농업의 고소득을 얻기 위한 공백기에 관행농업으로 수익을 보상하기 위해
4. 친환경 농업이 고소득이 될 거라는 확신이 없어서
5. 정부의 친환경 농업 지원금을 받기위해서
6. 작목마다 고소득을 얻는 농법이 달라서
7. 기타 (                                        )

B5. 선생님께서는 향후 현재의 관행농업에서 친환경농업으로 바꿀 의향이 있습니까?

1. 있다 ☞ B5-2 로
2. 없다 ☞ B5-1 로

B5-1. 기존의 연구 결과에 따르면, 관행농업에서 친환경농업으로 전환할 시 전체의 생산량은 5년 이내로 회복된다고 합니다. 만약 최대 5년 동안 소득 감소율을 100% 보상해 준다면 친환경농업으로 바꾸실 의향이 있으십니까?

1. 있다 ☞ B5-2 로
2. 없다 ☞ B5-3 으로

B5-2. 만약 바꾸실 의향이 있다면, 그 이유는 무엇입니까? 중요하다고 생각하시는 순서대로 번호를 적어주십시오. (1순위: , 2순위: ) ☞ B5-2-1로

1. 친환경농업이 관행농업보다 고소득을 얻을 수 있을 것 같아서
2. 환경 친화적인 농사를 통해 환경을 보전하기 위해
3. 본인의 건강을 위하여
4. 친환경 농업 육성법에 의한 정부의 직불금 등을 받기 위해서
5. 친환경제품에 대한 소비가 증가하고 있는 추세여서
6. 농촌관광객(마을방문객)을 고객화하기 위하여

B5-2-1. 선생님께서는 향후 친환경농업으로 전환 한다면 어떤 점을 가장 중요하게 고려하시겠습니까? ☞ B5-2-2 로

1. 노동력
2. 생산비/직접비
3. 보조금
4. 판매 가격
5. 소득 (수익성)
6. 기타 ( )

B5-2-2. 선생님께서는 향후 친환경농업으로 전환 한다면 수익성이 어떨 것으로 전망하십니까? ☞ B6 으로

1. 현재보다 수익성이 더 떨어질 것이다
2. 현재수준과 비슷할 것이다
3. 현재보다 수익성이 더 좋아질 것이다

B5-3. 만약 바꾸실 의향이 없으시다면, 그 이유는 무엇입니까? 중요하다고 생각하시는 순서대로 번호를 적어주십시오. (1순위: , 2순위: ) ☞ B6 으로

1. 관행농업이 친환경농업보다 수익이 더 높은 것 같기 때문에
2. 나이로 인해 친환경농업 전환에 대한 부담이 있어서
3. 농지규모가 커서 친환경농업을 하기 어려울까봐
4. 친환경농업으로 전환하기에는 노동력이 부족해서
5. 친환경농업 기술을 잘 알지 못해서
6. 정부의 친환경농업에 대한 보조금이 적어서
7. 친환경 농업을 같이 할 이웃 주민(농업인)이 없어서
8. 기타 ( )

B6. 귀하께서는 <u>2011년</u> 한 해 동안 정부로부터 보조금이나 친환경농업 직접지불제를 받은 경험이 있으십니까?

1. 있다 ☞ B6-1 로
2. 없다 ☞ B7 로

B6-1. <u>2011년</u> 한 해 동안 정부로부터 보조금을 받아보신 경험이 있으시다면, 얼마나 받으셨습니까?

1. 보조금 ( 만원)
2. 친환경농업 직접지불제 ( 만원)

B7. 선생님께서는 친환경농업이 환경 보전에 긍정적인 영향을 미친다고 생각하십니까?

1. 예 ☞ B8 로
2. 아니오 ☞ B9 로

B8. 친환경농업이 환경에 긍정적인 영향을 미친다고 생각하신다면, 다음의 요인들이 환경 개선에 어느 정도 효과가 있다고 생각하십니까?

| 구 분 | 매우 효과적 | 효과적 | 보 통 | 효과 없음 | 전혀 효과없음 |
|---|---|---|---|---|---|
| 곤충 및 생물 보호 | | | | | |
| 수질 오염 보호 | | | | | |
| 토양 보존 | | | | | |
| 꽃가루가 이동하여 | | | | | |
| 농작물 생산 증가 | | | | | |
| 저탄소 배출 | | | | | |

※ 일반적 사항

C1. 귀하의 성별은 무엇입니까?

1. 남자
2. 여자

C2. 귀하의 연령대는 어떻게 되십니까?

1. 20 대
2. 30 대
3. 40 대
4. 50 대
5. 60 대
6. 70 대
7. 80 대 이상

C3. 귀하께서는 현재 거주하시는 시(군)에 거주하신 기간이 얼마나 되십니까? (　　)년

C4. 선생님께서는 학교 교육을 어디까지 받으셨습니까?

1. 무학
2. 초등학교 중퇴

3. 초등학교 졸업
4. 중학교 중퇴
5. 중학교 졸업
6. 고등학교 중퇴
7. 고등학교 졸업
8. 전문대학/대학교 중퇴
9. 전문대학/대학교 졸업
10. 석사/박사 이상

C5. 선생님께서는 어떤 농업인 단체에 소속되어 있으십니까?

1. 농협
2. 영농조합
3. 작목반
4. NGO
5. 소속 된 단체 없음

C6. 설문지 전반에 대한 질문입니다. 각각의 항목에 대해서 해당되는 곳에 체크 하여 주십시오.

| 내 용 | 매우 그렇다 | 그렇다 | 보통 | 아니다 | 매우 아니다 |
|---|---|---|---|---|---|
| 설문지를 작성하는데 제공된 정보는 충분했다고 생각하십니까? | | | | | |
| 각각의 제공된 정보들이 귀하가 알고 있던 것과 동일합니까? | | | | | |
| 설문지의 정보 및 설문지 작성을 잘 이해했습니까? | | | | | |

## 4.10.3. Consumer questionnaire Ⅰ

SQ1. Are you married? (Please, circle the correct response)

1. Yes
2. No ☞ Stop this survey

SQ2. Are you the primary shopper in your household? (Please, circle the correct response)

1. Yes
2. No ☞ Stop this survey

SQ3. Have you ever purchased organic produce and products?

1. Yes
2. No ☞ Stop this survey

SQ4. Where do you live? (Please circle the correct response)

1. Seoul in main area (Jongno-gu, Jung-gu, Yongsan-gu)
2. Seoul, in Northeast area (Gangbuk, Seongbuk, Dobong, Nowon, jungnang, Dongdaemun, Gwangjin, Seongdong)
3. Seoul, in Northwest area (Eunpyeong, Seodaemun, Mapo)
4. Seoul, in Southwest area (Gangseo, Yangcheon, Guro, Yeongdeungpo, Dongjak, Gwanak, Geumcheon)
5. Seoul, in Southeast area (Seocho, Gangnam, Songpa, Gangdong)
6. Other city aside from Seoul ☞ Stop this survey

SQ5. How old are you?

1. Twenties
2. Thirties
3. Forties
4. Fifties
5. More than sixty

A1. When is the first time you purchased organic foods?

1. 2013
2. 2012
3. 2011
4. 2010
5. 2009
6. 2008
7. 2007
8. 2006
9. 2005
10. 2004
11. 2003
12. 2002
13. 2001
14. 2000
15. No experience

A2. How much do you spend environmentally friendly and conventional food on average each month? (Excluding milk and meat)

| Conventional food | Environmentally friendly food | Total |
|---|---|---|
| | | |

A3. Do you have willingness to increase your purchasing of environmentally friendly foods?

(Excluding milk and meat)

1. I plan to increase the rate of purchase
2. I plan to maintain the rate of purchase
3. I plan to decrease the rate of purchase

A4. Please circle the main environmentally friendly foods you purchased in the past six months and those that you plan to purchase in the future? (Multiple responses) (Excluding for milk and meat)

| Categories | Recent six months | | | | Future | |
|---|---|---|---|---|---|---|
| | General | | Organic | | | |
| | Buy | Non-buy | Buy | Non-buy | | |
| Fruit vegetables<br>(Watermelon, Sweet melon, Strawberry,<br>Cucumber, Pumpkin, Tomato) | | | | | | |
| Leafy and Stem vegetables<br>(Chinese cabbage, Cabbage, Spinach, Lettuce) | | | | | | |
| Root vegetables<br>(Radish, Carrot) | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Flavor vegetables<br>(Red pepper, Welsh onion, Onions, Ginger, Garlic) | | | | | | |
| Production of oil seeds and Cash crops<br>(Sesame, Wild sesame, Peanut, Rapeseed) | | | | | | |
| Fruit Production<br>(Apple, Pear, Peach, Grape, Persimmon, Plum, Others) | | | | | | |
| Miscellaneous Grains(Corn, Sorghum, Millet, Others) | | | | | | |
| Beans(Soy bean, Red bean, Green bean, Others) | | | | | | |
| Potatoes (Sweet potato, White potato) | | | | | | |
| Mushroom | | | | | | |
| Rice | | | | | | |
| No experience | | | | | | |

A5. Are you familiar with organic agricultural products certification labels by National Agricultural Products Quality Management Service?

1. Yes
2. No

A6. Which label is the most trustworthy?

<table>
<tr><td colspan="2">1. Organic produce</td><td colspan="2">2. No-pesticide produce</td><td>3. Low-pesticide produce</td><td rowspan="4">4. None<br>are trustworthy</td></tr>
<tr><td>A 형</td><td>B 형</td><td>A 형</td><td>B 형</td><td rowspan="3">저농약농산물</td></tr>
<tr><td>유기농산물</td><td>유기농<br>(ORGANIC)<br>농림수산식품부</td><td>무농약농산물</td><td>무농약<br>(NON PESTICIDE)<br>농림수산식품부</td></tr>
<tr><td colspan="4">Use of Both A and B type certification labels until 2013<br>No use of A type label after 2014</td></tr>
</table>

A7. When you purchase environmentally friendly foods, which factors are most important?

| Category | Very important | Important | Normal | Less important | Never important |
|---|---|---|---|---|---|
| Price | | | | | |
| Healthiness | | | | | |
| Good taste | | | | | |
| Color | | | | | |
| Conservation of biodiversity | | | | | |
| Conservation of water quality | | | | | |
| Freshness | | | | | |

A8. Please, circle the response that describes how much more expensive organic food is in comparison to conventional foods.

| | | |
|---|---|---|
| 1. Less than 10% | 2. 40%-50% | 3. 81~90% |
| 4. 11-20% | 5. 51-60% | 6. more than 91% |
| 7. 21~30% | 8. 61~70% | 9. no expensive |
| 10. 31~40% | 11. 71~80% | |

Part B. Perception of the Environment

B1. Do you think the threat to each of the following environmental sectors is growing serious?

| Category | Very serious | Serious | Normal | Less serious | No serious |
|---|---|---|---|---|---|
| Water quality | | | | | |
| Soil | | | | | |
| Biodiversity | | | | | |

B2. Are you familiar with environmentally friendly farming?

1. Yes
2. No

B3. What is environmentally friendly farming in your understanding?

1. Organic agriculture using organic fertilizers and chemicals
2. Natural agriculture using ducks or river snails
3. Agriculture using no chemical fertilizers and pesticides
4. Agriculture using less chemical fertilizers and pesticides
5. Agriculture maintained in the environment regardless of farming techniques
6. Other (                              )

B4. Do you think environmentally friendly farming has been associated with protecting environment?

1. Yes
2. No

B5. Under the Environmentally Friendly Direct Payment Program (EFDPP) the government provides incentives and transitional support for farmers who switch to environmentally friendly farming methods. Do you think that EFDPP is helpful for the spread of environmentally friendly farming methods?

1. Yes
2. No

B6. When farmers change farming techniques from conventional farming to environmentally friendly farming, they experience income losses for 5 years. Who should pay for this loss of income?

1. Farmers
2. Consumers
3. Local government
4. Central government
5. Lower level local government
6. Others (                        )

B7. Do you think environmentally friendly farming has positive impacts on improving the environment?

1. Yes
2. No

B8. What elements of the environment are being improved?

| Very little ☜ | ① | ② | ③ | ④ | ⑤ | ☞ Very much |
|---|---|---|---|---|---|---|
| Biodiversity protection | | | | | | |
| Water quality | | | | | | |
| Erosion control | | | | | | |
| Pollination | | | | | | |
| Crop production | | | | | | |
| Carbon sequestration | | | | | | |

Part C. Willingness to Pay for Consumers

Soyang dam located in the upsteam of Bukhan river is one of the main causes of the muddy water in Bukhan River. Since 1999, muddy water problems in all basins of the Bukhan River have occurred, with a high degree of mud in flowing into the river whenever heavy rain falls. Intensive heavy rains have caused long term muddy water problems with very high concentrations. This has caused a decrease in fish resources, destruction of river ecosystems, and decline in water resource values, which has been a main issue between the central government and Ganwon-do as well as related provincial governments and Gangwon-do. Additionally, the frequency of intensive heavy rain has been increasing because of climate change. Mudflow into the river is reducing the possibility of natural purification. Therefore, it is necessary to change the method of agriculture from conventional to the environmentally friendly agriculture which reduces soil erosion. Environmentally friendly agriculture will likewise prevent influx of muddy water as a meaning of preventing several damages to the water source.

"Suppose that this proposal will improve the water quality through the adoption of EFF from muddy water to fresh water along the Soyang watershed, if you would make a payment of KRW A in a tax. The proposal would reduce runoff from heavy rains during the monsoon period in the mountainous agricultural farmland area and would ensure more sustainable clean water supply. Remember that if this would be implemented, the water quality will be improved as a result of EFF practices from muddy water (grade 2) to fresh water (grade 1)".

C1. Do you agree with changing farming technique from conventional farming to environmentally friendly farming?

1. Yes ☞ Go to C2
2. No ☞ Go to C3

C2. Are you willing to pay KRW 2,000 per month by tax for supporting the conversion of environmentally friendly agriculture?

1. Yes
2. No

| If yes, are you willing to pay KRW 3,000 per month? | | If no, are you willing to pay KRW 1,500 per month? | |
|---|---|---|---|
| 1. Yes | 2. No | 1. Yes | 2. No |

C3. Please indicate the final accepted amount regardless of 'yes' or 'no' response. How much is the largest amount of money would you pay for the measure to protect the water flow from chemical pesticide and fertilizer contaminants? (                ) won. (Include respondents who said '0' won)

C4. What is the reason why you don't want to pay for the expense?

1. I can't afford it financially.
2. Government should have responsibility for environmental issues
3. Local government should have responsibility for environmental preventative measures
4. Farmers should have responsibility for their agriculture as polluters

Part D. Social economic background

D1. How many children do you have?

| Infants | Kindergartener | Elementary school | Middle school | High school | Twenties |
|---|---|---|---|---|---|
| | | | | | |

D2. How many years have lived in your current city? (        ) years

D3. What is your employment? (If you are a homemaker, please, circle the items based on the primary source of income in your household)

1 Agriculture/forestry/fishing/livestock
2 Self-employed
3 Government employee
4 Specialized job

5 Paraprofessional
6 Clerk
7 Service industry employee
8 Marketer
9 Engineer
10 Machiner
11 Driver
12 Student
13 Labor (                    )

D4. What is your highest level of academic education?

| No schooling | Elementary school | Middle school | High school | College/ University | Master/Ph.D |
|---|---|---|---|---|---|
| | | | | | |

D5. How much do you earn per year in your household?

| | | |
|---|---|---|
| 1. Less than 5 million won | 2. 5 million won ~ less than 10 million won | 3. 10 million won ~ less than 20 million won |
| 4. 20 million won ~ less than 30million won | 5. 30 million won ~ less than 40 million won | 6. 40 million won ~ less than 50 million won |
| 7. 50 million won ~ less than 60 million won | 8. 60 million won ~ less than 70 million won | 9. 70 million won ~ less than 80 million won |
| 10. 80 million won ~ less than 90 million won | 11. 90 million won ~ less than 100 million won | 12. More than 100 million won |

D6. Please, mark '√'.

| | Very little ☜ | ① | ② | ③ | ④ | ⑤ | ☞ Very much |
|---|---|---|---|---|---|---|---|
| Do you think that the information given in this questionnaire is sufficient to answer? | | | | | | | |
| Do you think that the information given in this questionnaire is the same as what you know? | | | | | | | |
| Do you think that the information given in this questionnaire is enough to be understood? | | | | | | | |

### 4.10.4. Consumers questionnaire II (Korean)

SQ1. 선생님께서는 결혼 하셨습니까?

1. 기혼
2. 미혼 ☞ 설문중단

SQ2. 선생님께서는 마트나 시장에서 직접 장을 보십니까?

1. 예
2. 아니오 ☞ 설문중단

SQ3. 선생님께서 거주하고 계신 지역은 어디입니까?

1. 서울시 도심권 [ 종로구 중구 용산구]
2. 서울시 동북권 [ 강북구 성북구 도봉구 노원구 중랑구 동대문구 광진구 성동구]
3. 서울시 서북권 [ 은평구 서대문구 마포구]
4. 서울시 서남권 [ 강서구 양천구 구로구 영등포구 동작구 관악구 금천구]
5. 서울시 동남권 [ 서초구 강남구 송파구 강동구]
6. 서울지역 이외 ☞ 설문중단

SQ4. 선생님께서는 현재 친환경 농식품을 구매하고 계십니까?

1. 예
2. 아니오

SQ5. 선생님의 나이는 어떻게 되십니까?

1. 20대
2. 30대
3. 40대
4. 50대
5. 60대 이상

PART A. 친환경 농식품 인식 및 구매 행태

A1. 선생님께서 친환경 농식품을 언제 처음 구입하셨습니까?

1. 2013년
2. 2012년
3. 2011년
4. 2010년
5. 2009년
6. 2008년
7. 2007년
8. 2006년
9. 2005년
10. 2004년
11. 2003년
12. 2002년
13. 2001년
14. 2000년
15. 구매 경험 없음

A2. 최근 한 달 평균 선생님께서 구매한 일반 농식품과 친환경 농식품의 구매 금액을 각각 말씀해 주십시오.

| 최근 한 달 평균 일반/친환경 농식품 구매 금액 | | |
|---|---|---|
| 일반 농식품 구매 금액 | 친환경 농식품 구매 금액 | 친환경 + 일반 농식품 구매 금액 |
| 원 | 원 | 합 계: 원 |

A3. 선생님께서는 앞으로 친환경 농식품의 구매 비율을 늘릴 계획이 있습니까?

1. 구매 비율을 늘릴 계획이 있다
2. 구매 비율을 늘릴 계획이 없다 (현재 비율 유지)
3. 구매 비율을 줄일 계획이 있다

A4. 최근 6개월간 선생님께서 구매하신 일반 농산물과 친환경 농식품을 모두 말씀해 주십시오. 그리고 향후 구매할 의향이 있는 친환경 농식품을 모두 말씀해 주십시오.

| 농산물 목록 | 최근6개월 간 구매한 농산물 | | | | 향후 구매 의향 있는 친환경 농식품 | |
|---|---|---|---|---|---|---|
| | 일반 농식품 | | 친환경 농식품 | | | |
| | 구매 | 비구매 | 구매 | 비구매 | 있음 | 없음 |
| 과채류 [수박, 참외, 딸기, 오이, 호박,토마토 등] | | | | | | |
| 엽채류 [배추, 양배추, 시금치, 상추 등] | | | | | | |
| 근채류[무, 당근 등] | | | | | | |
| 조미 채소류 [고추, 파, 양파, 생각, 마늘 등] | | | | | | |
| 특용 작물 [참깨, 들깨, 땅콩, 유채 등] | | | | | | |
| 과실류 [사과, 배, 복숭아, 포도, 감, 자두 등] | | | | | | |
| 잡곡[조, 수수, 옥수수, 메밀 등] | | | | | | |
| 두류[콩, 팥, 녹두 등] | | | | | | |
| 서류[고구마, 감자 등] | | | | | | |
| 버섯류 [팽이 버섯, 느타리 버섯, 표고버섯 등] | | | | | | |
| 곡류[쌀, 찹쌀, 보리] | | | | | | |
| 기타[ ] | | | | | | |

A5. 선생님께서는 국립농산물품질관리원에서 인증한 [친환경 농식품 인증 마크]가 있다는 사실을 알고 계십니까?

1. 알고 있다
2. 모르고 있다

A6. 그렇다면, 이번에는 국립농산물품질관리원에서 인증한 다음의 [친환경 농식품 인증 마크] 중 가장 신뢰가 가는 인증 마크는 무엇입니까?

<table>
<tr><td colspan="2">① 유기 농산물</td><td colspan="2">② 무농약 농산물</td><td rowspan="2">③ 저농약 농산물</td><td rowspan="2">④</td></tr>
<tr><td>A 형</td><td>B 형</td><td>A 형</td><td>B 형</td></tr>
<tr><td></td><td></td><td></td><td></td><td rowspan="2"></td><td rowspan="2">신뢰가는 마크 없음</td></tr>
<tr><td colspan="4">2013 년까지 A/B 형 인증 마트 모두 사용되나, 2014 년부터는 A 형 마크 없어짐</td></tr>
</table>

A7. 선생님께서는 친환경 농식품을 구매할 때, 다음의 각 항목이 어느 정도 중요하다고 생각하십니까?

| 항 목 | 전혀 중요하지 않다 | 중요하지 않다 | 보통 | 중요하다 | 매우 중요하다 |
|---|---|---|---|---|---|
| 가격 | | | | | |
| 건강(식품 안전성) | | | | | |
| 맛 | | | | | |
| 색감 | | | | | |
| 생물 다양성 보존 | | | | | |
| 수질 보존 | | | | | |
| 신선도 | | | | | |

A8. 친환경 농식품 가격이 일반 농식품 가격에 비해 얼마나 더 비싸다고 생각하십니까?

1. 10% 이하
2. 11-20%
3. 21~30%
4. 31~40%
5. 41~ 50%
6. 51~60%
7. 61~70%
8. 71~80%
9. 81~90%
10. 91% 이상
11. 비싸지 않음

PART B. 환경 및 친환경 농업에 대한 인식도

B1. 우리나라의 경우 현재 다음의 각 환경 요소들에 대한 오염의 심각성이 어느 정도 있다고 생각하십니까?

| | 매우 심각하다 | 심각하다 | 보통이다 | 심각하지 않다 | 전혀 심각하지 않다 |
|---|---|---|---|---|---|
| 수질 | | | | | |
| 토양 | | | | | |
| 생물 다양성 | | | | | |

B2. 선생님께서는 친환경 농업에 대해 어느 정도 알고 계신다고 생각하십니까?

1. 조금이라도 알고 있다
2. 조금도 모르고 있다

B3. 선생님께서는 친환경 농업을 무엇이라고 생각하십니까?

1. 유기 비료와 친환경 생물농약을 사용하는 농업
2. 오리, 우렁이 등을 사용하는 농업(인위적으로 먹이사슬을 이용하는 농업)
3. 화학 비료와 농약을 전혀 사용하지 않는 농업(자연 상태에서 스스로 자라게 하는 농업)
4. 화학 비료와 농약 사용량을 현재보다 줄여서 사용하는 농업
5. 어떤 농법을 적용하든 상관없이 환경을 건실하게 유지/보전하는 농업
6. 기타 (                                        )

B4. 선생님께서는 친환경 농업 기술로 농작물을 재배하는 것이 환경을 보호하는 대책이 될 수 있다고 생각하십니까?

1. 그렇다
2. 그렇지 않다

B5. [친환경 농업 직불제]는 친환경 농업 육성을 위해 정부가 농가에게 보조금을 지불하는 정책입니다. 선생님께서는 친환경 농업직불제가 친환경농업을 실시하는 농작물을 재배하는 농업인 확대에 영향을 미친다고 생각하십니까?

1. 예
2. 아니오

B6. 농업인이 일반 농업에서 친환경 농업으로 전환하게 되면 평균 5 년 정도 생산량이 줄어들어 농가 손실액이 발생 됩니다. 이 손실액을 아무도 보조해주지 않기 때문에 이 점이 농업인이 친환경 농업 전환의 가장 큰 걸림돌이라고 평가되고 있습니다. 이처럼 친환경 농업으로 전환함으로 인한 농가의 손실액을 누가 부담하는 것이 가장 적절하다고 생각하십니까?

1. 농업인 스스로
2. 친환경 농작물을 구매하는 소비자
3. 해당 광역지자체
4. 중앙 정부
5. 해당 기초지자체
6. 기타 (                    )

B7. 친환경 농업이 환경에 긍정적인 영향을 미친다고 생각하십니까?

1. 예
2. 아니오

B8. 친환경 농업으로 인한 아래의 각 항목들이 환경 보호에 어느 정도 영향을 미친다고 생각하십니까?

| 항 목 | 전혀 영향을 미치지 않음 | 영향을 미치지 않음 | 보 통 | 어느 정도 영향을 미침 | 매우 영향을 미침 |
|---|---|---|---|---|---|
| 곤충 및 생물 다양성 보호 | | | | | |
| 수질 오염 보호 | | | | | |
| 토양 보존 | | | | | |
| 꽃가루가 이동하여 식물에 영향 | | | | | |
| 농작물 생산 증가 | | | | | |
| 저탄소 배출 | | | | | |

PART C. 친환경 농업 인식도

※ 아래의 내용을 읽고 답하여 주십시오.

가을에 무/배추가 출하되기 전까지 강원도 등 고랭지 지역에서 생산되는 무/배추만이 김치의 주원료로 공급되어 한여름에도 우리나라 국민들이 국내산 김치를 먹을 수 있습니다. 그러나 고랭지 지역에서의 무/배추는 400m 이상의 산간 경사지에서 생산되기 때문에 비가 오면 많은 토사가 하천으로 유입되어 하천을 흙탕물로 만들게 됩니다.

고랭지 지역 토사 유출로 인한 피해

− 북한강 하류 지역의 동 . 식물의 서식지가 파괴

− 북한강 하류 지역의 식수 사용을 위한 정화 처리 비용 상승 또는 식수 사용 불가능

− 북한강 하류 지역의 하천경관이 나빠져 하천을 생활 반경에 두고 있는 주민들의 피해 발생

− 한강(북한강/남한강) 하류 지역의 하천 경관이 나빠져 관광 불가능

이러한 북한강/남한강)의 흙탕물 변화는 무/배추 고랭지 농업의 약 85% 가 위치한 강원도 고랭지 농업지대의 토사 유출이 주요 원인인 것으로 조사되었습니다.

농약과 비료가 포함되어 있는 고랭지 지역의 흙탕물 방지 대책이 나오기 전까지 폭우로 인한 토사 유출 가능성이 존재합니다. 그러므로 농약과 비료로부터 북한강 수질을 보호하기 위하여 고랭지 밭 지역에서 농약과 화학비료를 사용하지 않는 친환경 농업으로 바꿀 필요성이 절실한 상황입니다.

따라서 기후변화로 인한 수도권 지역의 먹는 물 위협 등 각종 피해를 막기 위한 일환으로 한강 상류지역(소양댐 상류지역의 고랭지밭)의 농약과 비료를 차단하기 위한 친환경 농업 전환 프로그램을 실행 할 경우 수질이 깨끗한 물로 1단계 상승한다고 여겨지며, 소요되는 재원은 세금을 통해 이루어지게 된다고 가정해 주십시오.

C1. 위의 글을 읽으신 후, 선생님께서는 북한강 상류 고랭지 농업 지역에서의 무/배추 경작 행위로 비가 오면 토사가 유출되어 북한강 하류 지역이 흙탕물로 변하는 것을 방지하기 위하여 북한강 상류 고랭지 농업 지역이 친환경 농업으로 전환하는 것에 찬성하십니까?

1. 찬성한다 ☞ C2 로
2. 반대한다 ☞ C3 로

C2. “예” 라면, 귀하께서는 친환경 농업 전환 프로그램 시행을 위해, 매월 2,000 원을 추가로 세금을 납부하실 의향이 있으십니까?

1. 예 2. 아니오

| | |
|---|---|
| C2-1. 매월 2,000 원을 내실 수 있다면, 3,000 원을 내실 의향은 있으십니까?<br>① 예 ② 아니오 | C2-2. 매월 2,000 원을 내실 수 없다면, 1,000 원을 내실 의향은 있으십니까?<br>① 예 ① 아니오 |

C3. C2 에서 ‘예’ 또는 ‘아니오’라고 답하신 것에 상관없이 반드시 최종적으로 승인하는 금액을 아래에 적어주십시오. 귀하께서는 소양댐 상류 고랭지 밭에 뿌려진 화학비료와 농약이 북한강 상류에 유입되는 것을 방지하기 위한 대책으로서 친환경 농업 전환프로그램 실행 재원 마련에 매월 지불하고자 하는 최대금액은 얼마입니까? (         )원 ※ ‘0’원으로 답하신 경우도 해당

C4. 귀하께서 C3 에서 ‘0’원으로 답하시거나 C2 에서 ‘아니오-아니오-아니오’로 답하신 이유는 무엇입니까?

1. 세금을 추가로 지불할 경제적 여유가 없어서
2. 한강을 깨끗하게 보전하는 것은 정부가 책임질 일이다.
3. 한강 상류의 농약과 비료 유입원 차단은 해당 지자체가 책임질 일이다.
4. 한강 상류의 농약과 비료 유입원 차단은 농민이 책임질 일이다.

※ 일반적 사항

DQ1. 선생님께서는 아래 연령대에 속한 자녀가 있으시다면, 아래 계층별로 귀하의 자녀수를 말씀해 주십시오.

| 영유아 | 유치원생 | 초등학생 | 중학생 | 고등학생 |
|---|---|---|---|---|
| 명 | 명 | 명 | 명 | 명 |

DQ2. 선생님께서는 현재 거주하고 계신 곳에서 얼마나 거주 하셨습니까? (         ) 년

DQ3. 선생님의 직업은?

1. 농/임/어업 종사자 (가족 종사자 포함)
2. 자영업자 (소규모 장사 및 가족종사자, 개인택시운전사 등)
3. 입법공무원/ 고위임직원 및 관리자 (정부/기업 고위 임원, 일반관리자 등)
4. 전문가 (의사, 약사, 변호사, 회계사, 교수, 작가, 예술가 등)

5. 기술공 및 준전문가 (컴퓨터 관련 준전문가, 경찰, 소방수, 철도기관사, 운동선수, 연예인, 종교인 등)
6. 사무종사자 (일반사무 종사자, 공무원, 교사 등)
7. 서비스종사자 (이미용사, 보안서비스 종사자, 음식서비스 종사자등)
8. 판매종사자 (상점점원, 보험설계사, 나레이터 모델 및 홍보종사자 등)
9. 기능원 및 관련기능 종사자 (광부, 전기/전자장비 설비 및 정비 종사자, 수공예 종사자 등)
10. 장치/기계조작 및 조립종사자 (건설 및 기타 이동장치 운전종사자, 자동차 운전 종사자 등)
11. 단순노무종사자 (배달, 운반, 세탁, 기사, 청소원, 경비원 등)
12. 학생
13. 전업주부
14. 직업군인
15. 무직
16. 기타 (                    )

DQ4. 선생님께서는 학교 교육을 어디까지 받으셨습니까?

| 초등학교 | 중학교 | 고등학교 | 대학교 | 석사 | 박사 |
|---|---|---|---|---|---|
| | | | | | |

DQ5. 가족 모두의 (세금 공제 전) 연간 총 소득은 다음 중 어디에 해당 되십니까? (단, 혼자 독립하여 살고 있는 경우는 본인의 소득만을 고려하여 주십시오)

1. 1천만원 미만
2. 1천만원 – 2천만원 미만
3. 2천만원 – 3천만원 미만
4. 3천만원 – 4천만원 미만
5. 4천만원 – 5천만원 미만
6. 5천만원 – 6천만원 미만
7. 6천만원 – 7천만원 미만
8. 7천만원 – 8천만원 미만
9. 8천만원 – 9천만원 미만
10. 9천만원 – 1억원 미만
11. 1억원 이상

DQ6. 설문지 전반에 대한 질문입니다. 각각의 항목에 대해서 해당되는 곳에 체크 하여 주십시오.

| 내 용 | 매우 아니다 | 아니다 | 보통 | 그렇다 | 매우 그렇다 |
|---|---|---|---|---|---|
| 설문지를 작성하는데 제공된 정보는 충분했다고 생각하십니까? | | | | | |
| 각각의 제공된 정보들이 귀하가 알고 있던 것과 동일합니까? | | | | | |
| 설문지의 정보 및 설문지 작성을 잘 이해했습니까? | | | | | |

## (Eidesstattliche) Versicherungen und Erklärungen

(§ 9 Satz 2 Nr. 3 PromO BayNAT)

*Hiermit versichere ich eidesstattlich, dass ich die Arbeit selbständig verfasst und keine anderen als die von mir angegebenen Quellen und Hilfsmittel benutzt habe (vgl. Art. 64 Abs. 1 Satz 6 BayHSchG).*

(§ 9 Satz 2 Nr. 3 PromO BayNAT)

*Hiermit erkläre ich, dass ich die Dissertation nicht bereits zur Erlangung eines akademischen Grades eingereicht habe und dass ich nicht bereits diese oder eine gleichartige Doktorprüfung endgültig nicht bestanden habe.*

(§ 9 Satz 2 Nr. 4 PromO BayNAT)

*Hiermit erkläre ich, dass ich Hilfe von gewerblichen Promotionsberatern bzw. -vermittlern oder ähnlichen Dienstleistern weder bisher in Anspruch genommen habe noch künftig in Anspruch nehmen werde.*

(§ 9 Satz 2 Nr. 7 PromO BayNAT)

*Hiermit erkläre ich mein Einverständnis, dass die elektronische Fassung meiner Dissertation unter Wahrung meiner Urheberrechte und des Datenschutzes einer gesonderten Überprüfung unterzogen werden kann.*

(§ 9 Satz 2 Nr. 8 PromO BayNAT)

*Hiermit erkläre ich mein Einverständnis, dass bei Verdacht wissenschaftlichen Fehlverhaltens Ermittlungen durch universitätsinterne Organe der wissenschaftlichen Selbstkontrolle stattfinden können.*

…………………………………………………………………………………………….

Ort, Datum, Unterschrift