Choice Experiment Applications in Food, Agriculture, and Rural Planning Research in Japan

AGBM

Hideo Aizaki

Rural Development and Planning Division
Institute for Rural Engineering
National Agriculture and Food Research Organization
2-1-6 Kannondai, Tsukuba, Ibaraki 305-8609, Japan
e-mail: aizaki@affrc.go.jp

Abstract

The present monograph reviews applications of choice experiments in over 60 papers that have been published on three research topics related to agricultural economics in Japan: consumer valuation, farm management, and rural planning research. It also presents studies carried out by the author of this monograph and colleagues in each of these fields. First, consumers' valuations of beef derived from bovine embryo-cloned cattle were conducted to demonstrate that spreading technological information on cloning does not necessary improve consumers' intentions to purchase cloned beef. Second, rice farmers' behavior when using a joint-use facility was analyzed and integrated into a simulation to predict how changing the rate structure of the facility influences its acceptance of harvested rice. Finally, the environmental benefits of expanding ecologically friendly paddy fields among rice farmers were estimated and the results were compared with those derived from using the contingent valuation method. An application program for designing and analyzing choice experiments is also illustrated. In conclusion, expanding applications of choice experiments in search of solutions to social issues related to agricultural economics in Japan should consider various decision-making strategies, use other peoples' behavior as an attribute, and examine the information effects.

1. Introduction

The choice experiment approach, which is also known as the discrete choice experiment, stated choice method, or choice-based conjoint analysis, was introduced by Louviere and Woodworth (1983). Since its inception, it has been considerably developed and is now an important statistical method in the social sciences with applications in marketing research, environmental economics, agricultural economics, transportation economics, and health economics, among others (Louviere *et al*. 2000; Bennett and Blamey 2001; Bateman *et al*. 2002; Hensher *et al*. 2005; Kanninen 2007; Ryan *et al*. 2008). The approach has also been used to extract useful information on the public and private sectors of developed (e.g., Birol and Koundouri 2008) and developing countries (e.g., Bennett and Birol 2010). This information includes the public's willingness to pay to conserve the local environment and consumers' preferences for features of a newly developed product.

The choice experiment approach is a member of the wider family of stated preference methods. Stated preference methods are defined as statistical methodologies that gather data by surveying an individual's intentions to perform a specified behavior in certain statistically designed hypothetical situations. They also analyze the gathered data using discrete choice models that are derived from random utility theory (c.f., Ben-Akiva and Lerman 1985). The choice experiment approach restrictively belongs to choice modeling, which includes four variants: the choice experiment, contingent ranking, contingent rating, and paired comparison methods (Bateman *et al*. 2002). It is to be noted that traditional conjoint analysis (e.g., Green and Rao 1971) is not based on random utility theory, and as such, it is not included as a choice modeling approach in this monograph (Louviere *et al*. 2010).

The present monograph focuses on the choice experiment approach because this method has been used in almost all applied studies of choice modeling in the agricultural economics area of Japan. To my knowl-

edge, only three published studies have used the contingent ranking method (one is seen in Chapter 3 of this monograph), whereas choice experiments have been applied in at least 60 agricultural economics papers in Japan over the past decade (see Chapter 2 for further details). Furthermore, this number of research results would increase if studies published in non-academic journals (e.g., presented in books or provided by institutes) were also counted.

The author of this monograph has applied this technique in various empirical studies of food, agriculture, and rural planning in Japan following individual and collaborative research. Furthermore, on this specialized topic, the author has written a book in Japanese (Aizaki 2005b), which was translated into Chinese, published manuals for Japanese choice experiment beginners (e.g., Aizaki and Nishimura 2007), and developed basic application programs (Aizaki 2007b, 2009b, 2011). The present monograph's illustration of the applications of choice experiments in agricultural economics in Japan includes these previously published research results.

The outline of the monograph is as follows: Chapter 2 assembles and describes the applied studies of choice experiments and the contingent ranking method in the agricultural economics area of Japan. These studies are divided into three fields: consumer valuation research on agricultural and livestock products, farm management research, and rural planning research.

Chapters 3 to 5 briefly present the author's research papers in each field. Chapter 3 describes consumers' valuations of the beef derived from bovine embryo-cloned cattle as an example of consumer valuation research in the agriculture and livestock field. Consumers' valuations are analyzed using the contingent ranking approach to demonstrate that spreading technological information on this topic does not necessary improve consumers' intentions to consume bovine embryo-cloned beef. Chapter 4 provides an example of using choice experiments in farm management research. A choice experiment approach was used to capture rice farmers' behavior when using a joint-use facility, and the resultant model was integrated into a simulator to predict how changing the rate structure of the joint-use facility influences its acceptance of harvested rice from local rice farmers. Chapter 5 introduces and describes a rural planning research study that measured the environmental benefits of expanding ecologically friendly paddy fields in a local area. In this study, the environmental benefits were estimated through choice experiments, and the results were compared by applying the contingent valuation method.

Chapter 6 differs from the previous three chapters because it simply illustrates an application program for conducting choice experiments. This package, which runs in the integrated environment of Microsoft Excel and R, provides the functionality to design choice experiments and analyze the responses to choice experiment questions.

Finally, Chapter 7 suggests avenues for future research in the agricultural economics area of Japan. Appendix 1 lists the applications of choice experiments by the author of the monograph and colleagues. This list is not limited to only papers published in academic journals.

2. Review of choice experiment applications in the agricultural economics area of Japan

2-1. Introduction

This chapter reviews how choice experiments have been applied to previous food, agriculture, and rural planning studies in Japan. The aim of this review is to classify and elucidate the features of these studies. Specifically, the following three research areas are reviewed: consumer valuation research on agricultural and livestock products, farm management research, and rural planning research. In addition, the methodologies applied in these studies are summarized. It is noted that application papers that used choice modeling—including the choice experiment, contingent ranking, contingent rating, and paired comparison methods—had been sought at first, but most papers, except for three (i.e., Kodama 2001; Aizaki *et al*. 2004b; Aizaki and Sato 2007), were found to use choice experiments; therefore, the term "choice experiment" is used in this chapter. Of course, the three papers that used contingent ranking methods are also reviewed in this chapter.

The choice experiment studies reviewed in this chapter have been collected from a wide range of agricultural economics and related journals published until the second half of 2011 by the following Japanese academic societies: The Agricultural Economics Society of Japan; The Farm Management Society of Japan; The Food System Research Association of Japan; The Association for Regional Agricultural and Forestry Economics; The Agricultural Economics Society of Hokkaido; The Agricultural Economics Society of Tohoku; The Rural Economics Society in Chubu District; The Food, Agricultural and Resource Economics Society of Japan; The Association of Rural Planning; Japanese Society of Agricultural Informatics; and The Japanese Society of Irrigation, Drainage and Rural Engineering. Although the collected papers are peer-reviewed, these contain full-length papers and short-length papers such as proceedings papers. Furthermore, some of the included papers have been published in overseas journals by Japanese agricultural economists. This chapter does not provide an exhaustive literature review, but in contrast it describes the trend towards the use of choice experiments in agricultural economics in Japan.

This chapter builds on Aizaki (2005b, Chapter 3), which reviewed the applications of choice experiments and traditional conjoint analysis in the agricultural economics area of Japan until the mid-2000s and its English edition is Aizaki (2010a). Most of the papers described in this chapter discuss issues related to food, agriculture, and rural planning in Japan; therefore, the annual reports published by the Ministry of Agriculture, Forestry and Fisheries of Japan (MAFFJ) may be helpful for readers who are unfamiliar with these issues. These reports are freely available from the MAFFJ website (http://www.maff.go.jp/e/index.html). Furthermore, respondents in the papers reviewed in this chapter were Japanese unless otherwise stated.

2-2. Choice experiments in consumer valuation research

Consumer valuation research on agricultural and livestock products can be classified into the following four topics: consumers' valuations of region of origin and regional brand food, consumers' valuations of eco and organic foods, consumers' valuations of food safety, and the effects of providing information (**Table 1**).

2-2A. Consumers' valuations of region of origin and regional brand food

Competition in the agricultural and livestock production sector among domestic regions and between domestic and overseas regions has become more intensive over the past few decades. Domestic regions seek to establish their regional brands in order to receive favorable sales terms and thus maximize revenue. Although consumers' valuations of agricultural and livestock production by region has been measured using demand analysis based on statistics related to market prices and distributions about the products, choice experiments have also been applied to this topic over the past decade.

Studies of competition in this area have previously been carried out by Oura *et al.* (2002) and Iwamoto and Yamamoto (2006). Oura *et al.* (2002) used choice experiments to measure consumers' valuations of region of origin and growing method for five fruits and vegetables (i.e., mini tomato, a long variety of Welsh onion, broccoli, onion, and kiwi fruit). The study found that consumers place a higher value on local regions of origin and on regions of origin that have specific favorable images.

The latter finding was supported by Iwamoto and Yamamoto (2006). They conducted choice experiments to measure the regional brand values of five major producing regions for rice, potatoes, and milk, including Hokkaido. The results showed that consumers' valuations of Niigata and Akita, which are well known for producing rice, are higher than that of Hokkaido in the case of rice, while consumers' valuations of

Hokkaido, which is well known for producing potatoes and milk, are higher than those of the other four prefectures for potatoes and milk.

In Japan, there is a growing trend towards promoting agriculture and livestock production on the basis that some local residents prefer local products (so-called "local consumption of local products"). Thus, there has been an increase in studies aiming to measure consumers' valuations of the local consumption of local products. For example, Kodama (2001) valued the local consumption of locally produced Ajimu beef, which is beef that is derived exclusively from cattle that are fed and sold in Ajimu (a town in the Oita prefecture). The results clarified that consumers' valuations of Ajimu beef are higher compared with other types of domestic beef and imported beef. Moreover, Ajimu residents value this locally produced beef higher than do non-residents. Other similar studies have valued Fukushima strawberries (Hangui 2007); Kuretsubo turnips (Yamada *et al.* 2008); and spinach, bean curd, and a long variety of Welsh onion that are produced in Hyogo (Kato and Terawaki 2009; Kato *et al.* 2009).

Although the per capita annual consumption of rice has been decreasing (from 87 kg in 1980 to 65 kg in 2009), rice remains a special agricultural product for many Japanese. It is also an important agricultural product for many farmers: for example, the agricultural area devoted to rice paddy fields in Japan is approximately 1.6 million ha, while the area of cultivated land in Japan is approximately 4.2 million ha. In light of the foregoing, choice experiment studies of the market power of rice have also been conducted by Sato *et al.* (2001) and Yoshida and Peterson (2003).

Sato *et al.* (2001) was the first full-length paper in Japan to describe consumers' valuations of food and food safety using a choice experiment approach. Thus, it has affected subsequent choice experiment studies to a large degree. This study used choice experiments to measure the market power of Hokkaido rice with regard to its labeling, such as the organic growing method or low chemical use during production, and the region of origin among other factors. Consumers' valuations of general Hokkaido rice were lower than those of regions that compete with Hokkaido rice, while rice that displayed features such as low use of chemicals during production had an equal or higher value compared with rice from rival production regions.

Stated preference approaches are needed to examine how Japanese consumers value imported rice and understand what factors affect their valuations, since imported rice is rarely sold in the Japanese rice retail market. Yoshida and Peterson (2003) applied choice experiments to assess consumers' valuations of domestic rice and foreign rice (US, Australian, and Chinese rice). The study confirmed that even consumers who had a positive or neutral impression of food safety and

Table 1. The application of choice experiments in consumer valuation research by topic.

Authors	Respondents	Objective	Alternatives	Attributes
Region of origin and regional brand				
Oura *et al.* (2002)	Households in four prefectures	Valuing the region of origin and growing method for five fruits and vegetables	The five varieties were mini tomato, a long variety of Welsh onion, broccoli, onion, and kiwi fruit	(1) Region of origin, (2) growing method, and (3) price
Iwamoto and Yamamoto (2006)	Households in eight prefectures	Valuing the region of origin for three agricultural and livestock products	The three varieties were rice, potatoes, and milk	(1) Region of origin and (2) price
Kodama (2001)	Consumers who live in a local area and visitors to the local area	Valuing locally produced beef	Beef	(1) Region of origin and (2) price
Hangui (2007)	Households in a local area	Valuing the characteristics of a regional product	Fukushima strawberry	(1) Price, (2) size, (3) region of origin, (4) taste, and (5) the presence of variety on the label of the package
Yamada *et al.* (2008)	Visitors to a facility	Valuing the characteristics of a regional product	Kuretsubo turnip	(1) Vegetable (turnip and Japanese radish) and (2) price
Kato *et al.* (2009)	Customers in two shops	Valuing the characteristics of a regional product	A long variety of Welsh onion	(1) Price, (2) the presence of local government certification, and (3) variety
Kato and Terawaki (2009)	Part-time workers in a consumer cooperative and a private company	Valuing regional agricultural products certified by the local government	Spinach and bean curd (tofu)	(1) The word-of-mouth related to the product, (2) region of origin, (3) the presence of local government certification, (4) the presence of the verification of residues from agricultural chemicals, and (5) price
Sato *et al.* (2001)	Households in a local area	Assessing the competitiveness of a regional chemical-free rice	Rice	(1) Variety and region of origin, (2) the presence of the name of the city of origin and farmer, (3) growing method, and (4) price
Yoshida and Peterson (2003)	Households in a prefecture	Valuing domestic rice and foreign rice	Rice	(1) Variety and region (country) of origin, and (2) price
Ujiie (2009)	Women in two prefectures	Valuing regional brand beef	Beef	(1) Region of origin and (2) price
Kojiya and Aizaki (2011)	Consumers of green tea in a number of prefectures	Valuing the characteristics of regional green tea	Green tea	(1) Variety, (2) region of origin, (3) price, and (4) the presence of labeling describing the characteristics of the green tea
Nakamura *et al.* (2007)	Visitors to a school festival	Valuing the characteristics of apples	Apples	(1) Region (country) of origin, (2) the growing method, (3) the traceability system, (4) the verification of residues from agricultural chemicals, and (5) price

Authors	Respondents	Objective	Alternatives	Attributes
Nakamura *et al.* (2009)	Visitors to two school festivals	Valuing the characteristics of apple juice	Bottled and carton apple juice	(1) Country of origin, (2) type of cloudiness, (3) food additives added, (4) the presence of apple GAP, and (5) price
Nakamura and Maruyama (2009)	Shop customers in Singapore	Valuing the characteristics of imported grapes	Imported grapes	(1) Country of origin, (2) the size of a grain, (3) the presence of seeds (seedless or not), (4) growing method, and (5) price
Eco foods and organic foods				
Aizaki (2005a)	Households in a local area	Valuing rice produced in harmony with the ecosystem	Eco-rice	(1) The distance from home to the farm producing the eco-rice, (2) using the eco-field to capture wildlife living there, and (3) price
Iwamoto (2004)	Households in a local area	Valuing milk that has a HACCP label and an eco-label	Milk	(1) Days before the expiry date, (2) the HACCP label, (3) the eco-label, and (4) price
Iwamoto *et al.* (2006)	Households in four areas of Korea	Valuing milk that has a HACCP label and an eco-label	Milk	(1) Days before the expiry date, (2) the HACCP label, (3) the eco-label, and (4) price
Managi *et al.* (2008)	Households in a local area	Valuing organic milk	Milk	(1) Organic feed, (2) restrictions on use of animal medical products, (3) low-stress feeding, and (4) price
Saito *et al.* (2009)	Residents in a prefecture	Valuing pork derived from hogs fed on feed made from food waste	Pork	(1) Price, (2) country of origin, and (3) certification of eco-feed
Fujimoto and Tsunekawa (2007)	Consumers in a region of a prefecture	Valuing milk and beef derived from cows and beef cattle fed rice whole crop silage	Milk and beef	(1) Feed self-sufficiency ratio, (2) excrement recycling ratio, (3) ratio of rice paddy fields converted from fallow paddy fields, and (4) price
Food safety				
Kurihara *et al.* (1999)	Parents who have elementary or junior high school student(s) in a local area	Measuring their preferences towards food safety in school lunches	School lunches	(1) Cooking method, (2) expense, (3) food safety measures, and (4) nutritional balance
Hosono (2003)	Members of a consumer cooperative	Valuing characteristics of milk	Milk	(1) The milk/fat ratio, (2) days before the expiry date, (3) presence of the HACCP label, (4) presence of fortifying with calcium, and (5) price
Hosono (2004)	Members of a consumer cooperative	Valuing characteristics of milk	Milk	(1) The milk/fat ratio, (2) days before the expiry date, (3) presence of the HACCP label, (4) presence of fortifying with calcium, and (5) price

Table 1. (continued).

Authors	Respondents	Objective	Alternatives	Attributes
Aizaki and Sato (2007)	Consumers living in a local area	Valuing GAP-certified tomatoes	Tomatoes	(1) Region of origin, (2) growing method, and (3) price
Ohtani and Yabe (2004)	Members of a web service	Valuing second-generation genetically modified technology and the traceability system	Vegetables	(1) Appearance, (2) growing method and the use of agricultural chemicals, (3) traceability and verification, and (4) price
Yabe *et al.* (2002)	Consumers in the UK	Valuing the safety and labeling of eggs	Eggs	(1) The living conditions of hens, (2) the use of agrochemicals and fertilizers in the production of chicken feed, (3) the ratio of genetically modified content in chicken feed, (4) the presence of information about production history, and (5) price
Yabe *et al.* (2003)	Consumers in the UK	Valuing the safety and labeling of eggs	Eggs	(1) The living conditions of hens, (2) the use of agrochemicals and fertilizers in the production of chicken feed, (3) the ratio of genetically modified content in chicken feed, (4) the presence of information about production history, and (5) price
Aizaki *et al.* (2004b)	Households in a local area	Valuing beef derived from bovine embryo-cloned cattle	Beef	(1) Breeding technology, (2) country of origin, and (3) price
Aizaki *et al.* (2004c)	Households in a local area	Valuing the food safety of beef	Beef	(1) Country of origin, (2) feeding method, and (3) price
Aizaki *et al.* (2006b)	Households in a local area	Valuing the production information disclosed about beef and BSE-tested imported beef	Beef	(1) Country of origin, (2) BSE test status, (3) information on the individual identification of cattle, (4) information on feeds and pharmaceuticals, and (5) price
Aizaki *et al.* (2012)	Households in a local area	Valuing the country of origin and BSE test status for beef	Beef	(1) Country of origin, (2) BSE test status, and (3) price
Effects of providing information				
Nakamura and Keino (2006)	Female university students who specialize in nutrition science	Valuing the characteristics of vegetables and the traceability system	Various vegetables (carrot, edible burdock, onion, broccoli, mini tomato, ginger, and shiitake mushroom)	(1) Country of origin, (2) growing method, (3) price, (4) presence of traceability, and (5) appearance
Zhou *et al.* (2010)	Chinese customers in four shops	Valuing the information provided by the traceability system	Milk	(1) Information about the farm and/or farmer, (2) information about veterinary medicine use, (3) information about processing plantings, and (4) price

Authors	Respondents	Objective	Alternatives	Attributes
Kono et al. (2005)	Households in two local areas	Valuing Satsuma oranges selected using an optical sensor in a test of quality	Satsuma oranges	(1) Region of origin, (2) the presence of the test, and (3) price
Isayama and Oura (2004)	Households in a local area	Valuing the labeling of vitamin C, iron content, and nitric acid on summer spinach	Summer spinach	(1) Vitamin C content, (2) iron content, (3) nitric acid content, and (4) price
Sato and Niiyama (2008)	Customers in two shops	Examining how the amount of information available influences consumers' valuations	Eggs	(1) Size, (2) price, (3) color of the shell, (4) days before the expiry date, (5) region of origin, (6) feeding method, (7) types of feed, (8) history of checking salmonella, (9) history of using vaccines, (10) history of disinfection, (11) code of traceability, and (12) indicators of environmental burden
Hara et al. (2007)	Members of a consumer cooperative	Valuing quality assurance information and the media providing it	Spinach	(1) The combination of quality assurance information and the media providing it and (2) price
Aizaki et al. (2010)	Members of a consumer cooperative	Examining the effects of providing information about agricultural chemicals on valuing tomatoes	Tomatoes	(1) Region of origin, (2) growing method, and (3) price

taste of foreign rice placed half or less value on it compared with domestic rice.

Other region of origin studies using choice experiment approaches include consumers' valuations of Sendai beef (Ujiie 2009); consumers' valuations of Mie green tea (Kojiya and Aizaki 2011); and consumers' valuations of apples, apple juice, and grapes (Nakamura *et al.* 2007, 2009; Nakamura and Maruyama 2009).

2-2B. Consumers' valuations of eco and organic foods

In line with the recent increase in consumers' concerns about the environment, farmers have been expanding environmentally friendly agriculture and livestock farming. This has been reflected in a number of choice experiment studies of agricultural and livestock products from environmentally friendly farms. These studies include consumers' valuations of rice produced from ecologically friendly rice farmers (Aizaki 2005a), consumers' valuations of milk derived from environmentally friendly dairy farmers (Iwamoto 2004; Iwamoto *et al.* 2006), consumers' valuations of organic milk (Managi *et al.* 2008), consumers' valuations of pork derived from hogs fed on feed made from food waste (Saito *et al.* 2009), and consumers' valuations of milk and beef derived from cows and cattle fed rice whole crop silage (Fujimoto and Tsunekawa 2007). Sato *et al.* (2001), which was introduced in Subsection 2-2A, is also regarded as a study on this sub-topic since it used "organic" as a level of a growing method attribute.

Aizaki (2005a) used choice experiments to measure consumers' valuations of eco-rice that was defined as rice produced taking into account various species of wildlife that live in paddy fields. The results showed that consumers' valuations of eco-rice varied from 2,639 yen per 10 kg to 6,830 yen per 10 kg according to the characteristics of respondents. Furthermore, some consumers were willing to pay 6,000 yen per 10 kg or more, which is the minimum price required for eco-rice farmers to produce it. In conclusion, selling eco-rice at cost price or just above is an ineffective way of diffusing ecologically friendly paddy fields in the survey area.

Iwamoto (2004) implemented a choice experiment to measure consumers' valuations of milk produced under conditions of environmentally friendly dairy farming and certified with a hazard analysis critical control point (HACCP). The study found that a representative milk consumer would be prepared to pay an additional 12 yen per liter for milk supplied from environmentally friendly dairy farmers compared with general milk. Based on the approach of Iwamoto (2004), Iwamoto *et al.* (2006) estimated that Korean consumers would be prepared to accept a 48% price increase over the price of general milk, for milk supplied from environmentally friendly dairy farmers.

Managi *et al*. (2008) confirmed that consumers' additional value of organic milk, which was defined as milk derived from cows fed organic feed, those fed restricted animal medical products, and those fed in a low-stress environment, was estimated to be 381 yen per liter.

The Japanese government has been promoting recycling resources related to food, agriculture, and livestock. Examples include compost or livestock feed that is made from food co-products or food waste that is supplied to farmers or livestock farmers, and rice whole crop silage that is made by rice farmers and supplied to livestock farmers. Saito *et al*. (2009) applied choice experiments to assess consumers' valuations of pork derived from hogs fed on feed made from food waste and found that their average added value was approximately 8 yen per 100 g. However, this value varied from −50 yen per 100 g to 50 yen per 100 g according to respondents, implying that some consumers refuse to purchase it. Fujimoto and Tsunekawa (2007) simulated the costs and benefits of a policy that promotes closer ties between rice farmers and livestock farmers: rice farmers supply rice whole crop silage to livestock farmers, while livestock farmers supply compost to rice farmers. Consumers' valuations of milk and beef derived from cows and cattle fed rice whole crop silage were estimated using choice experiments and then integrated into the simulation to calculate the benefits of the policy.

2-2C. Consumers' valuations of food safety

Consumer valuation studies of food safety using choice experiment approaches are roughly divided into the following three sub-topics: consumers' valuations of measures for enhancing food safety related to processes of producing agricultural products on farms and in factories (Hosono 2003, 2004; Iwamoto 2004; Iwamoto *et al*. 2006; Aizaki and Sato 2007; Nakamura *et al*. 2009), consumers' valuations of applying biotechnologies to agriculture and livestock (Yabe *et al*. 2002, 2003; Ohtani and Yabe 2004; Aizaki *et al*. 2004b), and consumers' valuations of countermeasures to Bovine Spongiform Encephalopathy (BSE; Aizaki *et al*. 2004c, 2006b, 2012). Although it is difficult to classify Kurihara *et al*. (1999) into any one of the three sub-topics, it applied choice experiments to measure the preferences of parents of school students for the food safety of school lunches.

(a) HACCP and good agricultural practice (GAP)

The Food Sanitation Law that was partially amended in 1995 has improved hygiene management in food production by introducing the HACCP. The HACCP label is now attached onto processed food products that are made in a factory that has been certified by the Approval of Comprehensive Sanitation Management and Production Process. Furthermore, the Act on Temporary Measures concerning the Sophistication of the Management of Food Manufacturing Processes pro-

motes investment into the equipment needed for food producing companies to introduce the HACCP to their products. Choice experiment approaches have been applied to measure consumers' preferences towards the HACCP. Iwamoto (2004), which was introduced as a paper related to eco-foods, also estimated the marginal willingness to pay for the HACCP to be approximately 6 yen per liter of milk. Hosono (2003, 2004) also conducted choice experiments on consumers' valuations of the HACCP on milk products. These studies found that consumer values were estimated to range from 17 yen per liter to 26 yen per liter and that they increased further according to providing detailed information on the HACCP.

According to the FAO (2003, Introduction section, Paragraph 2), GAP "applies available knowledge to addressing environmental, economic and social sustainability for on-farm production and post-production process resulting in safe and healthy food and non-food agricultural products." GAP contains practices related to soil, water, crop and fodder production, crop protection, animal production, animal health and welfare, harvest and on-farm processing and storage, energy and waste management, human welfare, health and safety, and wildlife and landscape (FAO 2003). Various GAPs have been established by private companies, non-profit organizations, and the government and local governments in Japan since the 2000s. However, Japanese consumers' perceptions of GAP are still low. An example of consumers' valuations of GAP was conducted by Aizaki and Sato (2007). They used a contingent ranking approach that asked respondents to rank their top three tomatoes from a set of 16 types. The tomatoes were expressed using three attributes: region of origin, growing method (GAP or general), and price. It is noted that they defined GAP as a food safety management system, namely their definition excluded farming activities such as environmental conservation and the maintenance of the welfare of farm workers. Compared with general tomatoes, which were priced between 100 and 115 yen a piece, the added value of GAP tomatoes was estimated to be approximately 10 yen a piece. Nakamura *et al*. (2009), which was introduced as a region of origin study in the previous section, also used a GAP as one of their attributes to measure preferences towards apple juice.

(b) Genetically modified food and cloning

Consumer valuation studies of the application of biotechnologies in the agriculture and livestock sector have been conducted by Ohtani and Yabe (2004), Yabe *et al*. (2002, 2003), and Aizaki *et al*. (2004b). Ohtani and Yabe (2004) used choice experiments to measure consumers' valuations of second-generation genetically modified technology that aims at increasing consumers' benefits and the traceability system. The study showed that a proportion of consumers would accept second-generation genetically modified technology if

it made way for no-chemical farming. Yabe *et al.* (2002, 2003) applied choice experiments to analyze how UK consumers choose eggs in order to value the living conditions of hens, the use of agrochemicals and fertilizers in the production of chicken feed, and the certification of health standards and quality of eggs, as well as the genetically modified content in chicken feed.

Aizaki *et al.* (2004b) applied a contingent ranking approach to value beef derived from bovine embryo-cloned cattle. Structural equation modeling was conducted to analyze the relationship between knowledge and attitudes towards bovine embryo cloning technology. By introducing attitudes that had been calculated from the results of the structural equation modeling as independent variables in the contingent ranking analysis, the effects of consumers' attitudes towards cloning on their valuations of bovine embryo-cloned beef were examined. The study found that consumers' levels of technological knowledge on cloning influenced their attitudes towards bovine embryo-cloned beef to a non-significant extent, whereas their attitudes significantly affected their valuations of bovine embryo-cloned beef. Thus, consumers' valuations of bovine embryo-cloned beef would not be improved only by providing them with technological information on cloning (see also Chapter 3 of the monograph for details).

(c) Discovery of BSE in Japan

The first discovery of cattle infected with BSE occurred in Japan in September 2001. This discovery created a great disturbance in the beef market and BSE-testing was immediately introduced at slaughterhouses for cattle of all ages. A traceability system for domestic beef also was fully introduced in 2004 based on the Law for Special Measures Concerning the Management and Relay of Information for the Individual Identification of Cattle. The law mandatorily applies ear tags that use an ID number to identify all domestic cattle and records this ID number as well as date of birth, sex, and any other information related to the distribution of the beef (from dairy farmers to retail stores). Consumers can get the information corresponding to the beef package that they purchase or want to purchase by searching for the ID number printed on the package or displayed on the price board on the website of the National Livestock Breeding Center. Furthermore, Japanese Agricultural Standards made the disclosure of production information such as feeds and pharmaceuticals for cattle discretionary. Although the beef market returned to normal by mid-2002 (Ishida *et al.* 2010: see also Peterson and Chen 2005; Kawashima and Sari 2010), Japanese consumers have been anxious about the safety of beef ever since. Thus, examining factors that affect this anxiety for beef safety plays an important role in considering how the risk of beef safety should be communicated to consumers.

Aizaki *et al.* (2004c) used choice experiments and structural equation modeling to examine how consumers' attitudes towards beef influenced their valuations of its safety after the BSE outbreak in Japan. The choice experiment questions asked about the price and feeding method of four types of beef: domestic beef, domestic Wagyu beef, Australian beef, and US beef. Furthermore, feeding method had two levels: conventional and safe. The former means that the beef is derived from cattle fed conventionally, whereas the latter means that the beef is derived from cattle fed in accordance with hypothetical food safety measures. The study found that an increase in caution regarding food safety decreases the probability of selecting conventional domestic beef and conventional domestic Wagyu beef and increases the probability of selecting safety domestic beef and safety domestic Wagyu beef. Furthermore, the marginal willingness to pay for safety beef in the cases of two types of imported beef was lower compared with the cases of domestic beef and domestic Wagyu beef.

In December 2003, Japan banned imports of US beef following the first discovery of BSE-infected cattle in the US. Because a quarter of beef consumed in Japan was US beef before the ban, the ban greatly affected the Japanese beef market. Aizaki *et al.* (2006b) assumed that the BSE testing carried out in Japan was arbitrarily introduced in the US and Australia and used choice experiment questions that required respondents to select their preferred beef from domestic beef, domestic Wagyu beef, Australian beef, and US beef. The study confirmed that consumers' valuations of both BSE-tested US beef and BSE-untested US beef are lower (indeed negative) compared with the other options. The results suggest that consumers are considerably anxious about the safety of US beef and thus many would not want to purchase it even if its price is very low and it has been BSE-tested.

In that same vein, Aizaki *et al.* (2012) used a choice experiment approach to consider the non-compensatory valuation of BSE testing with regard to the purchase of the same four types of beef. This study confirmed that consumers who would consider purchasing US beef if its price was reasonable—even if it had not been tested for BSE—would be willing to pay 391 yen per 100 g and –11 yen per 100 g for BSE-tested US beef and BSE-untested US beef, respectively. By contrast, consumers who would not consider purchasing US beef regardless of its BSE test status would be willing to pay –814 yen per 100 g and –2,110 yen per 100 g for BSE-tested US beef and BSE-untested US beef, respectively. These results indicate that the non-compensatory choice rule is important for measuring the valuation of food safety by consumers who are conscious of food safety, while BSE test status greatly affects consumers' decisions on purchasing beef.

2-2D. Effects of providing information

Providing consumers with information on the nutri-

tion of agricultural and livestock products and introducing a traceability system in which the production and distribution information of these products is certified and accessed by consumers has improved public health and maintained food safety. Although some previous papers have measured consumers' valuations of the nutritional content of these products and the traceability system using a choice experiment approach (e.g., Hosono 2003, 2004; Ohtani and Yabe 2004; Nakamura and Keino 2006; Zhou *et al.* 2010), the more important issue is to examine how to provide consumers with information related to food because the probability of inappropriately choosing food might increase if information is not available to consumers.

For example, consumers' valuations of the suitable characteristics/features of food might be negative if they do not have appropriate information on it. Kono *et al.* (2005) used a choice experiment approach to examine the effects of the provision of information and consumers' knowledge on their valuations of Satsuma oranges that were inspected by an optical sensor. This testing reduced a variation in the quality (taste) of Satsuma oranges because low quality fruits were rejected by the sensor; therefore, the optical sensor testing benefits consumers. The study divided respondents into two groups. One group was informed that the benefit of the optical sensor was that it nullified differences in the taste of Satsuma oranges. The other group was not informed about this advantage. Informed respondents placed a high value on the Satsuma oranges that had been inspected by the sensor, whereas uninformed respondents who were also previously unaware of it, evaluated sensor-inspected Satsuma oranges as lower than non-inspected Satsuma oranges.

Isayama and Oura (2004) demonstrated that the value of an attribute may vary according to combinations of the attribute and the other attributes that jointly provide an alternative. They examined how combinations of ingredients that are labeled on spinach influenced consumers' valuations of each ingredient by implementing three different types of choice experiment questionnaires. The first one displayed the vitamin C and iron content on the label. The second one displayed only the nitric acid content on the label. The third one displayed the vitamin C, iron, and nitric acid content on the label. The study showed that each coefficient related to the vitamin C and iron content is significant when only two ingredients are shown, whereas they are partially not significant when all three ingredients are shown. The results suggested that negative information might affect consumers' valuations of positive information when both negative and positive information are jointly available.

The results of the papers mentioned above highlight the importance of the manner in which information is provided to consumers. In order to make consumers fully aware of food and/or food safety, food suppliers

might be motivated to provide them with more detailed information. However, because of the limitations of processing information, the provision of detailed information does not necessarily improve the accuracy of consumers' decisions related to food and/or food safety.

Sato and Niiyama (2008) conducted a choice experiment to examine how much information should be provided to consumers through a traceability system. They set five types of egg alternatives that differ from each other in the amount of information available in the traceability system (from four to 12 pieces of information). They conducted five types of choice experiment questionnaires according to these five alternatives. In each questionnaire, respondents were asked to select their preferred egg. The study showed that an increase in the amount of information available in the traceability system improves the accuracy of consumers' choices up to six pieces of information. However, accuracy decreases when the amount of information more than six. This finding implies that consumers' cognitive burdens of valuing egg alternatives exceed the effects of the increase in the amount of information available on the accuracy of valuing egg alternatives.

The effects of informing consumers differs according to the media used to inform them. Hara *et al.* (2007) and Aizaki *et al.* (2010) examined the possibility of using Internet-enabled cellular phones to provide consumers with food safety information. Hara *et al.* (2007) conducted a choice experiment study to understand the desirable combination of the types of quality assurance information related to agricultural products and the types of media to provide this information. The types of quality assurance information used were information on the agrochemicals used to grow the agricultural product, information on the farmer who grew the agricultural product, and information on the distribution of the agricultural product from the farmer to the retail shop where it was sold. The types of media providing the information were a package label, a display at the point-of-purchase (a poster in the retail shop), and a QR code (a two-dimensional barcode). It was assumed that the QR code indicates a URL and that detailed information related to a product is obtained when the cellular phone's digital camera captures the QR code printed on the food label. Respondents were asked to select their preferred spinach option created by two attributes: one was the combination of the quality assurance information and the media providing it and the other was the price. The results showed that consumers' valuations of being informed through the QR code are the least preferred. Although the QR code can provide consumers with the most information of the three types of media, the pecuniary and psychological costs of browsing the web using Internet-enabled cellular phones are relatively higher than those of gathering information through package labels or

point-of-purchase displays.

Aizaki *et al*. (2010) examined the effects of providing consumers with food safety information via an Internet-enabled cellular phone. Identical choice experiment questions on specially and conventionally grown tomatoes were asked via the Internet-enabled cellular phone before and after informing participants about the usage of agricultural chemicals in their production (the information was also provided via the Internet-enabled cellular phones). Respondents modified their valuations of specially and conventionally grown tomatoes according to this information, whereas some respondents decreased their accuracy of selecting their preferred tomato because of the cognitive burden caused by the large amount of information.

2-3. Choice experiments in farm management research

A notable feature of the application of choice experiments in the field of agricultural economics in Japan is their widespread use in farm management research. While some previous studies have measured farmers' (marginal) willingness to pay for attributes and/or attribute levels related to farming, others have found the factors that influence farmers' activities and carried out simulation analyses on the basis of the resultant models. Therefore, the application of choice experiments in this area can be divided into (1) farmers' valuations of farm input and services, (2) analyses of farmers' decisions about farmland use, and (3) farmers' valuations of agricultural technology and farming systems (**Table 2**).

2-3A. Farmers' valuations of farm input and services

Some farm input and/or services are frequently supplied by local organizations such as farmers' groups or Japan Agricultural Cooperatives. Because these local organizations tend to fix their prices, we cannot estimate the (factor) demand functions of farmers on the basis of revealed preference data, which describe the relationship between the price and purchased quantity of a factor (i.e., an input or service). In addition, few data on farm input and/or services contain detailed information about their features/attributes. Therefore, it is difficult to carry out demand function analyses for farm input and/or services in a specific geographical area, which is important information for building a regional agricultural plan for local input and/or services. For these reasons, choice experiments have been applied to capture farmers' purchasing behavior concerning farm input and/or services.

Aizaki (2001) used choice experiments to examine the factors that influence how rice farmers use a rice center, which is a joint-use agricultural facility that dries and processes their harvested rice. This study

asked rice farmers to select their preferred administration plan that had been created on the basis of the following three attributes: the average time required to unload harvested rice at the facility (staying time), the closing time of the facility, and the rate for processing rice at the facility. The results indicated that these attributes significantly affect how rice farmers use the rice center. The marginal willingness to pay for staying time and closing time was estimated to be 190 yen and 101 yen per 60 kg of harvested rice, respectively. These values imply that staying time simply wastes farmers' time, whereas advancing the closing time does not because farmers can perform other farming activities after the facility has closed. This study also found that a farmer's price elasticity of the probability of using the facility was lower as the area of his/her paddy field decreased. This finding suggests that the pricing policy might be modified to increase the operating rate of the rice center under a condition of maintaining equilibrium between the facility's revenue and cost.

Nishimura (2009) also applied a choice experiment approach to estimate dairy farmers' valuations of a so-called total mixed ration (TMR), which is a kind of feed made by mixing roughage. The choice experiment questions consisted of three attributes related to the characteristics of the TMR (price, improvement in the amount of milk supplied from cows that are fed the TMR, and additional services) and one attribute showing the proportion of dairy farmers who purchase the TMR in a local area (neighborhood effect). The results showed that the three attributes related to the characteristics of the TMR significantly influenced whether dairy farmers decide to purchase the TMR, whereas the neighborhood effect was not significant.

Iizumi (2005) used a choice experiment approach to elicit rice farmers' preferences for insurance against the tentative loss of revenue from rice farming. The study found that preferences differ among rice farmers according to the geographical conditions of their farming locations, which were shown to affect the quality and quantity of rice. Furthermore, Hirako and Senda (2006) carried out a choice experiment to ascertain dairy farmers' valuations of the characteristics of rice whole crop silage (RWCS) and found that their valuations vary according to their yields per day of milking.

Integrating the results of choice experiments into a decision support system for regional agricultural planning makes it possible to evaluate more realistic scenarios compared with simulation based on only the results of choice experiment application. For example, as discussed, Aizaki (2001) found that user rate and staying time are significant factors that affect how rice farmers use the joint-use facility. Both factors change as the number of rice farmers who use the facility increases or decreases, but in opposite directions. In other words, as the number of farmers increases, congestion

Table 2. The application of choice experiments in farm management research by topic.

Authors	Respondents	Objective	Alternatives	Attributes
Farm input and services				
Aizaki (2001)	Rice farmers in a local area	Examining why rice farmers use a rice center	Administrative plan for the rice center	(1) Staying time, (2) closing time, and (3) user rate
Nishimura (2009)	Dairy farmers in a local area	Valuing a TMR supplied from a local TMR supply center	A combination of a TMR package plan and a proportion of dairy farmers using the TMR	(1) Price per kg of TMR, (2) data on improvement in the amount of milk supplied by cows that are fed the TMR, (3) additional services such as diagnosing feed and examining cows, and (4) the proportion of dairy farmers who use (purchase) the TMR in the area local to the TMR supply center.
Iizumi (2005)	Rice farmers in two local areas	Eliciting rice farmers' preferences for tentative revenue insurance	Tentative revenue insurance plans	(1) Insurance bill and rate of compensation per 10 a of paddy fields; (2) a way of setting the insurance bill: this shows whether the insurance bill is determined according to expected loss in a local area; and (3) duty to adjust rice production: this shows whether a rice farmer who purchases insurance has a duty to adjust rice production.
Hirako and Senda (2006)	Dairy farmers who join a user group of RWCS	Valuing attributes of RWCS	RWCS plan	(1) Price per kg of RWCS, (2) a period of supplying RWCS (the RWCS is supplied until the spring (after harvesting rice) or supplied throughout the year), (3) quality improvement of RWCS, and (4) the availability of feeding cows that can be milked.
Farmland use				
Endo *et al.* (2003)	Fruit farmers in a local area	Examining why fruit farmers increase their cultivation areas of Japanese pear and why they continue farming	A combination of the market prices of varieties of Japanese pear	(1) Price of Japanese pear growing in plastic greenhouses per kg, (2) price of Japanese pear growing in open fields per kg, and (3) average prices of other species of Japanese pear per kg
Endo (2007)	Rice farmers in a local area, who rent paddy fields or who want to rent paddy fields	Examining why rice farmers, who rent or who want to rent a paddy field, do so in a hilly and mountainous area	A combination of the economic conditions of rice farming and paddy fields for rent	(1) Price of rice per 60 kg, (2) rent for a tenancy per 10 a, (3) direct payment to rice farmers from the government per 10 a, and (4) the condition of paddy fields for rent
Hirano *et al.* (2005)	Rice farmers in a local area	Analyzing the effects of changing the paddy field crop diversion policy on rice farmers' behavior	Two different choice experiment scenarios were set: one provides the package of paddy field crop diversion policy as an alternative and the other provides the contract plan of farming activities related to diversion crops as an alternative	The paddy field crop diversion policy: (1) Price of rice per 60 kg when rice farmers sell their rice through Japan Agricultural Cooperatives, (2) the compensation for income loss while accepting this adjustment of rice production, and (3) the amount of subsidy for the establishment of high-productivity paddy field farming. The contract plan of farming activities related to diversion crops: (1) the consignment charge for accepting the contract, (2) prices of wheat and soybean per 60 kg, (3) yields of wheat and soybean per 10 a, and (4) conditions of the paddy fields where the crops are diverted

Authors	Respondents	Objective	Alternatives	Attributes
Agricultural technology and farming systems				
Naka and Fujimoto (2002)	Strawberry farmers in a particular region of a prefecture	Valuing a strawberry cultivation approach that uses a high bench culture system in order to improve working conditions	Strawberry cultivation system plan	(1) Income reduction when farmers fail to introduce the cultivation system, (2) the cost of introducing the cultivation system, (3) the additional net earnings from introducing the cultivation system, and (4) the form of work
Wang (2011)	Chinese farmers in a lake basin	Valuing a farming system for preventing agricultural non-point source pollution	A combination of the conditions of a farming system that prevents agricultural non-point source pollution	(1) The application of fertilizers, (2) support services for diagnosing soil and planning for a combination of fertilizers according to the diagnosis, (3) technological instruction for the farming system, (4) low interest loan, and (5) subsidy for introducing the farming system
Torigoe *et al.* (2009)	Farmers in three cooperative groups that produce a regional agricultural brand product	Valuing the characteristics of a cooperative group that produces a regional agricultural brand product	A combination of the characteristics of a cooperative group	(1) The group's atmosphere related to competitive spirit, (2) the amount of prize money when the farmer wins a contest related to the quality of a regional agricultural brand product in a group, (3) the number of farmers in a group, (4) the way of sorting products based on shape, (5) the way of sorting products based on taste, (6) the price of product per kg, and (7) the degree of fluctuation in the prices of products
Nakamura *et al.* (2005)	Pineapple farmers in two local areas	Valuing the agricultural management policy and desirable species of pineapple	Agricultural management policy and pineapple species	The case of management policy: (1) production ratio of pineapples eaten raw, (2) the degree of positive attitudes towards renewing species of pineapple, (3) the degree of positive attitudes towards changing the size of greenhouses for growing pineapples, (4) the development of a new market for pineapples, (5) gross agricultural earnings, and (6) the size of farmland for pineapples. The case of desirable species of pineapple: (1) the weight of pineapples, (2) the warts and needles of pineapples, (3) the height of pineapple plants, (4) the color of the flesh of pineapples, (5) the price of pineapples, and (6) the variety of ripening times (early, late).
Ashida (2010)	Farmers' blood relatives who live outside a local rural community	Valuing options supporting their families' paddy rice farming	A combination of options supporting their families' paddy rice farming	(1) The number of times per year relatives return to their native places in order to support their families' paddy rice farming and (2) payments to support their families' paddy rice farming per year

at the entrance to the facility intensifies and staying time increases, whereas user rate reduces (because the rate is equal to the average cost of the facility). Thus, it is difficult to predict rice farmers' use behavior by setting the combination of staying time and user rate merely on the basis of choice experiment results. Therefore, Aizaki (2002a) developed a simulation that includes farmers' behavior (Aizaki 2001), staying time (Aizaki 2000), and user rate, which then predicted that the volume of the facility's harvested rice from rice farmers increases by approximately 10% by changing its rate structure from a linear meter rate to a declining step meter rate (see also Chapter 4 of the monograph for details).

2-3B. Analyses of farmers' decisions about farmland use

Because farms are generally small, any increase in the size of farmland is an important policy issue in Japan. However, the increase of farmland size per farmer is not proceeding smoothly. By contrast, the area of abandoned farmland located in less favorable conditions has been increasing. Therefore, a method to allow for the transaction of farmland between farmers and an approach to using farmland more effectively are necessary. A choice experiment approach is seen as a suitable technique for both.

For example, in order to expand the micro-simulation system for predicting paddy field use in hilly and mountainous areas developed by Endo (2004), farmers' decision-making models were constructed using choice experiments and integrated into the micro-simulation system. Endo *et al*. (2003) carried out two choice experiments: one examined why Japanese pear farmers have increased or why they want to increase the farmland available to this fruit, and the other examined why they continue Japanese pear farming. The resultant model of the former application was integrated into the micro-simulation system developed by Endo (2004), which then predicted that the total area of farmland available to the Japanese pear would decrease by 6.7% in 10 years (Endo *et al*. 2006).

Endo (2007) carried out a choice experiment to examine why rice farmers have rented or why they want to rent a paddy field in a mountainous area. The author integrated its results into a micro-simulation system, which predicted that the decrease in mountainous farmland would reduce if farmers who wanted to rent farmland from other farmers could do so.

Hirano *et al*. (2005) analyzed how changes in a paddy field crop diversion policy influenced farmers' behavior using choice experiments. Two scenarios were illustrated: one analyzed why rice farmers adjusted rice production, whereas the other analyzed why rice farmers accepted farming activities related to growing wheat and/or soybean in paddy fields owned by other rice farmers. In the former scenario, on the basis of the as-

sumption that each farmer freely decided whether to adjust rice production, farmers were asked to select their preferred option from rice production plan alternatives that had been created from a combination of three attributes. These attributes were the price received when they sell their rice through a Japan Agricultural Cooperative, the amount of compensation received for income loss while adjusting rice production, the amount of subsidy received for the establishment of high-productivity paddy field farming.

In the latter scenario, farmers were asked to select their preferred option from among contract plan alternatives proposed by other farmers who wanted to entrust their farming activities related to diversion crops. The alternatives were created from the combination of four attributes: the consignment charge for accepting the contract, prices of wheat and soybean per 60 kg, yields of wheat and soybean per 10 a, and conditions of the paddy fields where the crops are diverted. On the basis of the results of these two choice experiments, the authors considered the conditions under which rice farmers accept paddy field crop diversion plans and simulated the effect of changing the consignment charge on farmers' probability of accepting the contract plans.

2-3C. Farmers' valuations of agricultural technology and farming systems

If agricultural technology can be valued based on quantitative attributes, mathematical programming based on data obtained from farm surveys or econometric analyses derived from revealed preference data can be applied to value agricultural technology. However, if qualitative factors play an important role when agricultural technology is evaluated by farmers, these approaches are inappropriate for valuing the said technology. Thus, a choice experiment approach that can directly ascertain farmers' preferences for the technology is needed.

For example, Naka and Fujimoto (2002) carried out choice experiments to assess farmers' valuations of a strawberry cultivation approach that used a high bench culture system that improved working conditions. The system was explained according to four attributes: the income reduction when farmers fail to introduce the cultivation system, cost of introducing the cultivation system, amount of additional net earnings from introducing the cultivation system, and form of work. The study found that improving working conditions was estimated to generate additional net earnings of 481,000 yen per annum.

Other similar studies include: Chinese farmers' decisions to accept a farming system that prevented agricultural non-point source pollution (Wang 2011); farmers' valuations of the characteristics of a cooperative group for producing a regional agricultural brand product (Torigoe *et al*. 2009); pineapple farmers' prefer-

ences for their agricultural management policies and the species of pineapple they grow (Nakamura *et al.* 2005). Although Ashida (2010) is slightly difficult to classify into this sub-topic, it targeted farmers' blood relatives who live outside the local rural community to ascertain their preferences for plans to support their family's paddy rice farming.

2-4. Choice experiments in rural planning research

The application of choice experiments in previous rural planning research can be classified into (1) economic valuations of the multifunctionality of agriculture and rural areas, (2) decision-making analysis related to the agricultural and rural resource management, and (3) residents/users' valuations of agricultural and rural recreation facilities (**Table 3**).

2-4A. Multifunctionality of agriculture and rural areas

The multifunctionality of agriculture and rural areas is an important element of agricultural and rural policy (e.g., OECD 2001, 2003). Previous studies have estimated its economic values in developed and in developing countries (e.g., Randall 2002; Bergstrom and Ready 2009; Renting *et al.* 2009). Such economic valuations in Japan have been carried out using the contingent valuation method (e.g., Yoshida *et al.* 1997; Yoshida 1999; Aizaki *et al.* 2006a), travel cost method (e.g., Tanaka 2000; Watanabe 2004; Sato 2005), and hedonic price method (e.g., Nishizawa *et al.* 1991; Maruyama *et al.* 1995; Watanabe and Asano 2002).

The application of choice experiments in agro-environmental valuations in Japan has also expanded since their introduction in the early 2000s because they can decompose the economic value into its individual elements. There are two methods of expressing the attribute for the decomposition. One approach to expressing the attribute is by physical unit such as "number of birds" or "targeted area of environmental conservation." Another approach is by an individual function expressing the rate of difference from the current state in percentage terms such as "60% improved" or "50% deterioration."

In terms of the former approach, Aizaki (2003a) applied choice experiments to value the environmental benefits to local residents of plans to promote ecologically friendly paddy fields among local rice farmers. The study used the population density of Intermediate Egrets in a paddy field as an indicator of its ecological condition. Participants were required to select their preferred plan for promoting ecologically friendly paddy fields of the three proposals that had been created using four attributes. These attributes were the population density of Intermediate Egrets in a paddy field area; the presence of a bird-watching paddy field;

the presence of an eco-field where children could capture animals such as loach, crucian carp, and aquatic insects living there; and the contribution per household per year (the costs necessary to implement the plan were assumed to be financed by household contributions). The results showed that the marginal willingness to pay for one Intermediate Egret per 10 ha, a bird-watching paddy field, and an eco-field is 3,715 yen, 642 yen, and 1,630 yen per household per year, respectively (see also Chapter 5 of the monograph for details).

Yabe and Yoshida (2006) measured the environmental benefits of implementing an environmentally friendly agricultural policy to preserve the water quality of Lake Biwa, which is the largest lake in Japan, and the landscape around it. The policy alternative in the questionnaire had three attributes: the farmland area that agreed to use fewer pesticides and fertilizers (termed the area of environmentally friendly agriculture), the conservation of the landscape and national land compared with the status quo, and annual household contribution. They found that the willingness to pay for an increase from 1,000 ha to 7,500 ha in the area of environmentally friendly agriculture and that to keep the status quo by avoiding a 10% deterioration in the landscape/national land is 875.6 yen and 538.2 yen per year per household, respectively. Yabe and Yoshida (2006) also carried out a contingent valuation survey and found that the rate of protest bids in the case of choice experiment questions is 9%, which is considerably less than that for contingent valuation questions (42%).

In terms of the latter approach, Yoshida *et al.* (2002) and Yoshida (2003a) applied choice experiments to value the preservation plans of terraced paddy fields from the viewpoint of both environmental benefits (preservation of rural landscape and environment for wildlife and prevention of disasters such as floods and landslides) and environmental burden (pollution of rivers and groundwater caused by agricultural chemicals and fertilizers).

Yoshida *et al.* (2002) found that benefit transfers between regions are statistically possible as long as the surveys were conducted in the same month. They concluded that the possibility of benefit transfers in environmental valuation studies might be affected by differences, when each study was conducted because the landscape or other environmental conditions might differ. In this study, three regions were surveyed in November which falls after the rice harvesting season, whereas one region was surveyed in July which is before the season starts; thus, the landscape largely differs between these two periods.

In order to examine whether the order of attributes that construct an alternative influence a marginal willingness to pay, Yoshida (2003a) carried out two versions of a choice experiment questionnaire. One ques-

Table 3. The application of choice experiments in rural planning research by topic.

Authors	Respondents	Objective	Alternatives	Attributes
Multifunctionality of agriculture and rural areas				
Aizaki (2003a)	Households in a local area	Measuring the environmental benefits of expanding ecologically friendly paddy fields among local rice farmers	Plan of expanding ecologically friendly paddy fields	(1) The population density of Intermediate Egrets in the paddy field area, (2) a paddy field used for bird watching, (3) a paddy field where children can capture animals, and (4) the contribution per household per year to the plan
Yabe and Yoshida (2006)	Households in a prefecture	Measuring the environmental benefits of environmentally friendly agricultural policies	Agro-environmental policy plan	(1) The amount of farmland area that uses reduced levels of pesticides and fertilizers, (2) the conservation of the landscape and national land compared with the status quo, and (3) the annual contribution per household
Yoshida et al. (2002)	Households in four local areas	Testing the transfer of policy evaluation of preserving terraced paddy fields	Policy package of preserving terraced paddy fields from the viewpoints of the environmental benefits and burdens	(1) Preserving the landscape of terraced paddy fields and the environment for local wildlife, (2) preventing disasters such as floods and landslides, (3) pollution in rivers and groundwater caused by agricultural chemicals and fertilizers, and (4) the amount of donations (the costs of the policy were assumed to be covered by donations)
Yoshida (2003a)	Households in a local area	Testing the marginal willingness-to-pay for certain attributes	Policy package of preserving terraced paddy fields from the viewpoints of the environmental benefits and burdens	(1) Preserving the landscape of terraced paddy fields and the environment for local wildlife, (2) preventing disasters such as floods and landslides, (3) pollution in rivers and groundwater caused by agricultural chemicals and fertilizers, and (4) the amount of donations (the costs of the policy were assumed to be covered by donations)
Sato and Kakuta (2006)	Households in a local area	Measuring the economic benefit of improving the food self-sufficiency ratio	Policy package for improving the food self-sufficiency ratio (three measures were assumed)	(1) Food self-sufficiency ratio in Japan, (2) food self-sufficiency ratio in Hokkaido, (3) food self-sufficiency ratio in the Ishikari region, and (4) additional annual tax per household for implementing the package
Terada and Yoshida (2006)	Households in two local areas	Measuring the economic benefit of a food security function of farmland	Policy package of food security measures (three measures were assumed)	(1) The amount of main food crops (rice, wheat, and soybean) stored for emergencies, (2) the number of countries from which Japan imports main food crops, (3) the area of farmland secured for emergencies, and (4) additional annual tax per household for implementing the package
Aizaki et al. (2004d)	Households in a local area	Modifying a choice experiment to value the multifunctionality of agriculture and rural areas	Policy package of preserving/improving each of the seven or more functions	(1) Most important function, (2) second most important function, (3) third most important function, and (4) amount of tax per household per year for implementing the policy. Each respondent was asked to rank each function in terms of importance to them. The eight functions were flood prevention, groundwater conservation, soil erosion prevention, health and rest, wildlife protection, landscape management, water environment conservation, and organic waste disposal.

Authors	Respondents	Objective	Alternatives	Attributes
Agricultural and rural resource management				
Aizaki et al. (2006d)	Households in a local area	Examining the factors that influence households' intentions to participate in maintaining agricultural canals	Activity plan package of maintaining agricultural canals	(1) Annual payment per household for the maintenance activity plan, (2) the number of maintenance activities per year, and (3) the number of meetings to discuss the activities per year
Kojiya (2011)	Households in 24 activity groups in a prefecture	Examining the factors that influence households' intentions to preserve agricultural resources such as agricultural canals, agricultural roads, and the rural environment	Activity plan package of preserving agricultural resources	(1) Annual payment per household for the activities, (2) the number of activities for maintaining agricultural resources per year such as weeding, dredging, and repairing agricultural canals and roads, (3) the number of activities for improving the rural environment per year such as cleaning streets, growing flowers, and cleaning rivers
Aizaki (2006a)	Households in a local area	Examining the factors that influence households' intentions to collect household food waste	A combination of a plan for collecting household food waste and the percentage of neighbors who agree with the plan	(1) The frequency of food waste collections per week, (2) the number of neighbors who share the same scrapheap, and (3) the percentage of neighbors who agree with the plan
Agricultural and rural recreation facilities				
Sasaki et al. (2000)	Households in a local area	Valuing each component of a rural park development project	Package plan of the rural park	(1) Tree planting in the park, (2) construction of a promenade, (3) construction of an observation platform, (4) construction of other facilities, and (5) annual payment for implementing the plan per household
Aizaki (2003b)	Households in a local area	Valuing each component of a park	Elements of the park	(1) Flowers, (2) bird watching, (3) agriculture experience, (4) wildlife in and around paddy fields, (5) distance, and (6) entrance fee
Ratanak and Yabe (2008)	Cambodian and international tourists	Valuing each component of a package eco-tour	Package of the eco-tour	(1) The number of species of wildlife that tourists enjoy watching, (2) the number of types of cultural performances that tourists can enjoy, (3) the number of types of water-based activities, (4) the types of accommodation and transportation, and (5) the price of the package tour
Aizaki et al. (2004a)	Households in a local area	Examining the factors that influence households' intentions to use an allotment garden	Package of the allotment garden	(1) The distance from the allotment garden to a respondent's house, (2) annual rent, (3) the presence of instruction services about growing agricultural products, (4) the construction of a rest facility, and (5) the construction of a small warehouse for storing agricultural machines and implements

tionnaire prioritized the preservation of the rural landscape and environment for wildlife, whereas the other set the pollution of rivers and groundwater as the top attribute. The study found that marginal willingness to pay for the pollution of rivers and groundwater in the former questionnaire was approximately twice than that in the latter, while the order effects in other attributes were only between 10% and 30%. The findings suggest that it is appropriate to use choice experiments to value the multifunctionality of agriculture and rural areas and the environmental burden caused by agricultural and rural activities simultaneously: such joint valuation is desirable for considering agro-environmental policy (e.g., OECD 2003). However, careful consideration concerning the combination of functions/burdens is necessary.

Sato and Kakuta (2006) and Terada and Yoshida (2006) used choice experiments to value the benefits of improving Japan's so-called food self-sufficiency ratio and of the food security function from farmland, respectively. Japan's food self-sufficiency ratio, which is a ratio of domestic food consumption to domestic agricultural production based on calories, has decreased from 73% in 1965 to 39% in 2010. As a consequence of this decline, the Japanese government has targeted an increase in the food self-sufficiency ratio to 50% by 2020. Many Japanese consumers are also interested in this ratio. A survey of public opinion conducted in 2010 showed that almost 75% of the respondents believe that the current food self-sufficiency ratio in Japan is low or relatively low (Cabinet Office, Government of Japan 2010).

In the light of the foregoing, Sato and Kakuta (2006) followed a choice experiment approach to clarify how Japanese consumers evaluate an increase in the food self-sufficiency ratio. They defined three food self-sufficiency ratios according to the following areas: the ratio in Japan, ratio in an area of a local government, and ratio in a small region. Respondents were asked to select their preferred proposal to improve Japan's food self-sufficiency ratio according to three attributes corresponding to these three different food self-sufficiency ratios and one attribute of additional annual tax per household. The results showed that there is a substitution relationship between their evaluations of Japan's food self-sufficiency ratio and those of the two regional food self-sufficiency ratios. The authors also found that an improvement in these regional food self-sufficiency ratios has a positive economic value when the ratio for Japan is approximately 40%.

Terada and Yoshida (2006) measured the economic benefits of the food security function of farmland using choice experiments. According to item 2 of Article 2 of the Food, Agriculture and Rural Areas Basic Act, the food security function is assumed to be maintained by the following three measures: the storage of main food crops (rice, wheat, and soybean) for emergencies,

diversification of countries from which Japan imports main food crops, and maintenance of farmland secured for emergencies. In their choice experiment questions, respondents were asked to select their preferred policy package from alternatives that had been created from these three measures and an additional annual tax per household. The study found that improvement in each of the three measures has a positive benefit. Furthermore, it calculated that the benefit of maintaining 8,500 ha of farmland, which is the area urgently needed to produce the amount of main food crops that the Japanese population consumes in one day, for emergencies is 162.9 yen per year per household.

Although applying choice experiments to measure the multifunctionality of agriculture and rural areas can estimate the values of each individual function as stated above, the multifunctionality contains many individual functions (e.g., OECD 2001). As the number of attributes increases, the size of the choice set and/or the number of trials increases; consequently, it is difficult to efficiently carry out surveys. Moreover, it has been pointed out that there is an upper bound to the number of attributes that can be presented to participants simultaneously because of limited information-processing ability (Miller 1956). If the number of attributes exceeds this upper bound, the reliability of the responses to the questionnaire can become compromised.

A computer-assisted survey enables researchers to overcome this issue of choice experiment questions (c.f., using application packages such as that from Sawtooth Software, Inc.). However, a pen and paper questionnaire, which has generally been used to measure the economic values of the multifunctionality of agriculture and rural areas in Japan in previous studies, cannot use such a dynamic function.

Aizaki *et al*. (2004d) applied a method of measuring several attributes using choice experiments based on a pen and paper questionnaire to a case example that valued preserving the multifunctionality of agriculture and rural areas using eight functions. These functions were flood prevention, groundwater conservation, soil erosion prevention, health and rest, wildlife protection, landscape management, water environment conservation, and organic waste disposal. The method consisted of four steps. Firstly, the eight functions were explained to the respondents. Secondly, they were requested to rank their top three functions from these eight functions in terms of importance. Thirdly, they were asked to answer the choice experiment questions on valuing the functions that each respondent had selected in the second step. Finally, a data set was created by integrating the responses to these ranking questions with responses to the choice experiment questions, and the eight functions were valued by conducting a conditional logit model analysis based on the data set. The case study showed a significant marginal willingness to pay for each function except for health and rest and

landscape management, which were evaluated lower compared with the others.

2-4B. Agricultural and rural resource management

Choice experiment applications in the agricultural and rural resources management area can be divided into two groups: the analysis of how households decide to participate in the maintenance activities of agricultural canals (Aizaki *et al.* 2006d; Kojiya 2011) and the analysis of how households decide to collect household food waste (Aizaki 2006a).

Agricultural and rural resources such as farmland, canals, agricultural roads, grasslands, and coppices are maintained by rural communities. These resources have played an important role in forming the environment and landscape in rural areas as well as in the daily lives of the rural population. However, because rural communities' capacity to cooperate has been reduced by an ageing population and an increase of the number of non-farmers living in rural areas, maintenance activities have, in some cases, been abandoned. The idea of asking non-farmers, who also benefit from the resulting environmental benefits, to assist with this maintenance has been spreading across Japan.

Aizaki *et al.* (2006d) examined the factors that influence households' intentions to help maintain the agricultural canals on the basis of three attributes: annual payment per household for the maintenance activity plan, the number of maintenance activities per year, and the number of meetings to discuss the activities per year. The study found that households' preferences for the maintenance activity plans differ according to household type. For example, an increase in the annual payment for maintenance activity did not affect full-time rice farm households' utility for the plan, but it decreased non-farm households' utility for the plan. Full-time rice farm households preferred three maintenance activities per year, whereas non-farm households did not want to increase the number of maintenance activities per year. Furthermore, the probability of households accepting their least preferred alternative was 63% for full-time rice farm households and 6.8% for non-farm households. These results suggested that full-time rice farm households understand and accept that maintenance falls on their shoulders, whereas non-farm households have a strong tendency to reject heavy activities. Thus, maintenance activities should be adjusted according to household type in order to increase non-farmers' intentions to participate in them.

The Japanese government introduced the Measures to Conserve and Improve Agricultural Land, Water, and Environment in 2007, which promoted the idea of requesting that non-farmers assist with these maintenance activities. Kojiya (2011) examined how this introduction affected local residents' intentions to participate in maintenance activities using a choice experiment

approach. The study asked respondents whether they would like to join maintenance activities or not under a hypothetical situation where these improvement measures were assumed to be about to expire. The results showed that respondents tend to accept heavier work compared with the results of previous studies and concluded that the Measures to Conserve and Improve Agricultural Land, Water, and Environment could promote local residents' understanding of the importance of maintaining agricultural and rural resources.

The Japanese government has also been promoting food recycling, namely the use of food co-products and food waste to make livestock feed, compost, or energy. Although collecting household food waste is part of typical food recycling activities, it is not observed in Japan and thus the rate of recycling household food waste there is approximately 6% (Ministry of the Environment of Japan 2011).

Aizaki (2006a) applied choice experiments to explore the factors that influence how households collect food waste. The study focused on how households' behavior was influenced by that of their neighbors (i.e., neighborhood effect), because it has been shown that people's decisions on preserving the environment are affected by those of others (e.g., Schelling 1978; Dawes 1980). Aizaki (2006a) thus constructed alternatives in the choice experiment questions from three attributes: the frequency of food waste collections per week, the number of neighbors who share the same scrapheap, and the number of neighbors who agree with the plan. The last attribute was used as a proxy to capture the neighborhood effect. The results showed that households' preferences differ according to their concerns for the environment and their family sizes. Specifically, an increase in the number of neighbors who agree with the plan generates a stronger intention for other respondents to agree as well. In conclusion, the following three points are important: increasing the frequency of food waste collections per week, explaining environmental problems to households, and exploiting the neighborhood effect.

2-4C. Valuations of agricultural and rural recreation facilities

Many people visit rural areas to enjoy the landscape and local amenities. In order to promote green tourism, it is thus important to measure visitors' preferences and to develop rural areas according to them. The fact that a choice experiment approach can decompose the value of goods or services into each of its components makes it suitable to capture visitors' preferences, which can then assist in composing a development plan for visitors.

For example, Sasaki *et al.* (2000) and Aizaki (2003b) applied choice experiments to value public parks. Sasaki *et al.* (2000) targeted a park that had been constructed as part of a rural improvement project. On the

basis of a hypothetical situation where a portion of the park would not have been built if residents had been unwilling to contribute towards it, they aimed to value certain components of the original park design, including tree planting, a promenade, and an observation platform. As a result, the promenade was found to be the most valuable component, whereas the value of the observation platform was not significant.

Aizaki (2003b) used choice experiments to analyze how certain elements of an agricultural and rural park influenced residents' visiting intention. The elements were the flowers, capacity for bird watching, experience of agriculture, and wildlife in and around paddy fields. The distances to the park and entrance fee for adults were also set as attributes of the park. The marginal willingness to pay for these four elements was estimated to be 2,633, 1,822, 1,297, and 1,335 yen per adult, respectively.

In addition, Ratanak and Yabe (2008) conducted choice experiments to value each component of a package eco-tour to Cambodia and found that Cambodian tourists' preferences are different from those of international tourists.

Further, it is possible to consider more detailed plans by combining the results of choice experiments with other methods. For example, Aizaki *et al*. (2004a) applied choice experiments to model residents' behavior of using an allotment garden and integrated the resultant model into a decision support system that could generate a regional plan of the allotment garden using GIS. In the study, the allotment garden alternatives consisted of five attributes: distance from the allotment garden to the respondent's house, annual rent, presence of instruction services about growing agricultural products, the construction of a rest facility, and the construction of a small warehouse for storing agricultural machines and implements. Respondents were asked whether they would use the allotment garden. The number of users of the allotment garden was thus found by integrating the resultant model and local demographic and land use information on GIS.

2-5. Methodological features of the reviewed papers

This section describes the methodological features of the papers that have been reviewed in the three previous sections. A total of 64 papers have been reviewed in this chapter: of these, four were published in foreign journals (i.e., Aizaki *et al*. 2010, 2012; Yabe and Yoshida 2006; Managi *et al*. 2008), and 60 were obtained from domestic journals that were published by the academic societies listed in Section 2-1. These 60 papers can be decomposed into three areas of application: 35 papers are from the field of consumer valuation research, 12 are from farm management research, and 13 are from rural planning research.
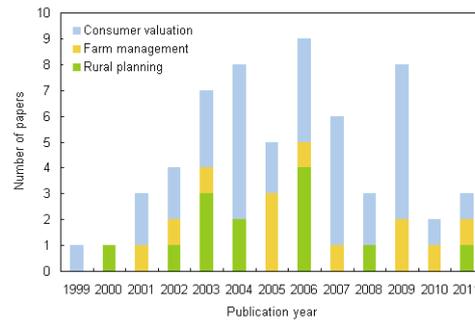

Fig. 1. Domestic papers by publication year during the period under investigation.

Figure 1 shows the 60 papers published in domestic journals by publication year during the study period. Kurihara *et al*. (1999) was one of the first papers to apply a choice experiment approach. Although the actual term "choice experiment" was not used in Kurihara *et al*. (1999), it was the first paper to be based on a way of designing alternatives within questions and statistically analyzing the responses. The number of choice experiment application papers increased until the mid-2000s. Although eight papers were published in 2009 (as well as in 2004), there seems to be a falling trend in the number of papers in this field in recent years.

Table 4 describes the methodological features of the 60 domestic papers under study. The major methods of constructing choice experiment questions (choice sets) in these 60 papers were orthogonal design (29 of 60 papers: 48%) and D-efficiency design (18 of 60 papers: 30%). Orthogonal design methods contain variations in which choice experiment questions are created by directly using an orthogonal array (e.g., L^{MA} design method, explained in Louviere *et al*. 2000) or by modifying an orthogonal array (e.g., shifting or cyclic design method, explained in Louviere *et al*. 2000). The orthogonal array is borrowed from a catalog of orthogonal arrays in books (e.g., Hedayat *et al*. 1999) and on websites (e.g., Sloane 2011) or is generated by application packages (e.g., SAS or SPSS).

The D-efficiency design method, which was developed by Zwerina *et al*. (1996), needs computer programs; for example, some papers (e.g., Oura *et al*. 2002; Hirano *et al*. 2005) have used an SAS macro (Zwerina *et al*. 1996; see also Kuhfeld 2006), whereas others (e.g., Sato *et al*. 2001; Aizaki *et al*. 2004c) have used a program developed on the basis of Zwerina *et al*. (1996). Prior information on the parameter vector is needed to calculate the D-efficiency criterion under a number of different cases. These cases include setting all parameters to be zero (e.g., Oura *et al*. 2002; Kono *et al*. 2005), setting all parameters on the basis of the expected sign of each parameter (e.g., Aizaki 2001),

Table 4. Methodological features of the 60 domestic papers under investigation.

Item	Category	
Design types		
	Full factorial	1
	Orthogonal	29
	Non-orthogonal	2
	D-efficiency	18
	Not clearly reported	10
Types of alternatives		
	Labeled	8
	Unlabeled	42
	Not clearly stated	10
Number of alternatives per choice set[*1]		
	Min	2
	Max	16
	Mean	3.9
	Median	4
	Not clearly reported	5
Presence/absence of an opt-out option		
	Present	48
	Absent	5
	Not clearly reported	7
Number of attributes per alternative		
	Min	2
	Max	7
	Mean	3.9
	Median	4
	Not clearly reported	0
Total number of choice sets		
	Min	1
	Max	60
	Mean	15.0
	Median	10
	Not clearly reported	23
Number of choices per respondent		
	Min	1
	Max	17
	Mean	6.5
	Median	6
	Not clearly reported	7
Number of respondents		
	Min	5
	Max	1,804
	Mean	257.8
	Median	164
	Not clearly reported	11
Number of observations		
	Min	27
	Max	14,432
	Mean	1,348.8
	Median	781
	Not clearly reported	9

Table 4. (continued).

Item	Category	
Types of discrete choice models used for analysis*[2]		
	Conditional logit model	43
	Random parameters logit model	6
	Latent class logit model	4
	Nested logit model	4
	Other multinomial models	3
	Binary models	5
	Not clearly reported	3

*[1]Number of alternatives per choice set includes an opt-out option if it exists.
*[2]Totals do not add up to 60 because some papers used multiple models.

or setting all parameters on the basis of the estimated parameters obtained from a preliminary survey (e.g., Sato *et al.* 2001; Aizaki *et al.* 2004c).

The compositional features of the research designs used in the reviewed papers can be categorized as follows. Of these 60 papers, 42 (70%) used an unlabeled type of choice experiment design, whereas eight (13%) used a labeled type of design. For example, the latter type was used to estimate the price coefficient of each country of origin for beef products (e.g., Aizaki *et al.* 2004c, 2006b). The number of alternatives per choice set, which may include an opt-out option, varied between 2 and 16. However, cases of 16 alternatives per choice set (Aizaki and Sato 2007) and even 10 alternatives per choice set (Kojiya 2011), which was the second highest in the studied papers, are unusual. By omitting these two special cases, the mean number of alternatives per choice set decreased to a more typical 3.6.

Almost all the papers (80%) used an opt-out option in their choice sets. The number of attributes per alternative ranged from two to seven, with a mean and a median of 3.9 and 4, respectively. The total number of choice sets generated by the choice experiment designs varied from one to 60 with an average and a median of 15.0 and 10, respectively, indicating that there were many cases where respondents' cognitive burdens might be high if all these choice sets were presented. With the aim of lowering this cognitive burden, most papers divided the total choice sets into two or more sub-blocks: the mean and median number of choice sets per respondent was 6.5 and 6, respectively, which were smaller than the mean and median number of total choice sets.

The number of respondents varied widely from 5 to 1,804 with a mean and a median of 257.8 and 164, respectively. Similarly, the number of observations, which is calculated by multiplying the number of choice sets per respondent by the number of respondents as long as there are no invalid responses, ranged from 27 and 14,432 with a mean and a median of

1,348.8 and 781, respectively. The most popular type of discrete choice model that was applied to analyze the responses to choice experiment questions was a conditional logit model (43 papers), which was followed by a random parameter logit model (six papers), latent class model (four papers), and nested logit model (four papers).

Compared with previous reviews in health economics (Ryan and Gerard 2003; de Bekker-Grob *et al.* 2012) and transportation research (Bliemer and Rose 2011), the presented results show a notable finding: in contrast to the increased trend in publications in the fields of health economics and transportation research, the number of papers published in the agricultural economics area of Japan tend to decrease in recent years.

The choice experiment approach is recognized as a powerful and distinguished statistical method that can convert a researcher's awareness of issues into research questions that can be empirically tested on the basis of economics or related behavioral sciences. Therefore, its applications have been growing around the world and its theoretical and methodological development has been progressing. A reason for the declining trend in agricultural economics in Japan might be the lack of suitable application packages for designing and analyzing choice experiments that can easily be used by Japanese choice experiment beginners (see also Chapter 6 of this monograph). Further investigation into the background of this trend should be carried out by checking similar trends in other research areas.

3. Consumers' valuations of beef derived from bovine embryo-cloned cattle

This chapter that is based on Aizaki *et al.* (2004b) introduces a study of consumers' valuations of bovine embryo-cloned beef. The study focuses on "embryo cloning." Embryo cloning is different from "somatic cell cloning," which has been targeted by recent U.S. consumer valuation studies that have used choice experiments (Brooks and Lusk 2010; Lusk and Marette

2010). However, because Aizaki *et al.* (2011) showed that consumers generally have similar attitudes towards the consumption of these two types of cloned beef, the study described in this chapter can be compared with these U.S. consumer valuation studies.

3-1. Introduction

Following rapid developments in life sciences research, agricultural and livestock production using novel biotechnologies has been expanded. This includes the growing application of embryo cloning, a technique that artificially produces a number of individuals with identical genes using cells from the embryos of the donor. Consumers frequently feel anxious about the food safety of these types of products. However, because embryo cloning is a breeding technology using artificial insemination that is generally applied in livestock, researchers who engage in animal cloning have seen it as having no food safety concerns.

This changed in April 1999 when a newspaper reported that some beef derived from bovine embryo-cloned cattle, which are reared for the purpose of research in livestock experiment stations, had been shipped to Japanese beef markets as edible products (Nihon Keizai Shinbun, 14 April 1999). Although the shipping of bovine embryo-cloned beef was legal, some consumers questioned the shipping. Since then, the Ministry of Agriculture, Forestry and Fisheries of Japan (MAFFJ) has further attempted to provide information and promote public awareness about embryo cloning. The MAFFJ considers that consumers' subjective evaluations (i.e., free from anxiety) depend on their understanding of the technology (Livestock Industry Bureau and Secretariat of Agriculture, Forestry and Fisheries Research Council, Ministry of Agriculture, Forestry and Fisheries of Japan 1999; Takahashi 1999). This linkage is based on the assumption of a cause and effect relationship between knowledge, attitudes, and evaluation/behavior. However, there is no guarantee that this assumption is valid for beef derived from bovine embryo-cloned cattle.

This study examined the validity of the relationships between consumers' knowledge, attitudes, and evaluations of bovine embryo-cloned beef. A structural equation modeling (SEM) approach was used to model the relationship between consumers' knowledge and their attitudes related to embryo-cloned beef. A contingent ranking method was also used to measure consumers' valuations of beef derived from bovine embryo-cloned cattle. This method can replicate a situation in which consumers evaluate beef in a retail store in order to extract their preferences for bovine embryo-cloned beef even when such beef is hardly sold in the beef market, namely consumers' revealed preference data related to embryo cloned-beef are unavailable. Predicted values of the attitudes towards bovine

embryo-cloned beef were calculated from the results of the SEM and used as independent variables in the contingent ranking analysis. This sequential approach enabled us to examine the relationship between consumers' knowledge, attitudes, and evaluations of bovine embryo-cloned beef.

3-2. Framework of the study

Following previous reports of the problem of shipping bovine embryo-cloned beef to a Japanese meat market (Livestock Industry Bureau and Secretariat of Agriculture, Forestry and Fisheries Research Council, Ministry of Agriculture, Forestry and Fisheries of Japan 1999; Secretariat of Agriculture, Forestry and Fisheries Research Council and Livestock Industry Bureau, Ministry of Agriculture, Forestry and Fisheries of Japan 1999; Ministry of Agriculture, Forestry and Fisheries of Japan 2000; Takahashi 1999; Amagasa 2000), we hypothesized the relationships between consumers' knowledge, attitudes, and evaluations towards bovine embryo-cloned beef.

This study pays attention to the technological knowledge related to bovine embryo-cloned beef, since the MAFFJ recognized that the dearth of this knowledge caused consumer anxiety about the cloned beef. It is interesting to examine to what degree providing technological information on this subject influences consumers' attitudes. Therefore, the following three latent knowledge variables are proposed: "basic knowledge," which is defined as a latent knowledge variable related to basic topics such as the definition of cloning or application of bovine embryo cloning; "advanced knowledge," which is defined as a latent knowledge variable related to the existing animal and plant reproduction; and "safety knowledge," which is defined as a latent knowledge variable related to the food safety of products derived from bovine embryo-cloned cattle.

Consumers' attitudes towards bovine embryo-cloned beef are assumed to be constructed by the following three latent attitudes: "food safety anxiety," which is defined as a latent attitude variable expressing anxiety about food safety of bovine embryo-cloned products; "ethical issues," which is defined as a latent attitude variable showing ethical attitudes towards using embryo cloning as a livestock reproduction technology; and "direct benefits," which is defined as a latent attitude variable evaluating the benefits of introducing bovine embryo cloning into livestock farming.

The following relationship between consumers' knowledge, attitudes, and behavior is assumed. Advanced and safety knowledge are constructed on the basis of basic knowledge and influence the three attitudes of food safety anxiety, ethical issues, and direct benefits. Consequently, these three attitudes influence consumers' purchase behavior in terms of bovine embryo-cloned beef.

Table 5. Questions used to capture the knowledge of and attitudes towards bovine embryo-cloned beef.

Variable	Question
Knowledge	
K1: Artificial Insemination	Almost all the cattle reared in Japan are produced through artificial insemination
K2: Definition	Cloning is a technique that artificially produces a number of individuals with identical genes
K3: Embryo Cloning	Embryo cloning is a technique that inserts the cell of the embryos of the donor individual into another individual's ovum, fuses the donor cell and the ovum, and implants the fused embryo into a surrogate individual
K4: Practical Use	At present, the practical use of bovine embryo cloning as a next-generation breeding technology is developing
K5: Twins	Calves bred through bovine embryo cloning are biologically the same as single ovum twins or triplets that are bred naturally
K6: Cutting of Plants	Cutting plants and reproduction through bulbs are forms of cloning
K7: Cell Culture	Cell culture technology that artificially reproduces cells of plants is a form of cloning
K8: Genetically Engineered	Bovine embryo-cloned cattle reared in Japan are not genetically engineered
K9: MHLW	The Ministry of Health, Labour and Welfare of Japan explains that products (meat, milk, etc.) derived from bovine embryo-cloned cattle do not pose any food safety problems
K10: Medication	Bovine embryo-cloned cattle are given the same feed as conventional cattle. It is not necessary for bovine embryo-cloned cattle to be fed under special medical supervision
Attitude	
A1: Food Safety	I feel anxious about the food safety of beef derived from bovine embryo-cloned cattle
A2: Long-term Effect	I feel anxious about the long-term effects of beef derived from bovine embryo-cloned cattle on my children and offspring even though there is no effect on me
A3: Unknown Effect	I feel anxious about bovine embryo-cloned beef's effects that are not able to be judged as good or bad for the human body
A4: Preceding Development	I feel anxious about preceding a development and the improvement of embryo clone technology
A5: Violating Nature	I think that bovine embryo cloning is an action of violating the laws governing nature
A6: Method of Producing	I think that embryo cloning overly considers cattle, which are domestic animals, as a method of producing food
A7: Low Cost	I think that bovine embryo cloning contributes to improving the production efficiency of animal husbandry (low cost production)
A8: Improving Quality	I think that bovine embryo cloning contributes to improving the quality of livestock products
A9: Homogeneity	I think that we should only purchase beef that has the same taste or quality
A10: Limited Benefits	I think that there are limited benefits for consumers

Please rank the following three types of beef according to your willingness to purchase

Rank	( )	( )	( )
Breeding technology	Conventional cattle	Bovine embryo-cloned cattle	Conventional cattle
Country of origin	Domestic	Domestic Wagyu	Australian
Price	498 yen / 100 g	298 yen / 100 g	398 yen / 100 g

Fig. 2. An example of a contingent ranking question in this study.

3-3. Data and methods

3-3A. Indicator variables related to knowledge and attitudes

Questions for creating indicator variables on knowledge and attitudes were constructed according to the previous reports mentioned above. **Table 5** shows the questions used to capture basic knowledge on "artificial insemination," "definition," "embryo cloning," and "practical use." The questions used to capture advanced knowledge contained "twins," "cutting of plants," and "cell culture," and the questions used to capture safety knowledge contained "genetically engineered," "MHLW (Ministry of Health, Labour and Welfare)" and "medication." Respondents were asked to express their degree of knowledge on these items using a 4-point Likert scale (the values in parentheses are the scores used for the statistical analysis): "I know" (=4); "I have heard of it, but I don't know the details" (=3); "I think I have heard of it" (=2); and "I don't know" (=1).

The questions on attitudes towards bovine embryo-cloned beef were as follows (**Table 5**). The questions used to capture food safety anxiety contained "food safety," "long-term effect," and "unknown effect." The questions used to capture ethical issues were "preceding development," "violating nature," and "method of producing," and the questions used to capture direct benefits were "low cost," "improving quality," "homogeneity," and "limited benefits." The responses to these questions were measured using a 5-point Likert scale: "I strongly agree" (=5); "I agree" (=4); "I am uncertain" (=3); "I disagree" (=2); and "I strongly disagree" (=1).

3-3B. Designing contingent ranking questions

Figure 2 shows an example of a question used to capture respondents' preferences for purchasing beef using the contingent ranking method. Respondents were asked to rank three types of beef. Each type had a different breeding technology ("conventional cattle" and "bovine embryo-cloned cattle"), country of origin ("U.S.," "Australian," "Domestic" and "Domestic Wagyu"), and price per 100 g ("98 yen," "148 yen," "198 yen," "248 yen," "298 yen," "398 yen," and "498 yen"). Note that bovine embryo-cloned cattle must be

shown with domestic Wagyu. Respondents were requested to answer this type of ranking question five times.

3-3C. Statistical analysis

A multiple indicator model was used for the statistical analysis within the SEM package Amos 5.0J (SPSS Japan Inc., Tokyo, Japan). A rank-ordered logit model (Beggs *et al.* 1981) was used to analyze the responses to the contingent ranking questions. This model is based on a random utility theory. Thus, the systematic component of the utility of respondent i for beef j in a choice set of contingent ranking questions was formulated as follows:

$$V_{ij} = (b_{CLN} + b_{CLNA}\,ATT_i)\,CLN_{ij} + b_{WGY}\,WGY_{ij} \\ + b_{DOM}\,DOM_{ij} + b_{US}\,US_{ij} + b_P\,PRICE_{ij},$$

where each b is a coefficient; CLN is a dummy variable taking a value of 1 if beef j is bovine embryo-cloned cattle, otherwise 0; ATT is an attitude variable calculated from an estimation result of the multiple indicator model; WGY is a dummy variable taking a value of 1 if beef j is domestic Wagyu beef, otherwise 0; DOM is a dummy variable taking a value of 1 if beef j is domestic beef, otherwise 0; US is a dummy variable taking a value of 1 if beef j is U.S. beef, otherwise 0; and $PRICE$ is a price variable.

The three attribute variables of food safety anxiety, ethical issues, and direct benefits cannot be used simultaneously as independent variables in a rank-ordered logit model (for reasons described in Section 3-4). Therefore, the systematic components of the utility of beef j contains only one attitude variable. The coefficient of the variable CLN is $(b_{CLN} + b_{CLNA}\,ATT_i)$, supposing that consumers' valuations of bovine embryo-cloned beef are affected by their attitudes towards the beef $(b_{CLNA}\,ATT_i)$. This assumption can be statistically tested by examining the value of the coefficient estimate of the variable ATT.

3-3D. Questionnaire survey

A total of 450 consumers were randomly selected from the voting register of the Kiyota district of Sapporo, Hokkaido, in August 2001, and 206 consumers returned the questionnaire. After excluding invalid re-
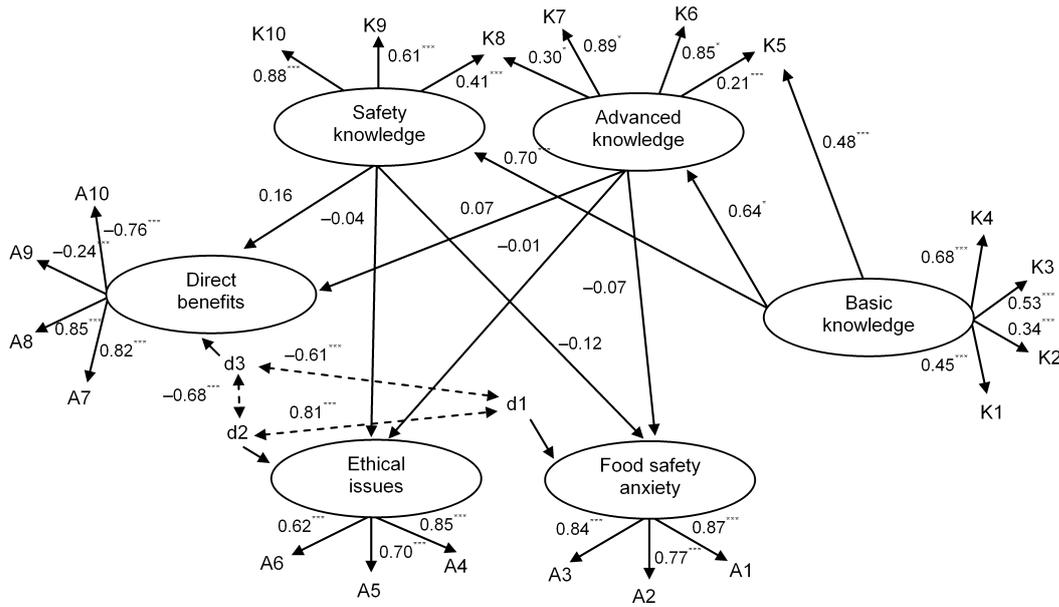
Fig. 3. Standardized result of the integrated model of the knowledge of and attitudes towards bovine embryo-cloned beef. Note: 1) ***, **, and * denote the values that are significantly different from zero at the 1%, 5%, and 10% levels, respectively. 2) Some error terms are omitted for the sake of simplicity.

sponses because of missing information, the final sample comprised 171 respondents (response rate: 38%).

3-4. Results and discussion

The SEM analysis of the effects of consumers' knowledge on their attitudes was divided into two steps. First, a knowledge model and an attitude model were analyzed independently, and then an integrated model including knowledge and attitudes was analyzed (**Fig. 3**). Each coefficient of the paths from latent variables to indicator variables is significantly different from zero. However, the coefficients of the paths from two latent knowledge variables (advanced and safety knowledge) to three attitude variables are very small and not significant. In addition, the error terms related to the three attitudes have strong correlations (from 0.61 to 0.81 in absolute values). These results indicate that the described attitudes are affected by other factors. In other words, consumers' technological knowledge of bovine embryo cloning does not seem to be the main factor affecting their attitudes towards it.

Table 6 shows the estimation results generated by the contingent ranking method. Note that model 1 does not contain an attitude variable. Since the three attitudes have strong correlations with each other, we estimated three models (model 2 includes food safety anxiety, model 3 includes ethical issues, and model 4 includes direct benefits). Except for the coefficient b_{CLN} in models 2 and 3, all other coefficients are significantly different from zero. The price coefficient is nega-

tive, meaning that a lower price of beef is preferred. The effects of attitudes on consumers' evaluations of bovine embryo-cloned beef, which are captured by the coefficient b_{CLNA} in each model, are negative for food safety anxiety and ethical issues but positive for direct benefits. This implies that food safety anxiety and ethical issues lead to a lower evaluation of bovine embryo-cloned beef and direct benefits lead to a higher evaluation of it.

The relationship the between level of attitude (*ATT*) and the evaluation of bovine embryo-cloned beef (b_{CLN} + b_{CLNA} *ATT*) in the three models is numerically summarized in **Table 7**. This table shows respondents' values of (b_{CLN} + b_{CLNA} *ATT*) in each of the three models at the 10th, 25th, 50th, 75th, and 90th percentile points of empirical distribution for each attitude. According to the model specifications, consumers' valuations of Australian beef are normalized to zero. Therefore, even respondents who feel relatively little anxiety for food safety (–0.2998), who have relatively low attitudes towards ethical issues (–0.2584), or who have relatively great attitudes towards direct benefits (–0.3232) have a lower evaluation of bovine embryo-cloned beef than that of Australian beef. By contrast, their evaluations of bovine embryo-cloned beef are higher than that of U.S. beef in each model (–0.4798, –0.4797, and –0.4806 in model 2, model 3, and model 4, respectively).

3-5. Concluding remarks

The presented contingent ranking results show that

Table 6. Estimation results of the contingent ranking method.

Coefficient	Model 1	Model 2	Model 3	Model 4
b_{CLN}	−0.4805***	0.1501	0.2295	−0.5548***
b_{CLNA}		−0.1719*	−0.1999**	0.1703*
b_{WGY}	0.8942***	0.8967***	0.8963***	0.8966***
b_{DOM}	0.6658***	0.6700***	0.6699***	0.6699***
b_{US}	−0.4872***	−0.4798***	−0.4797***	−0.4806***
b_{PRICE}	−0.0026***	−0.0027***	−0.0027***	−0.0026***
Log likelihood at convergence	−1,428.3	−1,426.9	−1,426.2	−1,427.1

***, **, and * denote the values that are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

Table 7. Effects of respondents' attitudes towards bovine embryo-cloned beef on their evaluations of it.

Latent Attitude (variable ATT_i)	10% point	25% point	50% point	75% point	90% point
Food safety anxiety	−0.2998	−0.3906	−0.4743	−0.6025	−0.6379
Ethical issues	−0.2584	−0.3848	−0.4771	−0.6243	−0.6838
Direct benefits	−0.6303	−0.5464	−0.4751	−0.3906	−0.3232

even respondents who have relatively positive attitudes towards bovine embryo-cloned beef prefer Australian beef to bovine embryo-cloned domestic Wagyu beef. The SEM results also show that the effects of their knowledge of cloning on their attitudes towards bovine embryo-cloned beef are not significant. In conclusion, contrary to the presuppositions of the MAFFJ, consumers' valuations of bovine embryo-cloned beef would not be improved by only providing them with technological information on bovine embryo cloning.

4. Development of a simulation to construct administration plans for agricultural joint-use facilities

This chapter is based on Aizaki (2002a) and describes a study that investigated how to use a simulation to construct administration plans for agricultural joint-use facilities. Choice experiments in the field of agricultural economics in Japan are usually applied to assess willingness to pay for certain attributes and/or attribute levels. However, the study in question used choice experiments to investigate how rice farmers make decisions about using an agricultural joint-use facility, to predict farmers' behavior, and thus to construct administration plans for the use of such agricultural facilities. Rice farmers' revealed preference data related to agricultural joint-use facilities are frequently available, since such data is published as official statistics or is able to be gathered by researchers. However, the fee charged by the facilities tends to remain the same in time and space, meaning that it is extremely

difficult to statistically measure the impact of the fee on rice farmers' behavior when using the facilities. Furthermore, the facility's other features such as waiting time, which is the time spent waiting until other rice farmers have finished using the facilities, are rarely recorded. These features may also affect rice farmers' behavior when using the facilities. Therefore, choice experiments are the most suitable method for comprehensively examining how the facility's features affect rice farmers' behavior.

4-1. Introduction

Because an average paddy field in Japan is small (approximately 1 ha per rice farmer in 2005), rice farmers have to use shared agricultural machines and/or facilities to increase their productivity levels. However, the common use of these facilities frequently leads to terrible congestion because many farmers tend to use them simultaneously. This degree of congestion increases the costs for farmers who use these joint-use facilities, because farmers have to wait until their colleagues have finished.

In order to avoid these increased costs, some farmers do not use or stop using joint-use facilities, which causes the operating rate of the facility to drop. This decrease in the number of farmers using the facilities reduces congestion and lowers user costs owing to prolonged waiting times. Subsequently these reductions are an incentive for farmers to (re-)use the facility. Therefore, in order to construct an appropriate administration plan for the joint-use facility, we need to simu-
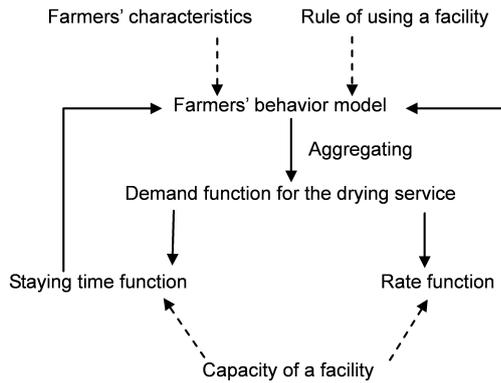
Fig. 4. The structure relationship between the demand function, staying time function, and rate function.

late farmers' behavior on the basis of the interdependence between the farmers and the facility.

The present study developed a simulation to construct administration plans for agricultural joint-use facilities such as a rice center and country elevator. While a rice center accepts harvested rice from rice farmers and dries and processes it, a country elevator further stores the processed rice (for the purpose of simplicity, in this chapter we will use the term "rice center" to mean both a "rice center" and a "country elevator"). Approximately 28% of rice farmers in Japan use rice centers (Department of Agriculture, Hokkaido Government 2011), many of which are managed by local Japan Agricultural Cooperatives.

4-2. Formulating the simulation

4-2A. Framework of the simulation

In the simulation developed in the study under question, the relationship between rice farmers and the rice center was modeled using the following three simultaneous equations: the demand function for the drying service, time function of staying in the facility, and rate function of using the facility (**Fig. 4**).

The demand function for the drying service was constructed by aggregating farmers' behavior when using the rice center (i.e., purchasing a service to dry and process harvested rice). This behavior was modeled by a discrete choice model. The time function of staying in the facility was modeled using a link performance function (e.g., Small 1992). This function has been used in traffic simulations to express the relationship between the amount of traffic in a certain section of road and transit time in that section. This time function enables us to forecast the relationship between the number of farmers who arrive at a facility and their staying time in the facility. Finally, a rate function was constructed on the basis of operating and maintenance costs and the volume of accepted rice.

4-2B. Demand function for the drying service

A rice farmer who uses a rice center is burdened with user costs, namely the rate for the drying service and the time cost including waiting time and working time in the facility. Rice farmers are assumed to use the facility if their utility for using the facility, including the user costs, is at least the same as or larger than that for not using the facility. Following a binary logit model, a probability function that rice farmer i uses the facility is defined as follows:

$$P_i^{USE} = \exp(V_i^{USE})/[\exp(V_i^{USE}) + \exp(V_i^{NON})],$$

where V_i^{USE} and V_i^{NON} are a systematic component of the utility of rice farmer i for using the facility and that for not using the facility, respectively. A demand function for the drying service is thus defined as follows:

$$Q = \sum_i P_i^{USE} AREA_i \, q_i,$$

where $AREA_i$ is the paddy field area of rice farmer i and q_i is rice farmer i's harvested rice production per unit area of paddy field.

4-2C. Time function

Each rice farmer who uses a rice center has to wait until other farmers have finished bringing their harvested rice from their trucks to the facility (waiting time). In addition, each farmer uses time to bring his/her harvested rice from his/her truck to the facility (working time). Working time is related to the facility's capacity to accept harvested rice. Therefore, staying time, that is the sum of waiting time and working time, for any individual farmer thus depends on the number of waiting farmers when the farmer arrives at the facility and the facility's capacity to accept harvested rice per unit of time. Following the link performance function, staying time (*STAY*) is defined as follows:

$$STAY = T0 + a \, (A/K)^b,$$

$$A = f(Q),$$

where a and b are parameters; $T0$ is working time; A is the number of rice farmers who arrive at the facility per unit of time; K is the facility's capacity to accept farmers per unit of time; and $f(Q)$ is a function that converts Q into A.

4-2D. Rate function

A local Japan Agricultural Cooperative is assumed to manage the facility. Thus, the rate function is decided according to the restrictions on maintaining equilibrium between revenue and operating and maintenance costs. This rate function is expressed as follows:

Which of these plans do you agree with?

1	2	3
First plan is as follows: Staying time 90 minutes Closing time 4 pm Rate 900 yen	Second plan is as follows: Staying time 30 minutes Closing time 8 pm Rate 1,100 yen	I would not like to use the facility under either of these two plans

Fig. 5. An example of a choice experiment question in this study. Source: figure 2 in Aizaki (2001).

$$RATE = AVC + FC/Q,$$

where *AVC* is the average variable cost and *FC* is the fixed cost of the facility.

4-3. Simulation of the effect of changing the rate structure on the volume of harvested rice

4-3A. Case study area

A rice center in Biei, Hokkaido, was used to demonstrate the effect of changing the rate structure on the volume of harvested rice received from rice farmers. The rate structure in the rice center when the survey was conducted was a linear meter rate. In the simulation, however, this was assumed to be a declining step meter rate that varied according to the area of the farmer's paddy field. The parameters in each model were set on the basis of previous research results (Aizaki 2000, 2001).

4-3B. Demand function

The fees charged by a rice center tend to remain the same in the long-term. Rice centers located in a certain area also tend to charge identical fees (e.g., if a local Japan Agricultural Cooperative has rice centers, they frequently all charge the same fee structure). Therefore, it is extremely difficult to estimate a valid demand function using revealed preference data: a demand function in this simulation was formulated on the basis of the results of a previous choice experiment (Aizaki 2001). Rice farmers were requested to select their preferred alternative from the following three choices: two administration plans for the facility and an opt-out option (**Fig. 5**). The plans had three attributes: staying time, closing time, and rate.

According to the answers given to the choice experiment questions, the demand function was specified as follows:

$$Q = Y\sum_g P_g^{USE} N_g AREA_g,$$

$$P_g^{USE} = \exp(V_g^{USE})/[\exp(V_g^{USE}) + \exp(V_g^{NON})]$$
$$= 1/[1 + \exp(V_g^{NON} - V_g^{USE})],$$

$$V_g^{NON} - V_g^{USE} = -0.0034RATE - 0.0107STAY$$
$$+ 0.3425CLOSE - 0.0215AREA_g + 1.7528DRYER_g$$
$$- 0.7933MAIN_g - 2.5145COMPETE_g + \alpha_g,$$

where *Y* is the harvested rice production per unit area of paddy field (all farmers have the same value); N_g is the number of rice farmers in the group *g*; *RATE* is the rate of the facility; *STAY* is staying time; *CLOSE* is closing time; *g* shows the rice farmer's category—33 groups of rice farmers are set according to the combinations of *AREA*, *DRYER*, *MAIN*, and *COMPETE* (**Table 8**); *AREA* is a farmer characteristic categorical variable that shows the farmer's paddy field area; *DRYER* is a farmer characteristic dummy variable taking a value of 1 if the farmer owns a dryer for harvested rice, otherwise 0; *MAIN* is a farmer characteristic dummy variable taking a value of 1 if the rice is treated as the main crop for the farmer, otherwise 0; *COMPETE* is a farmer characteristic variable taking a value of 1 if the farmer plants other crops that compete against rice in terms of a work plan, otherwise 0; and α is a correction value. The correction values for each group of farmers were calculated by correcting the forecasted number of rice farmers who use the facility on the basis of their actual behavior.

4-3C. Staying time function

According to Aizaki (2000), the staying time function is formulated as follows:

$$STAY = 15.8727 + 72.2728 (0.04606Q/950000).$$

The data needed to estimate the function were gathered based on a time and motion study at the facility (i.e., counting the number of farmers' trucks arriving at the facility and measuring staying time).

4-3D. Rate function

The rate function in the case of linear meter rate (yen per kg) is as follows:

$$RATE = 5.38 + 137332716/(Q + 11944757)$$
$$+ 5210587/Q,$$

Table 8. Classification of rice farmers in the simulation.

Type	Farmers' characteristics				Number of farmers	Area of paddy field (10 a)	Correction value
	AREA	DRYER	MAIN	COMPETE			
1	0	0	1	0	15	6.08	1.909
2	0	1	1	0	10		
3	1	0	0	0	4	15.72	1.970
4	1	0	1	0	9		
5	1	1	0	0	4		
6	1	1	1	0	9		
7	2	0	0	0	9	25.05	1.565
8	2	1	0	0	12		
9	2	1	1	0	6		
10	3	0	0	0	2	34.99	1.644
11	3	0	1	0	4		
12	3	1	0	0	11		
13	3	1	1	0	13		
14	4	0	1	0	11	44.89	1.396
15	4	1	0	0	17		
16	4	1	1	0	17		
17	5	0	1	0	5	54.66	1.542
18	5	1	0	0	18		
19	5	1	1	0	8		
20	6	0	1	0	2	63.87	1.120
21	6	1	0	0	9		
22	6	1	1	0	2		
23	6	1	1	1	7		
24	7	1	0	0	7	75.17	5.156
25	7	1	0	1	4		
26	7	1	1	1	2		
27	8	0	1	0	2	85.03	1.528
28	8	1	0	0	2		
29	8	1	0	1	2		
30	9	1	0	0	4	94.96	3.810
31	9	1	1	0	2		
32	10	1	0	0	2	125.85	0.858
33	10	1	0	1	8		

where the first term is the average variable cost of the facility and the second and third terms are the average fixed costs of the facility.

When a declining step meter rate based on the size of the farmer's paddy field is applied, the rate for those rice farmers who have paddy fields that are smaller than 1 ha is treated as the baseline rate and the rates for other farmers are calculated by multiplying a certain discount ratio by the baseline rate. Then, a combination of the baseline rate and discount ratio is determined under the condition of maintaining equilibrium between revenue and operating and maintenance costs.

4-3E. Results

Table 9 shows the results of the simulation. The simulation predicts that the volume of harvested rice received from rice farmers is 2,780 t based on the linear meter rate; this prediction is slightly larger than is

the actual volume (2,668 t). The predicted rate is 995 yen, which is also slightly higher than the actual rate (943 yen). Therefore, the predictive power of the simulation can be evaluated as good.

Two cases were simulated using the declining step meter rate: case 1 provides a prediction under the current conditions except for the rate structure, and case 2 provides a prediction under the condition where no farmers who have paddy fields smaller than 3 ha have their own dryers. The latter condition causes their price (rate) elasticities of demand for the drying service to be less than −1, thus increasing the tendency for small rice farmers to use the facility. As a result, the volume of harvested rice received from farmers in case 2 is larger than it is under the current rate structure. In order to increase the volume of harvested rice received from farmers in the case study area, the administrator of the rice center should change its rate structure and

Table 9. Simulation results.

Rate structure	Linear meter rate	Declining step meter rate	
		Case 1	Case 2
Rate (yen/60 kg)	995	Maximum 1,019/Minimum 917	Maximum 1,200/Minimum 840
Staying time (minutes)	20.9	20.9	21.8
Received harvested rice (t)	2,780	2,782	3,162

provide small rice farmers with an economic incentive to dispose of their own rice dryers voluntarily.

4-4. Concluding remarks

When constructing administration plans for agricultural joint-use facilities, demand side and supply side analysis are frequently implemented independently. However, this chapter presented a simulation to construct administration plans based on an analysis of both the supplier (facility) and users (farmers). Such an integrated approach can help overcome congestion, which is an unavoidable phenomenon in agricultural joint-use facilities, and thus construct more detailed plans.

The framework of this simulation can also be applied to other types of agricultural joint-use facilities. Although the simulation was constructed to examine how changing the rate structure influenced the activity of the facility, it could be modified to examine the size of the facilities. Furthermore, if rice farmers' decision-making models related to how they use farmland (e.g., Endo 2007; Hirano *et al*. 2005) were integrated into our simulation, a joint examination of regional farming plans and the administration plans of the facility would be available.

5. Measuring the environmental benefits of expanding ecologically friendly paddy fields among local rice farmers

The chapter based on Aizaki (2005b, Chapter 6), which was a revised version of Aizaki (2003a), compared the willingness to pay (WTP) for expanding ecologically friendly paddy fields over a local area as calculated by choice experiments and the contingent valuation method (CVM).

5-1. Introduction

Over recent decades, public concern about the role that paddy fields play as a wildlife habitat has been growing (e.g., Takeuchi *et al*. 2003). A considerable number of paddy fields, however, still do not meet the requirements to be a wildlife habitat. In order to promote ecologically friendly paddy fields that meet these requirements, it is necessary to gain public support.

However, the absence of a tool to measure the public benefits of providing the proposed plan might lead to a distorted allocation of resources. Therefore, economic approaches that can evaluate the environmental benefits of providing ecologically friendly paddy fields should help the decision-making process.

Previous studies have often used the CVM for the economic valuation of the multifunctionality of agriculture and rural areas in Japan (e.g., Yoshida *et al*. 1997; Yoshida 1999; Aizaki *et al*. 2006a). The CVM can measure a wide range of values of this multifunctionality compared with other environmental valuation methods such as the travel cost method, hedonic pricing method, or replacement cost method. However, it evaluates only one situation compared with the baseline situation and is unsuitable for evaluating two or more alternative plans. The comparison of various plans is crucial to ascertain which plan is the most valuable environmentally. The choice experiment approach, by contrast, allows alternatives to be constructed through a combination of attribute levels, which enables researchers to evaluate various environmental situations. These differences might create a gap between the WTP calculated by the CVM and that calculated by choice experiments. Therefore, this chapter compared the WTP for expanding ecologically friendly paddy fields over the Ibaraki prefecture as calculated by the CVM and by choice experiments.

5-2. Data and methods

5-2A. Sample selection

In January 2003, a questionnaire survey was mailed to 1,500 households living in Tsuchiura, Ibaraki, Japan. All households were selected at random from a commercial phone directory database. A reminder was sent three weeks after the first mailing. Altogether, 584 households returned the survey by mail, a response rate of 38.9%.

5-2B. Design of choice experiment questions

The environmental benefits evaluated in this survey were based on constructing facilities that would be used to improve the habitat of the wildlife that depends on the paddy fields in the central and southern regions of Ibaraki. We assumed that local residents would shoulder the cost of implementing this plan. Under the

Which of the following proposals do you most agree with?

Fig. 6. An example of a choice experiment question in this study.

Do you agree with the following plan?

Fig. 7. An example of a CVM question in this study.

above-described hypothetical situation, respondents were asked to select among three alternative proposals, namely, two plans and an opt-out option (**Fig. 6**). The opt-out option could be selected if the respondent disagreed with both plans.

The plans available to respondents had four attributes. The first attribute was the density of Intermediate Egrets per paddy field, which we selected as a proxy of the condition of the paddy fields as a wildlife habitat. Fujioka and Yoshida (2001) reported that the density of Intermediate Egrets can be used as an index of the number of animals in the paddy field area. Intermediate Egrets prey on animals such as the American crayfish, loach, brown frog, and pond frog, and the most suitable habitat for these animals is ecologically friendly paddy fields. The attribute had three levels: "1.1 egrets per 10 ha," "1.4 egrets per 10 ha," and "1.7 egrets per 10 ha." An explanation of the relationship between the density of Intermediate Egrets and the density of prey animals was illustrated in the questionnaire. The second attribute was whether a paddy field was used for bird watching (termed bird-watching paddy field), which had two levels: "planted" and "not planted." The third attribute was whether a paddy field was where children could capture animals such

as loach, crucian carp, and aquatic insects (eco-paddy field), which had two levels: "planted" and "not planted." The fourth attribute was contribution per household per year to the plan, which had five levels: "500 yen," "1,000 yen," "2,500 yen," "5,000 yen" and "10,000 yen" (1USD = approximately 77 yen as of September 2011).

5-2C. Design of CVM questions

A double-bounded dichotomous choice CVM was adopted for this study (**Fig. 7**). The format of the alternatives offered in the CVM was the same as that used in the choice experiments. However, except for the contribution attribute, the other three attributes had a fixed level: the density of Intermediate Egrets was set as 1.4 egrets per 10 ha; bird-watching paddy field was set as planted; and eco-paddy field was set as planted. By contrast, the contribution attributes had seven levels: "250 yen," "500 yen," "1,000 yen," "2,500 yen," "5,000 yen," "10,000 yen," and "20,000 yen."

In the first step of the CVM questioning, respondents were asked whether they agreed with the implementation of the plan and the contribution amount (500 yen in the case of **Fig. 7**). Respondents were then offered a new plan that suggested a different level of

Table 10. Estimation results of the conditional logit model analysis of choice experiment questions.

Variable	Coefficient[1]	Marginal WTP (yen/year/household)[2]
EGRET	1.2207**	3,715 [2,640 – 4,862]
BIRD	0.2110*	642 [147 – 1,147]
ECO	0.5357**	1,630 [1,171 – 2,112]
CONT	−0.0003**	
ASC_1	0.9930**	
ASC_2	1.3020**	
Number of respondents	422	
Sample size	1,266	
Log-likelihood at start	−1,390.8	
Log-likelihood at convergence	−1,001.2	
Adjustment ρ^2	0.276	

1) ***, **, and * denote values that are significantly different from zero at the 1%, 5%, and 10% levels, respectively.
2) Values in square brackets are the lower and upper bounds of the 95% confidence interval of marginal WTP, which are calculated according to Krinsky and Robb (1986).

contribution; a greater contribution was offered if the first response was "I agree" and a smaller contribution was offered if the first response was "I disagree."

5-2D. Statistical analysis

The responses to the choice experiment questions were analyzed using a conditional logit model with the following systematic components of the utility of respondent *i* for plan *j*:

$$V_{ij} = ASC_j + b_{EGRET}\ EGRET_{ij} + b_{BIRD}\ BIRD_{ij}$$
$$+ b_{ECO}\ ECO_{ij} + b_{CONT}\ CONT_{ij},$$

where *ASC* is an alternative specific constant; *EGRET* is the density of Intermediate Egrets per paddy field; *BIRD* is a dummy variable taking a value of 1 if the plan includes a bird-watching paddy field, otherwise 0; *ECO* is a dummy variable taking a value of 1 if the plan contains an eco-paddy field, otherwise 0; *CONT* is a contribution attribute variable; and b_{EGRET}, b_{BIRD}, b_{ECO}, and b_{CONT} are coefficients corresponding to the variables *EGRET*, *BIRD*, *ECO*, and *CONT*, respectively.

The CVM was modeled according to Hanemann *et al*. (1991). By using AIC, the final model was selected from among two models: one specified that the variable *CONT* had the value of the contributions presented to respondents, whereas the other specified that the variable *CONT* was set as the logarithm of the contributions presented to respondents.

5-3. Results

Table 10 shows the estimation results of the conditional logit model analysis of responses to the choice experiment questions. All coefficients are significantly

different from zero. The coefficient of *EGRET* has a positive value, meaning that the plan that has a larger density of Intermediate Egrets is preferred. The coefficients of *BIRD* and *ECO* also have positive values, which means that the construction of a bird-watching paddy field and an eco-paddy field is supported by local residents. However, *CONT* has a negative coefficient, meaning that a larger contribution decreases the utility of the plan for residents.

Table 11 shows the environmental benefits as calculated from the estimation results of the choice experiment questions. Each plan contains two sets of benefits. An upper side in each plan shows a value calculated from the estimation results excluding the *ASC* estimate and a lower side in each plan shows that including the *ASC* estimate. The *ASC* estimate, which is used to calculate the benefits, is the arithmetic mean of ASC_1 and ASC_2. The difference between the two benefits in each plan is 3,492 yen per household per year, which is the marginal WTP for the *ASC*.

Table 12 shows the estimation results of the CVM on the basis of the final model and WTP. The coefficient of the variable ln(*CONT*) is significantly negative, meaning that a smaller contribution is preferred. The WTP for the plan, which consists of a density of Intermediate Egrets of 1.4 per 10 ha and of the planting of a bird-watching paddy field and an eco-paddy field, is 4,093 yen per household per year. The same plan is evaluated using the choice experiment approach (**Table 11**) as 4,130 yen per household per year excluding the *ASC* and 7,622 yen per household per year including the *ASC*. The WTP based on calculations from the CVM is almost equal to that from the choice experiments excluding the *ASC*, but it is smaller than that from the choice experiments including the *ASC*.

Table 11. Environmental benefits calculated from the estimation results of the choice experiments.

Eco-paddy field	Bird-watching paddy field	The density of Intermediate Egrets		
		1.1 egrets/10 ha	1.4 egrets/10 ha	1.7 egrets/10 ha
Planted	Planted	3,016 [2,226 − 3,849]	4,130 [3,142 − 5,180]	5,245 [4,005 − 6,564]
		6,508 [5,793 − 7,315]	7,622 [6,918 − 8,440]	8,737 [7,903 − 9,698]
	Not planted	2,373 [1,856 − 2,931]	3,488 [2,757 − 4,276]	4,602 [3,598 − 5,680]
		5,866 [5,120 − 6,692]	6,980 [6,305 − 7,746]	8,095 [7,346 − 8,960]
Not planted	Planted	1,385 [794 − 1,995]	2,500 [1,675 − 3,359]	3,614 [2,508 − 4,775]
		4,877 [4,195 − 5,629]	5,992 [5,335 − 6,734]	7,107 [3,662 − 7,980]
	Not planted	743 [528 − 972]	1,858 [1,320 − 2,431]	2,972 [2,112 − 3,889]
		4,235 [3,483 − 5,040]	5,350 [4,693 − 6,081]	6,464 [5,744 − 7,271]

Values in square brackets are the lower and upper bounds of the 95% confidence interval of marginal WTP, which are calculated according to Krinsky and Robb (1986).

Table 12. Estimation results of the double-bounded dichotomous choice CVM for valuing ecologically friendly paddy fields and the environmental benefits.

Variable	Unit/definition	Coefficient
ln($CONT$)	Logarithm of contribution (yen/year/household)	−1.43375*
$CONSTANT$		11.9244*
Number of respondents		407
Log-likelihood at convergence		−520.4
Environmental benefit (WTP)	Yen/year/household	4,093 [3,584 − 4,683]

* denotes values that are significantly different from zero at the 1% level.
Values in square brackets are the lower and upper bounds of the 95% confidence interval of WTP, which are calculated according to Krinsky and Robb (1986).

The same trend is observed when the valid sample for the CVM equaled that for the choice experiments (note that number of respondents in **Table 10** is different from that in **Table 12**).

5-4. Concluding remarks

Bennett *et al.* (2001) pointed out that environmental benefits have to be calculated from estimation results including the alternative specific constant because this constant contains systematic and unobserved information related to why respondents tend to select a specific alternative in each choice experiment question. On the contrary, some previous environmental valuation studies that have used choice experiment approaches do not seem to consider the alternative specific constant in their models. The results of this study show that environmental values may vary according whether the alternative specific is included or not. In conclusion, the environmental valuation results from choice experiments should be interpreted cautiously, and readers should pay attention to whether the study considers the alternative specific constant in the process of estimating models and/or calculating WTP.

6. Development of an application package for designing and analyzing choice experiments in R

The author has developed a Microsoft Excel macro application for analyzing the responses to choice experiment questions using the solver function (Aizaki 2007b) and an application package for designing and analyzing choice experiments on the basis of MS Excel and R (Aizaki 2009b). The author has also developed an additional R package for supporting an implementation of choice experiments (Aizaki 2011). Although the first two packages may only work in the Japanese environment because they contain Japanese characters, the latter works in the English environment. In this chapter that is based on Aizaki (2009b), the second application, which consists of two macro programs such as REA_DCE and REA_ACE, is introduced.

6-1. Introduction

Compared with the contingent valuation method (CVM), which has been widely used in academic studies and policy evaluations in Japan (Kuriyama 2003b; Yoshida 2003b), choice experiment applications have been relatively limited. The choice experiments used in empirical studies have typically contained seven steps: characterizing the decision process, identifying and describing the attributes and attribute levels, designing a choice experiment (i.e., creating choice sets), developing the questionnaire, collecting data, analyzing the responses (estimating model), and interpreting the results to allow policy analysis or decision support (Louviere *et al*. 2000).

The two steps of designing a choice experiment and analyzing the responses require statistical analysis, that is, the design of the experiment and discrete choice model analysis. The lack of suitable application packages for these statistical processes that can be used by Japanese choice experiment beginners may limit the application of choice experiments in agricultural economics. To my knowledge, only two choice experiment application packages that work in the Japanese environment (i.e., those that have Japanese characters available and where explanations and outputs are written in Japanese) have been developed, namely, those created by Kuriyama (2003a) and Aizaki (2007b). However, these Japanese packages only analyze the responses to choice experiment questions; they do not have the capacity to design a choice experiment.

The present chapter describes a study that developed an application package to allow Japanese choice experiment beginners to design choice experiments and analyze the responses to choice experiment questions using MS Excel and R (Aizaki 2009b). The described package provides a way to design and analyze choice experiments in R explained by Aizaki and Nishimura (2007, 2008) through the graphical user interface (GUI) environment. R (R Development Core Team 2011) is a language and environment for statistical computing and graphics that is freely available from the website of R (http://www.r-project.org). Although R is used globally and Japanese characters are available, it is usually provided with a command line interface; therefore, it may be difficult to grasp for R beginners. Many Japanese choice experiment beginners may still consider themselves novices in R. The package introduced in this chapter uses MS Excel as the GUI to control R: the combination of MS Excel with R is realized by RExcel (Baier and Neuwirth 2007; see also the statconn website http://rcom.univie.ac.at/). This makes it easy for R beginners to use. The package contains two MS Excel macros: one is used to design choice experiments (REA_DCE) and the other is used to analyze the responses to choice experiment questions (REA_ACE).

Although this chapter is a summarized version of

Which milk do you purchase?

	Milk 1	Milk 2
HACCP	Labeled	Labeled
ECO	Not labeled	Labeled
Best-before date	Six days	Seven days
Price per liter	155 yen	160 yen

Fig. 8. A hypothetical example of a choice experiment question.

Aizaki (2009b), it is based on the latest version of the package distributed in December 2010. The package works in the Japanese environment because it contains Japanese characters (it was developed using the Japanese edition of MS Windows 7 Ultimate and Japanese edition of MS Excel 2003). The text in the screenshots, which are shown in the figures presented in this chapter, is translated from Japanese to English for the readers' convenience. It is also freely available under the terms of the GNU General Public License and downloadable through the Japanese website http://www.naro.affrc.go.jp/nkk/contents/useful_info/database/sentaku/(as of November 2012).

6-2. Explanation of the package

The following hypothetical example of consumers' valuations of milk (Sawada *et al*. 2002; Iwamoto 2004; Iwamoto *et al*. 2004) is used to explain the package. **Figure 8** shows an example of a choice experiment question that asks respondents to select from three alternatives: two alternatives of milk and an opt-out option. Each type of milk is expressed by four attributes: HACCP (hazard analysis of critical control points) label, eco-label, best-before date, and price per liter. HACCP label means that the HACCP system has been used for food safety control during the process of manufacturing milk in a factory. The eco-label shows that the raw milk is produced by cows that are fed by ecological dairy farmers who manage their dairy farms in harmony with the environment. Each of these attributes has two levels: "labeled" and "not labeled." The best-before date attribute has two levels: "seven days" and "six days." The price per liter attribute comprises four levels: "145 yen," "150 yen," "155 yen," and "160 yen" (1USD = approximately 77 yen as of September 2011).

6-3. Using the package

6-3A. Macro for creating choice sets for choice experiments

After opening the Excel file containing the macro for designing a choice experiment, the information about the attributes and attribute levels are inputted into the appropriate cells in Sheet 1 (**Fig. 9**). This fig-

Fig. 9. Excel sheet for inputting the basic information in order to design a choice experiment.

ure shows that the number of attributes is set as "4," the number of alternatives is set as "2," and the names of the four attributes are set as "HACCP," "ECO," "BBD (best-before date)," and "PRICE." The number of levels for each of the four attributes is set as "2" or "4." The levels for each attribute are inputted according to the above-mentioned setting.

Then, clicking "OK" in Sheet 1 transports this information into R and executes a process to design a choice experiment in R. In the package, following the first of the four methods explained by Louviere *et al*. (2000, p. 114), the choice experiment design (excluding an opt-out option if one exists) is created through three steps in R:

Step 1: Use the function oa.design included in the DoE.base package (Grömping 2011) to generate an orthogonal main-effect array.

Step 2: Make M − 1 copies of the array.

Step 3: In order to design a choice experiment with M alternatives, randomly select one of the alternatives (rows) from each of the M sets of the array without replacement. Repeat this step until all alternatives in each of the M sets of the array have been assigned to P choice sets.

The resultant design in R is then transported to Sheet 2 in Excel (**Fig. 10**). The choice experiment design created in R, which shows the attribute levels of each attribute as numerical codes, is displayed at the top of Sheet 2. The middle of Sheet 2 displays the choice experiment design with each attribute level translated from these above-described numerical codes to each unique and corresponding code defined in Sheet 1. The bottom of Sheet 2 denotes the choice experiment questions, which are transformed from the design shown in the middle of Sheet 2. Although the number of choice experiment questions is eight in this example, this number changes according to the number of attributes and/or number of levels for each attribute set in Sheet 1.

6-3B. Macro for analyzing responses to choice experiment questions

A conditional logit model, which has been applied in numerous previous choice experiment studies, can be applied using the function clogit included in the survival package (Therneau 2011) in R. When this function is used to analyze the responses to the choice experiment questions, a data set in a special format is needed; that is, each alternative should comprise one row of the data set. The MS Excel macro then generates a data set suitable for the function clogit and analyzes the responses to the choice experiment questions using this function.

Macro users should create three Excel worksheets. The basic information related to the responses to the choice experiment questions is inputted in Sheet 1. This includes the number of respondents, types of questionnaires (number of blocks), questions, alternatives, and independent variables (**Fig. 11**). In this example, 26 respondents were asked to respond to the choice experiment questionnaire; therefore, the number of respondents is set as "26."

The number of types of questionnaires and number of questions are set as "2" and "4," respectively. This means that there are two versions of the questionnaire and each version contains four choice experiment questions. When a large number of choice experiment questions is required, respondents carry a heavy psychological burden in terms of answering them. In such cases, the choice experiment design (total questions) is frequently divided into two or more blocks (subsets) of questions, and each respondent is asked to answer one block. The number of questions in the macro is thus equal to the number of questions included in one block. In the example, eight choice experiment questions were created in the previous section (see **Fig. 10**) and these were divided randomly into two blocks; therefore, the number of types of questionnaires is set as "2" and the number of questions is set as "4." In the choice experiment questions, respondents were requested to select among three alternatives: two milk alternatives and an opt-out option; therefore, the number of alternatives is set as "3."

The number of independent variables depends on the specification of the utility function in the conditional logit model analysis. In this example, the systematic

	A	B	C	D	E	F	G	H	I
1		1st alternative				2nd alternative			
2	Question	HACCP	ECO	BBD	PRICE	HACCP	ECO	BBD	PRICE
3	1	2	2	1	1	1	2	1	2
4	2	2	1	1	3	2	2	2	4
5	3	1	1	1	4	2	1	1	3
6	4	1	2	2	3	2	2	1	1
7	5	2	1	2	2	1	2	2	3
8	6	2	2	2	4	2	1	2	2
9	7	1	1	2	1	1	1	1	4
10	8	1	2	1	2	1	1	2	1
11									
12									
13		1st alternative				2nd alternative			
14	Question	HACCP	ECO	BBD	PRICE	HACCP	ECO	BBD	PRICE
15	1	Labeled	Labeled	Six days	145 yen	Not labeled	Labeled	Six days	150 yen
16	2	Labeled	Not labeled	Six days	155 yen	Labeled	Labeled	Seven days	160 yen
17	3	Not labeled	Not labeled	Six days	160 yen	Labeled	Not labeled	Six days	155 yen
18	4	Not labeled	Labeled	Seven days	155 yen	Labeled	Labeled	Six days	145 yen
19	5	Labeled	Not labeled	Seven days	150 yen	Not labeled	Labeled	Seven days	155 yen
20	6	Labeled	Labeled	Seven days	160 yen	Labeled	Not labeled	Seven days	150 yen
21	7	Not labeled	Not labeled	Seven days	145 yen	Not labeled	Not labeled	Six days	160 yen
22	8	Not labeled	Labeled	Six days	150 yen	Not labeled	Not labeled	Seven days	145 yen
23									
24									
25	Q1	1st alt.	2nd alt.						
26	HACCP	Labeled	Not labeled						
27	ECO	Labeled	Labeled						
28	Best-before date	Six days	Six days						
29	Price per 1 liter	145 yen	150 yen						
30									
31	Q2	1st alt.	2nd alt.						
32	HACCP	Labeled	Labeled						
33	ECO	Not labeled	Labeled						
34	Best-before date	Six days	Seven days						
35	Price per 1 liter	155 yen	160 yen						

Fig. 10. Choice experiment design transported into Sheet 2 in Excel.

components of the utility of respondent *i* to choose milk alternative *j* (=1, 2) are assumed to be as follows (the systematic component of the utility of the opt-out option is normalized to zero):

$$V_{ij} = ASC_j + b_{HACCP}\, HACCP_{ij} + b_{ECO}\, ECO_{ij} + b_{BBD}\, BBD_{ij} + b_{PRICE}\, PRICE_{ij},$$

where *ASC* refers to an alternative specific constant; *HACCP* represents a dummy variable taking a value of 1 if the *HACCP* label attribute is "labeled," and 0 otherwise; *ECO* is a dummy variable taking a value of 1 if the eco-label attribute is "labeled," and 0 otherwise; *BBD* is a dummy variable taking a value of 1 if the best-before date attribute is "seven days," and 0 otherwise; and *PRICE* is the price variable for the price per liter of milk and takes a numerical value of "145," "150," "155," or "160." The coefficients b_{HACCP}, b_{ECO}, b_{BBD}, and b_{PRICE} are associated with *HACCP*, *ECO*, *BBD*, and *PRICE*, respectively. In this case, the choice experiment questions are created as an unlabeled design; ASC_1 and ASC_2 are restricted to sharing the same value. According to these settings for the systematic components of the utility of the milk alternatives, the number of independent variables is set as "5."

Then, the design matrix data set, in which each row shows the alternatives for each question, should be inputted into Sheet 2 (**Fig. 12**). The data set is similar

Basic information about data set

Item	Setting	
Number of respondents	26	respondents
Types of questionnaires	2	types
Number of questions	4	questions / respondents
Number of alternatives	3	alternatives
Number of independent variables	5	variables

O K

Fig. 11. Excel sheet for inputting the basic information in order to analyze the responses to the choice experiment questions.

to the choice experiment design shown at the top of Sheet 2 for the choice experiment design macro (**Fig. 10**). However, each attribute level in the design matrix data set is coded according to the independent variables of the conditional logit model. Furthermore, the design matrix data set should also contain information related to the opt-out option, if one exists in the choice experiment questions.

The respondent data set, in which each row shows one respondent, contains the responses to the choice experiment questions (**Fig. 13**). The data set includes a column headed "ID" that shows the identification numbers of respondents, a column headed "Type" that shows the type of questionnaire that respondents an-

	A	B	C	D	E	F	G	H	I	J
1				1st alternative					2nd alternative	
2	Type	Question	TypeQues	ASC	HACCP	ECO	BBD	PRICE	ASC	HACCP
3	1	1	101	1	1	1	0	145	1	0
4	1	2	102	1	1	0	0	155	1	1
5	1	3	103	1	0	0	0	160	1	1
6	1	4	104	1	0	1	1	155	1	1
7	2	1	201	1	1	0	1	150	1	0
8	2	2	202	1	1	1	1	160	1	1
9	2	3	203	1	0	0	1	145	1	0
10	2	4	204	1	0	1	0	150	1	0

Fig. 12. A part of the design matrix data set inputted into Sheet 2 in Excel.

swered, and columns that show the responses to the choice experiment questions (Q1 to Q4 in **Fig. 13**). The response variables (columns) show the serial number of the alternative selected by the respondent for each choice experiment question. These serial numbers must be assigned an integer value as follows: milk 1 is assigned a value of 1, milk 2 is assigned a value of 2, and the opt-out alternative is assigned a value of 3 (**Fig. 8**).

After inputting each data set into the appropriate Excel sheets, clicking the "OK" button in Sheet 1 creates a data set that is suitable for the function clogit in Sheet 4 (**Fig. 14**). This data set is then transported into R and used to analyze the conditional logit model. Finally, the output of the function clogit is transported into Sheet 5 (**Fig. 15**). In Sheet 5, output items such as "coef," which is usually written in English in R, are translated into Japanese. The top of Sheet 5 shows the summary statistics related to the estimated model, while the bottom shows the coefficient, standard error, z-value, and p-value for each independent variable in the model.

	A	B	C	D	E	F
1	ID	Type	Q1	Q2	Q3	Q4
2	1	1	3	3	3	2
3	2	2	1	3	3	3
4	3	1	1	2	3	1
5	4	2	2	3	1	2
6	5	1	1	2	3	3
7	6	2	2	2	3	3
8	7	1	1	3	1	2
9	8	2	1	2	1	2
10	9	1	1	2	3	2
11	10	2	3	2	3	2
12	11	1	1	2	2	1
13	12	2	1	1	1	2
14	13	1	1	2	3	1
15	14	2	1	1	1	1
16	15	1	1	2	3	2
17	16	2	2	1	3	2
18	17	1	1	3	2	2
19	18	2	3	1	1	3
20	19	1	1	1	3	2
21	20	2	2	3	1	2
22	21	1	1	2	3	1
23	22	2	2	1	1	1
24	23	1	1	3	2	1
25	24	2	1	1	3	1
26	25	1	3	2	2	1
27	26	2	2	1	1	2

Fig. 13. Respondent data set inputted into Sheet 3 in Excel.

6-4.　Concluding remarks

A certain degree of effort by the user is still necessary to carry out and analyze a survey in order to appropriately use choice experiments, because the package illustrated in the present chapter supports only two of the seven steps in typical choice experiment applications. However, the package has the advantage of reducing barriers for Japanese choice experiment beginners.

There remain two limitations when using the package. The combinations of attributes and attribute levels are limited for two reasons. First, the package uses an orthogonal main-effect array to design choice experiments. Second, the Excel spreadsheet used to input the basic information related to this design (shown in **Fig. 9**) is fixed (i.e., the maximum number of attributes and maximum number of levels are set as 5 and 6, respectively). In addition, although there are many variants of discrete choice models, the package contains only a conditional logit model. However, the package could be modified to include other models because R has additional packages related to discrete choice models. Furthermore, the package may be useful for choice experiment beginners in other countries as long as the Japanese characters could be changed appropriately. Modifying the package to make it easier to use by using an additional R package support.CEs (Aizaki 2011), which provides more functions related to choice experiments, is a further issue.

7.　Conclusion

As discussed in Chapter 2, choice experiments have been widely applied in the field of agricultural economics in Japan. Choice experiments can express an alternative using a combination of attributes, model individual behavior by selecting alternatives on the basis of random utility theory, design questions according to these models, and statistically analyze the data collected by these questions. Therefore, a major benefit of choice experiments, compared with contingent valuation methods, is that they can capture a prefer-

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	ID	Type	Question	TypeQues	Alternative	Response	Resp. Dummy	IDTypeQues	ASC	HACCP	ECO	BBD	PRICE
2	1	1	1	101	1	3	0	10101	1	1	1	0	145
3	1	1	1	101	2	3	0	10101	1	0	1	0	150
4	1	1	1	101	3	3	1	10101	0	0	0	0	0
5	1	1	2	102	1	3	0	10102	1	1	0	0	155
6	1	1	2	102	2	3	0	10102	1	1	1	1	160
7	1	1	2	102	3	3	1	10102	0	0	0	0	0
8	1	1	3	103	1	3	0	10103	1	0	0	0	160
9	1	1	3	103	2	3	0	10103	1	1	0	0	155
10	1	1	3	103	3	3	1	10103	0	0	0	0	0
11	1	1	4	104	1	2	0	10104	1	0	1	1	155
12	1	1	4	104	2	2	1	10104	1	1	1	0	145
13	1	1	4	104	3	2	0	10104	0	0	0	0	0
14	2	2	1	201	1	1	1	20201	1	1	0	1	150
15	2	2	1	201	2	1	0	20201	1	0	1	1	155
16	2	2	1	201	3	1	0	20201	0	0	0	0	0
17	2	2	2	202	1	3	0	20202	1	1	1	1	160

Fig. 14. A data set suitable for the function clogit created in Sheet 4 in Excel.

ence for certain attributes and/or alternatives.

Although this advantage is widely recognized in Japan, the most important benefit of choice experiments is conducting various simulations on the basis of the estimated results. Future applications of choice experiments in the field of agricultural economics in Japan should aim to conduct simulations on the basis of these estimated models as well as to measure willingness to pay. Seeking a solution to a social issue is resource-intensive in terms of time and cost. Therefore, choice experiments should be considered a powerful method for extracting useful information on suitable solutions to various social issues through simulations based on estimated choice experiment models. For example, although non-farm residents are considered to benefit from the environmental advantages of agriculture and thus are expected to help maintain agricultural canals in Japan, their opinions on these maintenance activities can differ from those of rice farmers (Aizaki *et al.* 2006d). The number of people (farmers and non-farm residents) who agree with the planned maintenance activity could be predicted using the estimated results of choice experiments that measure their preferences for maintenance. Subsequently, a discussion about the desirable maintenance activity plan based on these simulation results by considering other information (e.g., monetary cost, labor force, and other materials needed for implementing each plan) could ensue. At the end of this monograph, some considerations are pointed out when applying choice experiments to seek solutions to social issues.

First, various decision-making strategies can be considered when a choice experiment approach is applied to aim to solve a social issue. Previous applications of choice experiments in the field of agricultural economics in Japan have mainly used a compensatory choice model, in which each attribute is weighted and added to calculate the overall utility of each alternative. Although the compensatory choice model can easily estimate the willingness to pay for each attribute, if

	A	B	C	D	E
1	Sample size	104			
2	Number of respondents	26			
3	Number of alternatives	3			
4	Number of independent variables	5			
5	Log-likelihood at zero	-114.256			
6	Log-likelihood at convergence	-92.5862			
7	Pseudo R-squared	0.189658			
8	Adj. pseudo R-squared	0.145896			
9	Time at start	37451.58			
10	Time at end	37453.17			
11	Execute time	1.59375			
12					
13	Variable	Coefficient	Std. error	z-value	p-value
14	ASC	15.80945	5.114103	3.091343	0.002
15	HACCP	0.82684	0.340076	2.431341	0.015
16	ECO	1.477786	0.370943	3.983864	0.000068
17	BBD	1.500386	0.382357	3.924043	0.000087
18	PRICE	-0.11511	0.034594	-3.32764	0.00088

Fig. 15. R output of the function clogit transported into Sheet 5 in Excel.

choice experiments are positively applied to examine factors that affect people's decisions on social issues, they should also be conducted on the basis of various decision-making rules. The diversification of people's values increases the variance in the weights that they use to value each attribute and in the rules that they use for valuing attributes and alternatives.

However, when a non-compensatory choice model is judged to be statistically appropriate when applying choice experiments, there are two different reasons why the model is statistically appropriate. First is the case where targeted decision-making in a real situation is perfectly suited to be expressed by a non-compensatory choice model. Second is the case where difficulties in responding to choice experiment questions would cause a psychological burden for respondents, and thus they would use the non-compensatory choice rule to answer choice experiment (hypothetical) questions. It is essential to discriminate between these two reasons and to avoid the latter case. In order to avoid it, it might be useful to apply an approach that combines stated preference and revealed preference data.

From the consideration of various decision-making

strategies, it is also important to use other peoples' behavior as an attribute that consists of an alternative in choice experiment questions. Previous papers have used the features/characteristics of goods and services or the individual options of policy proposals as attributes in alternatives. In addition, it is equally valuable to use others' decisions as an attribute (e.g., Aizaki 2006a). Social events are mainly caused by the interaction between individuals' decisions rather than by the simple accumulation of their decisions. Examples of this include the effect of word-of-mouth communication on food purchasing decisions and the relationship between leader farmers and follower farmers in the case of the diffusion of a new agricultural technology.

It is also important to examine the information effects when applying choice experiments to seek solutions to social issues. When people are faced with a social issue, they frequently need detailed information on it, for example information about the countermeasures needed when serious food safety issues occur. Governments also provide information to soothe a social issue. Although choice experiments that aim to examine this information effect have been applied in agricultural economics in Japan, most previous papers have set a simple two-sample problem: one group of respondents is provided with detailed information, whereas the other is not provided with the information. However, in order to examine what kind of information is appropriate, two or more kinds should be provided. In addition, the diversification of respondents should be considered because information effects can vary among types of respondents. Furthermore, research into improving peoples' incentives to read/hear information provided by others is to be encouraged. A necessary condition of showing the information effect is that people digest the information. Choice experiments should thus also be applied to examine how to increase the incentives to digest information or reduce the psychological barriers of doing so.

Appendix 1

The author of the monograph and colleagues have applied choice experiments and contingent ranking methods, which have been published in academic journals, non-academic journals, and books among others, in order to examine various issues in agricultural economics in Japan. Their publications, some of which have already been presented in Chapter 2, are listed by topic below.

A-1. Consumer valuation

• Consumers' valuations of food safety related to livestock products: Aizaki *et al*. (2004b, 2004c, 2006b, 2006c, 2012) and Sawada *et al*. (2009).

• Consumers' valuations of food safety related to agricultural products: Aizaki and Iwamoto (2004), Aizaki and Sato (2007), Hara *et al*. (2007), and Aizaki *et al*. (2010).
• Marketing research related to agricultural products: Oura *et al*. (2002), Aizaki (2005a), Kono *et al*. (2005), and Kojiya and Aizaki (2011).

A-2. Farm management

• Analysis of farmers' decisions on the use of joint-use facilities/plants: Aizaki (2001) and Aizaki (2006b).
• Analysis of farmers' decisions related to farmland use: Endo *et al*. (2003), and Hirano *et al*. (2005).

A-3. Rural planning

• Economic valuation of agricultural/rural recreation facilities: Aizaki (2003b), Aizaki *et al*. (2004a), and Aizaki (2004a).
• Examination of factors that affect decisions related to agricultural, environmental, and rural resources management: Aizaki *et al*. (2006d), Aizaki (2006a), and Launio *et al*. (2009).
• Economic valuation of the multifunctionality of agriculture and rural areas: Aizaki (2003a), Aizaki *et al*. (2004d), and Aizaki and Moriyama (2003).

A-4. Applications, manuals, and reviews

• Application packages related to choice experiments: Aizaki (2007b, 2009b, 2011).
• Manuals for conducting choice experiments: Aizaki (2002b, 2004b, 2005b, 2005c, 2009a, 2010d) and Aizaki and Nishimura (2007, 2008).
• Reviews related to choice experiments: Aizaki (2005b, 2007a, 2010a, 2010b, 2010c, 2012) and Aizaki and Nanseki (2012).

References

Aizaki H. Characteristics of congestion and the estimation of a waiting time function: a case of grain related facilities. *The Review of Agricultural Economics Hokkaido University* 2000; **56**: 63–75 (in Japanese).

Aizaki H. Demand analysis of agricultural services and the possibility of introducing a discriminatory pricing system: a choice-based conjoint analysis of farmer's behavior. *Hokkaido Journal of Agricultural Economics* 2001; **9**(2): 31–48 (in Japanese).

Aizaki H. Developing a grain-related facilities simulator for an evaluation of management policies. *Journal of Rural Economics* 2002a; **73**(4): 151–160 (in Japanese).

Aizaki H. Introduction to profile designs strategies for choice-based conjoint analysis using orthogonal arrays. *Technical Report of the National Institute for Rural Engineering* 2002b; **200**: 21–32 (in Japanese).

Aizaki H. Comparison of the environmental benefits of paddy fields considering a harmony with ecological system. *Jour-*

nal of Rural Economics 2003a; Special issue 2003: 347–349 (in Japanese).

Aizaki H. Economic pre-evaluation of facilities for promoting leisure activities in rural areas based on hypothetical travel behavior. *Journal of the Japanese Society of Irrigation, Drainage and Reclamation Engineering* 2003b; **71**(12): 13–16 (in Japanese).

Aizaki H. Effects of individual and household characteristics on evaluation of facilities for promoting leisure activities in rural areas: hypothetical travel behavior based on choice experiments. *Technical Report of the National Institute for Rural Engineering* 2004a; **202**: 45–60 (in Japanese).

Aizaki H. Evaluation method of environmental benefits for construction plans harmonizing with ecological system. *Journal of the Japanese Society of Irrigation, Drainage and Reclamation Engineering* 2004b; **72**(10): 37–40 (in Japanese).

Aizaki H. Choice experiment analysis of consumers' preference for ecologically friendly rice. *Agricultural Information Research* 2005a; **14**(2): 85–96 (in Japanese).

Aizaki H. *Economic Valuation of Agricultural and Rural Development Projects: Stated Preference Methods*. Association of Agriculture & Forestry Statistics, Tokyo. 2005b (in Japanese).

Aizaki H. Toward the holistic use of biomass resources (6): forecasting demand for goods and services made from biomass resources. *Journal of the Japanese Society of Irrigation, Drainage and Reclamation Engineering* 2005c; **73**(11): 55–60 (in Japanese).

Aizaki H. Analysis of the impact of others on household cooperative intention to collect household food waste. *Agricultural Information Research* 2006a; **15**(1): 1–14 (in Japanese).

Aizaki H. Proposal of compost demand forecast technique by choice experiments. *Journal of the Japanese Society of Irrigation, Drainage and Reclamation Engineering* 2006b; **74**(3): 25–28 (in Japanese).

Aizaki H. Economic valuation of the multifunctionality of agriculture and rural areas using stated preference methods. *Journal of the Japanese Agricultural Systems Society* 2007a; **23**(1): 41–46 (in Japanese).

Aizaki H. A macro program developed for the statistical analysis of choice experiment data by using MS Excel. *Agricultural Information Research* 2007b; **16**(3): 141–149.

Aizaki H. The choice experiment approach in measuring the external effects of land improvement. *Journal of the Japanese Society of Irrigation, Drainage and Reclamation Engineering* 2009a; **77**(3): 17–20 (in Japanese).

Aizaki H. Development of an application program for the design and analysis of choice experiments with R. *The Japanese Journal of Behaviormetrics* 2009b; **36**(1): 35–46 (in Japanese).

Aizaki H. Application of multi-attributes stated preference methods and conjoint analysis in agricultural economics in Japan: from the latter half of the 1990s to 2005. *Technical Report of the National Institute for Rural Engineering* 2010a; **210**: 265–284.

Aizaki H. Choice experiment approaches to measure the economic value of the multifunctionality of agriculture and rural areas. *Japan Agricultural Research Quarterly (JARQ)* 2010b; **44**(3): 249–257.

Aizaki H. Consumers' valuations of new technologies, countermeasures for food safety, and media of providing information related to agricultural and livestock products: empirical studies using stated preference methods in Japan [Nouchikusanbutsu no shin gijyutsu/anzen taisaku/jyouhou dentatsu syudan no syouhisya hyouka: hyoumei senkouhou wo riyoushita wagakuni no jissyou kenkyuu kara]. *Syokuniku no Kagaku* 2010c; **51**(1): 1–6 (in Japanese).

Aizaki H. Measuring residents' opinions towards agricultural and rural development projects using choice experiments/choice-based conjoint analysis [Sentaku jikken/sentaku gata conjoint bunseki ni yoru nougyou nouson seibi keikaku heno tayouna iken no haaku to keikaku sakutei heno katsuyou]. *ARIC Jyouhou* 2010d; **97**: 16–23 (in Japanese).

Aizaki H. support.CEs: Basic functions for supporting an implementation of choice experiments. R package version 0.2-0. 2011; http://cran.r-project.org/package=support.CEs

Aizaki H. Methods for analyzing behavior under hypothetical situations [Kasou jyoukyou-ka ni okeru koudou bunseki shuhou]. *In*: The Farm Management Society of Japan (ed.). *Review of Research for Farm Management*. Agriculture and Forestry Statistics Publishing Inc., Tokyo. 2012; 135–138 (in Japanese).

Aizaki H, Iwamoto H. Consumers' valuation of traceability system for fresh vegetables using choice experiments [Sentaku jikken ni yoru seisen yasai no traceability kinou no shouhisha hyouka]. *In*: Sawada M (ed.). *Valuing Food Safety: Stated Preference Methods Approach*. Association of Agriculture & Forestry Statistics, Tokyo. 2004; 64–87 (in Japanese).

Aizaki H, Moriyama H. Valuing environmental benefit of bird-watching paddy field as adjustment policy of rice production considering a harmony with ecological system. *Technical Report of the National Institute for Rural Engineering* 2003; **201**: 13–22 (in Japanese).

Aizaki H, Nanseki T. Effects of information/knowledge on consumers' attitudes/behaviors related to agricultural and livestock products [Nouchikusanbutsu ni kansuru jyouhou/chishiki to shouhishya no ishiki/koudou]. *In*: The Farm Management Society of Japan (ed.). *Review of Research for Farm Management*. Agriculture and Forestry Statistics Publishing Inc., Tokyo. 2012; 253–256 (in Japanese).

Aizaki H, Nishimura K. Introduction to choice experiments using R. *Technical Report of the National Institute for Rural Engineering* 2007; **206**: 151–173 (in Japanese).

Aizaki H, Nishimura K. Design and analysis of choice experiments using R: a brief introduction. *Agricultural Information Research* 2008; **17**(2): 86–94.

Aizaki H, Sato N. Consumers' valuation of good agricultural practice by using contingent valuation and contingent ranking methods: a case study of Miyagi prefecture, Japan. *Agricultural Information Research* 2007; **16**(3): 150–157.

Aizaki H, Endo K, Yagi H. Supporting system of construction plans for allotment garden considering potential users' requests. *Journal of the Japanese Society of Irrigation, Drainage and Reclamation Engineering* 2004a; **72**(11): 11–14 (in Japanese).

Aizaki H, Sato K, Iwamoto H. Effects of consumers' knowledge and attitudes on public acceptance of products de-

rived from bovine embryo clones. *Agricultural Information Research* 2004b; **13**(2): 139–154 (in Japanese).

Aizaki H, Sato K, Kikkawa T, Sawada M. Effects of attitudes concerning food safety on choice behavior of beef: a choice experiment including social-psychological factors. *Japanese Journal of Farm Management* 2004c; **42**(2): 22–32 (in Japanese).

Aizaki H, Sato K, Osari H. Improvement of choice experiments for economic evaluation of agriculture and rural areas' multifunctional roles: reducing displayed attributes to respondents. *Transactions of the Japanese Society of Irrigation, Drainage and Reclamation Engineering* 2004d; **72**(4): 433–441 (in Japanese).

Aizaki H, Sato K, Osari H. Contingent valuation approach in measuring the multifunctionality of agriculture and rural areas in Japan. *Paddy and Water Environment* 2006a; **4**: 217–222.

Aizaki H, Sawada M, Sato K, Kikkawa T. Consumer preferences for production information disclosed beef and BSE-tested imported beef: an application of choice experiments. *Agricultural Information Research* 2006b; **15**(3): 293–306 (in Japanese).

Aizaki H, Sawada M, Sato K, Kikkawa T. The influence of Japanese consumer attitudes toward food safety on beef valuations: a choice experiment analysis. *Third World Congress of Environmental and Resource Economists, Kyoto International Conference Hall, Kyoto, Japan July 3–7, 2006*. 2006c.

Aizaki H, Tsuchiya Y, Kondo T, Osanami F. The conditions related to non-farmer participation in agricultural canal maintenance activities: the case of Watari town, Miyagi prefecture. *Japanese Journal of Farm Management* 2006d; **44**(2): 1–11 (in Japanese).

Aizaki H, Nakashima Y, Ujiie K, Takeshita H, Tahara K. Influence of information about agrochemicals provided via Internet-enabled mobile phones on consumer valuation of food. *Journal of Agricultural & Food Information* 2010; **11**: 209–221.

Aizaki H, Sawada M, Sato K. Consumers' attitudes toward consumption of cloned beef: the impact of exposure to technological information about animal cloning. *Appetite* 2011; **57**: 459–466.

Aizaki H, Sawada M, Sato K, Kikkawa T. A noncompensatory choice experiment analysis of Japanese consumers' purchase preferences for beef. *Applied Economics Letters* 2012; **19**: 439–444.

Amagasa K. *One hundred questions related to genetic modification and cloning* [*Idenshi kumikae to clone gijyutsu hyaku no gimon*]. Toyo Keizai Inc., Tokyo. 2000 (in Japanese).

Ashida T. Examining the actual condition of migrants with families in villages and their intention to support their family's rice farming activities: a case study of a paddy field settlement in the mountainous and hilly areas of the Chugoku region. *Journal of Rural Problems* 2010; **46**(2): 220–226 (in Japanese).

Baier T, Neuwirth E. Excell::COM::R. *Computational Statistics* 2007; **22**: 91–108.

Bateman IJ, Carson RT, Day B, Hanemann M, Hanley N, Hett T, Jones-Lee M, Loomes G, Mourato S, Özdemiroglu E, Pearce DW, Sugden R, Swanson J. *Economic Valuation with Stated Preference Techniques*. Edward Elgar, Cheltenham. 2002.

Beggs S, Cardell S, Hausman J. Assessing the potential demand for electric cars. *Journal of Econometrics* 1981; **17**: 1–19.

Ben-Akiva M, Lerman SR. *Discrete Choice Analysis: Theory and Application to Travel Demand*. MIT Press, Massachusetts. 1985.

Bennett J, Birol E (eds.). *Choice Experiments in Developing Countries: Implementation, Challenges and Policy Implications*. Edward Elgar, Cheltenham. 2010.

Bennett J, Blamey R. (eds.). *The Choice Modelling Approach to Environmental Valuation*. Edward Elgar, Cheltenham 2001.

Bennett J, Rolfe J, Morrison M. Remnant vegetation and wetlands protection: non-market valuation. *In*: Bennett J, Blamey R (eds.). *The Choice Modelling Approach to Environmental Valuation*, Edward Elgar, Cheltenham. 2001; 93–114.

Bergstrom JC, Ready RC. What have we learned from over 20 years of farmland amenity valuation research in north America? *Review of Agricultural Economics* 2009; **31**(1): 21–49.

Birol E, Koundouri P (eds.). *Choice Experiments Informing Environmental Policy: A European Perspective*. Edward Elgar, Cheltenham. 2008.

Bliemer MCJ, Rose JM. Experimental design influences on stated choice outputs: an empirical study in air travel choice. *Transportation Research Part A* 2011; **45**: 63–79.

Brooks K, Lusk JL. Stated and revealed preferences for organic and cloned milk: combining choice experiment and scanner data. *American Journal of Agricultural Economics* 2010; **92**: 1229–1241.

Cabinet Office, Government of Japan. An outline of a special survey of public opinion on the supply of food [Shokuryou no kyoukyuu ni kansuru tokubetsu yoron chousa no gaiyou]. 2010; http://www8.cao.go.jp/survey/tokubetu/h22/h22-syokuryo.pdf (in Japanese).

Dawes RM. Social dilemmas. *Annual Review of Psychology* 1980; **31**: 169–193.

de Bekker-Grob EW, Ryan M, Gerard K. Discrete choice experiments in health economics: a review of the literature. *Health Economics* 2012; **21**(2): 145–172.

Department of Agriculture, Hokkaido Government. *Data on rice (production, price, and demand)* [*Kome ni kansuru shiryou (seisan, kakaku, jyuyou)*]. 2011 (in Japanese).

Endo K. A simulation method of agricultural land use about terrace paddy fields. *Journal of Rural Planning Association* 2004; **23**(1): 29–40 (in Japanese).

Endo K. Agricultural land use prediction and the future perspectives of paddy fields in hilly and mountainous areas: a case study of maki-ku in Joetsu city, Niigata prefecture. *Journal of Rural Planning* 2007; **26** (special issue): 359–364 (in Japanese).

Endo K, Hirano N, Aizaki H. Analysis of farmer's behavior about deciding whether to change a cultivating size of Japanese pear. *Journal of Rural Economics* 2003; Special issue 2003: 5–10 (in Japanese).

Endo K, Hirano N, Aizaki H. Examination of the method of agricultural land use prediction based on the intention investigation to the farmer. *Journal of Rural Economics* 2006; Special issue 2005: 172–179 (in Japanese).

FAO. Committee on Agriculture Seventeenth Session: De-

velopment of a Framework for Good Agricultural Practices. Rome, 31 March–4 April 2003; http://www.fao.org/docrep/meeting/006/y8704e.htm

Fujimoto T, Tsunekawa I. Costs and benefits for launching an integrated farming system of arable and livestock using rice whole crop silage: an economic evaluation of impacts on feed self-sufficiency, livestock waste recycling and paddy conservation. *Japanese Journal of Farm Management* 2007; **45**(1): 1–11 (in Japanese).

Fujioka M., Yoshida H. The potential and problems of agricultural ecosystems for birds in Japan. *Global Environmental Research* 2001; **5**(2): 151–161.

Green PE, Rao VR. Conjoint measurement for quantifying judgmental data. *Journal of Marketing Research* 1971; **8**: 355–363.

Grömping U. DoE.base: Full factorials, orthogonal arrays and base utilities for DoE package, R package version 0.22-8. 2011; http://cran.r-project.org/package=DoE.base

Hanemann M, Loomis J, Kanninen B. Statistical efficiency of double-bounded dichotomous choice contingent valuation. *American Journal of Agricultural Economics* 1991; **73**: 1255–1263.

Hangui S. Survey of the consumer needs and the purchasing behavior toward local agricultural products: a case study of strawberry in Koriyama-city, Fukushima, Japan. *Journal of Rural Economics* 2007; Special issue 2007: 231–238 (in Japanese).

Hara Y, Aizaki H, Nakashima Y. Consumer evaluation on information for quality assurance and labeling methods. *Journal of Rural Economics* 2007; Special issue 2007: 278–285 (in Japanese).

Hedayat AS, Sloane NJA, Stufken J. *Orthogonal Arrays: Theory and Applications*. Springer-Verlag New York, New York. 1999.

Hensher DA, Rose JM, Greene WH. *Applied Choice Analysis: A Primer*. Cambridge University Press, Cambridge. 2005.

Hirako S, Senda M. Potential demand for rice whole crop silage and examination of extension: an application of choice based conjoint model. *Agricultural Information Research* 2006; **15**(2): 165–172 (in Japanese).

Hirano N, Endo K, Aizaki H. A prediction of farmer behavior when faced with a paddy field crop diversion policy. *Japanese Journal of Farm Management* 2005; **43**(3): 11–21 (in Japanese).

Hosono H. Consumer preference for milk attributes: a choice experiment approach with focus on food safety and nutrition. *Journal of Rural Economics* 2003; Special issue 2003: 317–319 (in Japanese).

Hosono H. Nutritional and safety information and consumers' evaluation of commodity attributes: a choice experiments approach to milk demand. *Journal of Food System Research* 2004; **10**(3): 34–47 (in Japanese).

Iizumi T. Evaluation of the preference for tentative revenue insurance on rice farmers by conjoint analysis. *Japanese Journal of Farm Management* 2005; **43**(1): 69–72 (in Japanese).

Isayama T, Oura Y. Consumers' valuation of the summer spinach labeled with nutrition information [Seibun jyouhou wo hyouji shita kaki hourensou ni taisuru shouhisha no hyouka]. *Journal of Rural Problems* 2004; **40**(1): 225–228 (in Japanese).

Ishida T, Ishikawa N, Fukushige M. Impact of BSE and bird flu on consumers' meat demand in Japan. *Applied Economics* 2010; **42**(1): 49–56.

Iwamoto H. Consumers' willingness-to-pay for HACCP and eco labeled milk. *Hokkaido Journal of Agricultural Economics* 2004; **11**(2): 48–60 (in Japanese).

Iwamoto H, Yamamoto Y. Japanese consumer's responses on labels of geographical indications for agricultural products. *Journal of Rural Economics* 2006; Special issue 2005: 299–303 (in Japanese).

Iwamoto H, Sato K, Yamamoto Y, Sawada M. Consumers' valuations of the freshness, food safety, and eco-friendliness of milk using conjoint analysis [Shouhisha no gyuunyuu sentaku koudou ni okeru sendo anzensei green kounyuu shikou no conjoint bunseki]. *In*: Sawada M (ed.). *Valuing Food Safety: Stated Preference Methods Approach*. Association of Agriculture & Forestry Statistics, Tokyo. 2004; 9–48 (in Japanese).

Iwamoto H, Song JC, Seo MH, Park JS, Yamamoto Y, Demura K. Korean consumers' willingness to pay for HACCP and eco labeled milk. *Journal of Rural Economics* 2006; Special issue 2005: 257–264 (in Japanese).

Kanninen BJ (ed.). *Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice*. Springer, Dordrecht. 2007.

Kato M, Terawaki T. Food certification system by a local government and its consumers' benefits: A case study of food certification system in Hyogo prefecture [Chihoujichitai ni yoru shokuhin ninshou seido to shouhisha beneki: hyogo no shokuhin ninshou seido no jirei]. *Journal of Food System Research* 2009; **16**(3): 36–41 (in Japanese).

Kato M, Terawaki T, Arima M. Measuring the strength of preference for appearance of traditional vegetable crops. *Japanese Journal of Farm Management* 2009; **47**(1): 111–116 (in Japanese).

Kawashima S, Sari DAP. Time-varying Armington elasticity and country-of-origin bias: from the dynamic perspective of the Japanese demand for beef imports. *The Australian Journal of Agricultural and Resource Economics* 2010; **54**: 27–41.

Kodama Y. Analysis of consumer preference on local brands. *Journal of Rural Economics* 2001; Special issue 2001: 149–151 (in Japanese).

Kojiya H. Citizen intent to participate in "Measures to Conserve and Improve Agricultural Land, Water, and Environment" as a function of household type. *Agricultural Information Research* 2011; **20**(3): 122–130 (in Japanese).

Kojiya H, Aizaki H. Utilizing a green tea marketing strategy for establishing a regional brand: the case of Mie prefecture's kabuse tea (ISECHA). *Japanese Journal of Farm Management* 2011; **49**(1): 1–12 (in Japanese).

Kono Y, Oura Y, Aizaki H, Sugitani M. A discussion of the development of Satsuma orange products: a case study of producing area A in Kumamoto prefecture. *Review of Agricultural Economics* 2005; **56**(1): 111–119 (in Japanese).

Krinsky I, Robb AL. On approximating the statistical properties of elasticities. *The Review of Economics and Statistics* 1986; **68**: 715–719.

Kuhfeld WF. *Orthogonal Arrays*. SAS Institute Inc., TS-723. 2006; http://support.sas.com/techsup/technote/ts723.html

Kurihara S, Maruyama A, Matsuda T. Evaluation of food

safety in school lunch program. *Journal of Food System Research* 1999; **6**(2): 57–68 (in Japanese).

Kuriyama K. Conjoint analysis in Excel, version 1.1 [Excel de dekiru conjoint bunseki, version 1.1]. *Environmental Economics Working Paper #0302, School of Political Science and Economics, Waseda University.* 2003a; http://homepage1.nifty.com/kkuri/(in Japanese).

Kuriyama K. Public works and environmental valuations [Koukyou jigyou to kankyou hyouka]. *In*: Society for Environmental Economics and Policy Studies (ed.). *Koukyou Jigyou to Kankyou Hozen. 2003*. Toyo Keizai Inc., Tokyo. 2003b; 55–67 (in Japanese).

Launio CC, Aizaki H, Morooka Y. Understanding factors considered by fishermen in marine protected area planning and management: case study of Claveria, Philippines. *Journal of Applied Sciences* 2009; **9**(21): 3850–3856.

Livestock Industry Bureau and Secretariat of Agriculture, Forestry and Fisheries Research Council, Ministry of Agriculture, Forestry and Fisheries of Japan. About providing information related to cloned cattle [Clone gyu no jyouhou teikyou tou ni tsuite]. Press release 11 November 1999 (in Japanese).

Louviere JJ, Woodworth G. Design and analysis of simulated consumer choice or allocation experiments: an approach based on aggregate data. *Journal of Marketing Research* 1983; **20**: 350–367.

Louviere JJ, Hensher DA, Swait JD. *Stated Choice Methods*, Cambridge University Press, Cambridge. 2000.

Louviere JJ, Flynn TN, Carson RT. Discrete choice experiments are not conjoint analysis. *Journal of Choice Modelling* 2010; **3**(3): 57–72.

Lusk JL, Marette S. Welfare effects of food labels and bans with alternative willingness to pay measures. *Applied Economic Perspectives and Policy* 2010; **32**: 319–337.

Managi S, Yamamoto Y, Iwamoto H, Masuda K. Valuing the influence of underlying attitudes and the demand for organic milk in Japan. *Agricultural Economics* 2008; **39**: 339–348.

Maruyama A, Sugimoto Y, Kikuchi M. Farm land and green space in a residential area: hedonic evaluation of urban amenities in Chiba city. *Journal of Rural Economics* 1995; **67**(1): 1–9 (in Japanese).

Miller GA. The magical number seven, plus or minus two: some limits on our capacity for processing information. *The Psychological Review* 1956; **63**: 81–97.

Ministry of Agriculture, Forestry and Fisheries of Japan. Results of collecting public opinion on the state of labeling of products derived from bovine embryo-cloned cattle [Jyuseiran clone gyu yurai seisanbutsu no hyouji no arikata (an) ni tsuite no iken jyouhou no boshuu kekka ni tsuite]. Press release 31 March 2000 (in Japanese).

Ministry of the Environment of Japan. *Annual Report of the Environment, the Sound Material-Cycle Society and the Biodiversity in Japan 2011*. 2011; http://www.env.go.jp/policy/hakusyo/h23/index.html (in Japanese).

Naka T, Fujimoto T. A multiple aspects evaluation of farming technology using a choice based conjoint analysis: a case-study of strawberry bench culture. *Japanese Journal of Farm Management* 2002; **40**(1): 1–9 (in Japanese).

Nakamura T, Keino S. Consumers' criterion for selecting vegetables and their valuation of traceability system: an approach of choice-based conjoint analysis [Yasai no sentaku kijyun to traceability ni kansuru shouhisha hyouka: sentaku gata conjoint bunseki ni yoru sekkin]. *Journal of Rural Problems* 2006; **42**(1): 150–155 (in Japanese).

Nakamura T, Maruyama A. Exporting Tochigi's large purple-black grape to Singapore and consumers' perceptions: a survey in Isetan SCOTTS [Tochigi san kyohou no Singapore yushutsu to shouhisha ishiki: Isetan SCOTTS ten ni okeru ankeito chousa kara]. *Journal of Food System Research* 2009; **16**(3): 78–83 (in Japanese).

Nakamura T, Kikuchi K, Keino S, Yoshida M. Pineapple farmers' valuations of their farming management plan and the variety in Okinawa prefecture: an application of choice-based conjoint analysis [Okinawa ken seishoku pineapple seisan ni okeru keiei houshin/hinshu sentaku koudou ni kansuru hyouka: sentaku gata conjoint bunseki ni yoru sekkin]. *Journal of Rural Problems* 2005; **41**(1): 66–71 (in Japanese).

Nakamura T, Maruyama A, Keino S, Sato A. The analysis of consumers' preference after lifting the ban on import of fresh apples to Japan. *Japanese Journal of Farm Management* 2007; **45**(2): 73–78 (in Japanese).

Nakamura T, Maruyama A, Yano Y. Analysis of consumer's preference for apple juice after trade liberalization in Japan: an approach to choice-based conjoint analysis. *Journal of Rural Problems* 2009; **45**(1): 52–57 (in Japanese).

Nishimura K. Analysis of TMR demand in dairy farm. *Journal of Rural Economics* 2009; Special issue 2009: 131–138 (in Japanese).

Nishizawa E, Yoshida T, Kato T. An essay on valuation of amenity from agriculture and forestry: an estimation using a hedonic method [Nourinchi no motarasu amenity no hyouka ni kansuru shiron: hedonic hou ni yoru suikei]. *Nousouken Kihou* 1991; **11**: 1–8 (in Japanese).

OECD. *Multifunctionality: Towards an Analytical Framework*. OECD, Paris. 2001.

OECD. *Multifunctionality: The Policy Implications*. OECD, Paris. 2003.

Ohtani T, Yabe M. Consumers' preference on the second generation GMO and traceability system: an approach from latent class model based on web questionnaires. *Japanese Journal of Farm Management* 2004; **42**(2): 66–71 (in Japanese).

Oura Y, Kono Y, Aizaki H, Sato K. Estimation for brand power on fresh vegetables and fruits producing districts with choice-based conjoint analysis. *Japanese Journal of Farm Management* 2002; **40**(1): 106–111 (in Japanese).

Peterson HH, Chen YJ. The impact of BSE on Japanese retail meat demand. *Agribusiness* 2005; **21**(3): 313–327.

R Development Core Team. *R: A Language and Environment for Statistical Computing, version 2.14.1*. R Foundation for Statistical Computing, Vienna, Austria. 2011; http://www.r-project.org/

Randall A. Valuing the outputs of multifunctional agriculture. *European Review of Agricultural Economics* 2002; **29**(3): 289–307.

Ratanak O, Yabe M. Analyzing decision making of tourists and ecotourism development in Phnom Prich wildlife sanctuary, Cambodia. *Journal of Rural Economics* 2008; Special issue 2008: 513–520.

Renting H, Rossing WAH, Groot JCJ, Van der Ploeg JD, Laurent C, Perraud D, Stobbelaar DJ, Van Ittersum MK. Exploring multifunctional agriculture: a review of con-

ceptual approaches and prospects for an integrative transitional framework. *Journal of Environmental Management* 2009; **90**: S112–S123.

Ryan M, Gerard K. Using discrete choice experiments to value health care programmes: current practice and future research reflections. *Applied Health Economics and Health Policy* 2003: **2**(1): 55–64.

Ryan M, Gerard K, Amaya-Amaya M (eds.). *Using Discrete Choice Experiments to Value Health and Health Care*. Springer, Dordrecht. 2008.

Saito Y, Saito H, Sembokuya Y. Consumer evaluations of pork from hogs raised on recycled food waste. *Agricultural Information Research* 2009; **18**(3): 152–161 (in Japanese).

Sasaki J, Sato K, Iwamoto H, Demura K. Economic evaluation of rural development projects using choice based conjoint analysis. *Journal of Rural Economics* 2000; Special issue 2000: 174–176 (in Japanese).

Sato K. Economic evaluation of multi-functionality of horse production using individual travel cost method. *Journal of Rural Economics* 2005; **77**(1): 12–22 (in Japanese).

Sato K, Kakuta S. Economic evaluation of regional food security policy using choice experiments. *Agricultural Information Research* 2006; **15**(3): 255–266 (in Japanese).

Sato K, Iwamoto H, Demura K. Using choice based conjoint analysis to assess competitiveness of chemical-free Hokkaido rice. *Journal of Rural Problems* 2001; **37**(1): 37–49 (in Japanese).

Sato M, Niiyama Y. The information quantity and consumer choice behavior at the point-of-food-purchase: information providing on traceability-system. *Journal of Food System Research* 2008; **14**(3): 13–24 (in Japanese).

Sawada M, Iwamoto H, Yamamoto Y. Consumers' valuation of HACCP and Eco certified milk [Shouhisha no HACCP oyobi kankyou taisaku ninshou hyouji gyuunyuu ni taisuru kachi hyouka]. *In*: Higuchi A, Awaji K (eds.). *Nougyou no Yoken Henka to Taiousaku*. Association of Agriculture & Forestry Statistics, Tokyo. 2002; 46–58 (in Japanese).

Sawada M, Aizaki H, Sato K, Kikkawa T. Measuring Japanese consumers' evaluation of beef derived from cattle fed in accordance with improved food safety measures. *Research Bulletin of Obihiro University* 2009; **30**: 44–52.

Schelling TC. *Micromotives and Macrobehavior*. W. W. Norton & Company, New York. 1978.

Secretariat of Agriculture, Forestry and Fisheries Research Council and Livestock Industry Bureau, Ministry of Agriculture, Forestry and Fisheries of Japan. *Do you know cloned cattle?: a quick guide* [*Clone gyu ni tsuite shitte imasuka? hayawakari Q&A syuu*]. first edition. 1999 (in Japanese).

Sloane NJA. A Library of Orthogonal Arrays. 2011; http://www2.research.att.com/~njas/oadir/

Small KA. *Urban Transportation Economics*. Harwood Academic Publishers GmbH, Chur. 1992; 61–74.

Takahashi H. Clone technology and shipment of bovine embryo-cloned cattle [Clone gijyutsu to jyuseiran clone gyu no syukka ni tsuite]. *Chikusan no Jyouhou* (*Kokunai Hen*) 1999; October: 13–19 (in Japanese).

Takeuchi K, Brown RD, Washitani I, Tsunekawa A, Yokohari M (eds.). *Satoyama: The Traditional Rural Landscape of Japan*. Springer-Verlag Tokyo, Tokyo. 2003.

Tanaka H. Evaluation of rural recreation by the travel cost method. *Journal of Rural Economics* 2000; **71**(4): 211–218 (in Japanese).

Terada K, Yoshida K. Economic evaluation of food security benefits from farmlands. *Transactions of the Japanese Society of Irrigation, Drainage and Reclamation Engineering* 2006; **74**(6): 865–870 (in Japanese).

Therneau TM. A package for survival analysis in S, R package version 2.36-5. 2011; http://cran.r-project.org/package=survival

Torigoe K, Watanabe K, Kodama Y. Economic analysis of the quality management in regional agricultural products. *Journal of Rural Planning* 2009; **27** (special issue): 323–328 (in Japanese).

Ujiie K. Consumers' behavior related to regional brand: an analysis of influences of consumers' place of residence and characteristics of their household in a case of Sendai beef [Chiiki brand ni taisuru shouhisha koudou: Sendai gyu wo jirei toshita kyojyuuchi narabini setaizokusei ni tsuiteno bunseki]. *Journal of Food System Research* 2009; **16**(3): 32–35 (in Japanese).

Wang X. Evaluation of agricultural policy preventing agriculture non-point source pollution through choice experiment method: a case study on the watershed area of Tai Hu lake basin in Chaina. *Journal of Rural Problems* 2011; **47**(1): 14–25 (in Japanese).

Watanabe M. Solution to the substitute price problem in travel cost model by multiple indicators. *Journal of Rural Economics* 2004; **75**(4): 177–184 (in Japanese).

Watanabe M, Asano K. Evaluation of the externality of paddy fields using panel data via the hedonic method. *Journal of Rural Planning Association* 2002; **20**(4): 243–252 (in Japanese).

Yabe M, Yoshida K. Use of stated preference methods for environmental payments in Japan: comparison of contingent valuation method and choice experiments. *Quaterly Journal of International Agriculture* 2006; **45**: 437–453.

Yabe M, Kontoleon A, Ryan E, Yoshida K. Consumer preferences for food safety and labels in the United Kingdom: a latent class model in the GM content in chicken feed. *Journal of Rural Economics* 2002; Special issue 2002: 221–224 (in Japanese).

Yabe M, Yoshida K, Kontoleon A. The choice experiment studies of combined model using stated preference and revealed preference data: assessing the impacts of alternative 'opt-out'. *Journal of Rural Economics* 2003; Special issue 2003: 320–325 (in Japanese).

Yamada Y, Onuma A, Kodama Y. An empirical study of regional agricultural products: the case of Kuretsubokabu. *Japanese Journal of Farm Management* 2008; **45**(4): 99–108 (in Japanese).

Yoshida K. Contingent valuation approach to the environmental benefits from agriculture in the less-favored areas. *Quarterly Journal of Agricultural Economy* 1999; **53**(1): 45–87 (in Japanese).

Yoshida K. A choice modeling approach to test an order effect of environmental risk information. *Journal of Rural Planning Association* 2003a; **21**(4): 303–312 (in Japanese).

Yoshida K. The present state and future issues of environmental valuations used for policy evaluations [Seisaku hyouka ni okeru kankyou hyouka riyou no genjou to kadai]. *In*: Society for Environmental Economics and Policy Studies (ed.). *Koukyou Jigyou to Kankyou Hozen*.

Toyo Keizai Inc., Tokyo. 2003b: 68–81 (in Japanese).

Yoshida K, Peterson HH. Estimating the consumer response toward the country-of-origin labeling and food safety of imported rice. *Journal of Rural Economics* 2003; Special issue 2003: 297–302.

Yoshida K, Kinoshita J, Goda M. Valuing the environmental benefits of farmland and forests by the contingent valuation method. *Quarterly Journal of Agricultural Economy* 1997; **51**(1): 1–57 (in Japanese).

Yoshida K, Ohtani T, Kubozoe M. Benefit transfer of choice experiments for policy evaluation. *Journal of Rural Economics* 2002; Special issue 2002: 179–181 (in Japanese).

Zhou H, Nanseki T, Hotta K, Shinkai S. Traceability system in Chinese dairy products: an analysis of consumers' preference on products information. *Japanese Journal of Farm Management* 2010; **48**(1): 130–135.

Zwerina K, Huber J, Kuhfeld WF. A general method for constructing efficient choice designs. *SAS Technical Support Documents*, TS-694E. 1996.