Effects of Food Wastes Policies in Korea

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論 文

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HAN, Doo Bong[1]

1 Introduction

The agriculture and food system have played an important role not only to promote sustainable agriculture, but also to solve other development challenges. When we discuss sustainable development, United Nations' Sustainable Development Goals (SDGs) is mostly mentioned as global targets to transform the world in sustainable ways. The second goal of the proposed SDGs is "end hunger, achieve food security and improved nutrition and promote sustainable agriculture." Accordingly, agriculture and food system has also focused on the importance of sustainable development and raised its awareness among farmers, food industries, and consumers.

Even though modern agriculture has achieved in enhancing agricultural productivity for the past several decades, there are still millions of people in hunger and cannot afford them food properly. According to FAO in 2015, the number of people in undernourishment around world was about 795 million people. Thus, about one-ninth of people in the world did not access enough food. The majority of the hungry lives in developing countries where about 13 percent of their population is undernourished. Moreover, although some progress in hunger reduction has been achieved, there have been spikes of food prices since 2008, which have led vulnerable groups in food security to new challenges and global food shortage (Brinkman et al., 2010).

This study aims to present an alternative way to achieve sustainable food system above productivity growth which agriculture and food policies have placed their emphasis on. We suggest that it is not enough to strive for productivity growth, so food waste reduction should be emphasized as a strategy to solve current challenges such as food security and sustainability in the future. While increasing food supply is necessary to enhance food security, food waste reduction has a great potential to meet the future demand of a growing population. Therefore, food waste[2] is one of the major concerns for food security and sustainable development because food waste is the consequence of inadequately management of food after harvest and inefficient food consumption.

2 Literature Review

Current Status of Food Waste

There are many studies on food waste amount,

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2 There is no consensus on definitional framework of food waste. For example, in some studies food waste is subcategory of food loss, so several studies use the term food loss instead of waste. However, this study employs the definition of food waste occurring at final consumption stages such as household and restaurants because it is more relevant to consumer's behavioral characteristics.

its value, and relevant policies. At first, there are several studies on the importance of food waste. United Nations' population projects that the world population of 7.3 billion in 2016 is expected to reach 9.3 billion by 2025 (FAO, 2009), which implies that the future demand of food could exceed the supply of its production. Second, food waste is seen as a sign of inefficient food management after harvest because food waste is the depreciation amount of food stock available in food supply chain. In addition, food waste itself generates extra expenses for waste management in national and municipal levels. Therefore, the economic aspect of food waste means wasted investment, occurring inefficient use of existing resources (Gustavsson et al., 2011).

According to Buzby et al. (2012), the total value of food loss and waste was $165.6 billion at the retail and consumer levels in the United States in 2008; thus, one percent reduction of food loss and waste could lower the value of food loss by $1.66 billion. They also pointed out the lack of awareness on the waste problem at the consumer level, by presenting that each American did not consume and waste $390 of food purchased per year.

Venkat (2011) examined the economic and environmental impacts of food waste in the US and found that avoidable food waste was 55 million metric tons per year, which caused 113 metric tons of CO2. Food waste is about 29% of annual food production in weight and 2% of national greenhouse gas emission.

Secondie et al. (2015) identified whether individuals' behavior on food waste is related to demographic and socio-economic factors. One of their findings is the relationship between urbanization and food waste, indicating that people in urban areas tend to produce larger amount of food waste than those who live in rural areas. This result implies that policy interventions on food waste should consider demographic and socio-economic characteristics.

UN reported that more than 30 percent of edible food goes uneaten in the US, resulting in severe environmental, social and economic costs. In Canada, food waste costs over $30 billion annually and accounts for two percent of Canada's total GDP. If the value includes all resource expenses such as labor, energy and land to produce food waste, total food waste expenses could increase up to three times of direct food waste expense.

Food Waste Policy Development in Korea

Traditionally, the meals prepared in Korean households and restaurants include a large number of small dishes because it is courteous to provide more foods for a meal than can be eaten. The increasing amount of wasted food became a serious problem during early 1990s due to population and income growths. The volume-based waste fee system has therefore been implemented nationwide across the country in Korea on January 1, 1995.

Before the introduction of volume-based fee system, waste collection fee was charged with a fixed rate such as property taxation or monthly fee regardless of the amount of waste generation, which proved ineffective in reducing the amount of waste. Given the volume-based fee system, however, households and small-sized private sectors are required to purchase government-issued plastic bags of different sizes. In other words, each municipality imposes the price for the plastic bags with a 'pay as

you throw' principle; therefore, households should pay for disposal according to the amount of waste generated.

At the early stage of volume-based fee system, food waste was discarded in plastic bags with other solid wastes. Because soggy food waste rots easily, creates large amounts of leachate and results in high treatment cost, it should be separated with other solid wastes. On the other hand, technologies were not developed to transfer food waste to recycling resources such as animal feed and organic fertilizer in the beginning stage. Therefore, the separate collection of food waste has been disseminated since 1997 mainly targeted for large-scale food waste generators, and now each household should abide by this system (Kim et al., 2011). Under the free food waste collection program, there was no incentive to prevent landfilling which results in soil contamination, and to utilize nutrients for the feed and fertilizer.

Due to the Korean dietary culture such as preparing for abundant meals and serving various side dishes, the amount of food waste generated has been increasing. Therefore, there has been continuous demand to reduce food waste generated. Korean government changed policy direction for food waste to restrict the generation of food waste and started to implement a volume-based food waste fee system that imposes fees in proportion to the amount of food waste generated. This program has been carried out nationwide by expanding targets to include multi-unit housing staring in 2013 (Ministry of Environment, Republic of Korea, 2015).

As negative externalities of food waste have led to countermeasures, there have been several studies to describe household behavior and attitude on food waste separation in Korea. Jung et al. (2007) investigated how a unit pricing system imposed to household solid waste affect the waste amount. The study focused on six metropolitan cities and nine provinces, and used quasi-experimental design with panel dataset. The result showed that the waste fee system decreased the amount of waste, also leading the increase in the quantity of recycling.

Park (2015) analyzed the effect of a volume-rate food waste disposal system that was implemented since June 2013 after a pilot program at several municipalities. The interesting finding is that even though the RFID system reduced the total amount of food waste in early times, food waste has increased later. He pointed out that the imposed fee is too cheap to maximize the efficiency of economic incentives.

According to Hong (2015), even though the government increased the unit price of solid waste collection, the total amount of solid waste generated also increased. It indicates that solid wastes were measured properly after introducing volume-based fee system and the price of plastic bag would be cheap to reduce total amount of solid waste. The Korean experience on solid waste and food waste policies is an interesting case study because Korea successfully reduced food waste and increased its recycling dramatically over the past decade.

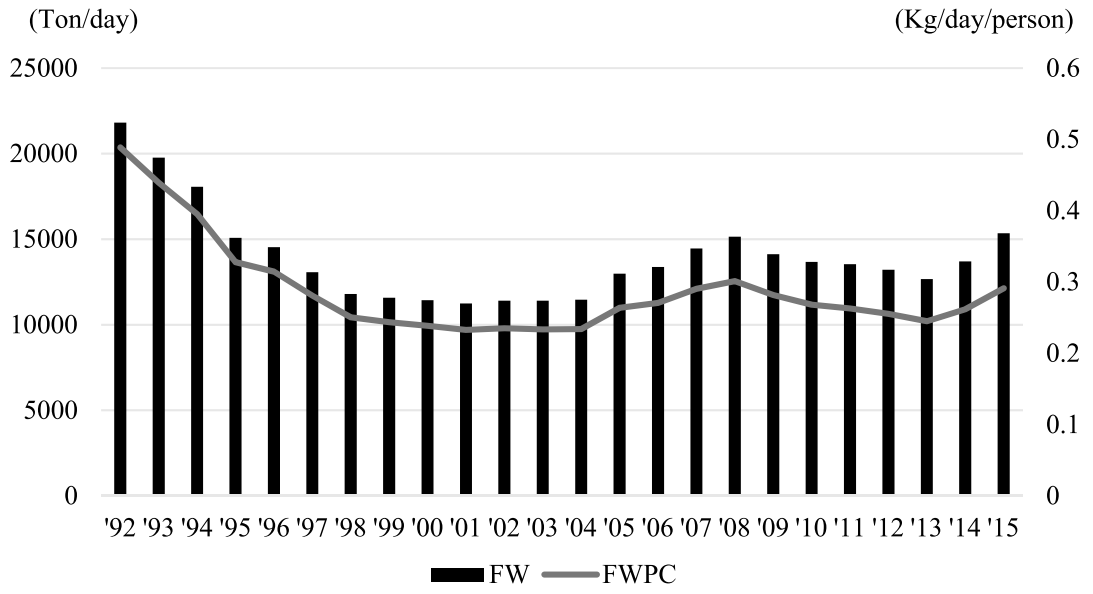
3 Data and Empirical Model

This study considered 15 cities and provinces for 24 years from 1992 to 2015 for analyzing the effects of food waste policies. The main focus of the study is to analyze how volume-based waste fee system and separate collection of food waste policies affect the amount of food waste. We use food waste data since

1992 because food waste data is available separated from solid waste.

Figure 1 illustrates the total amount of food waste and the amount per person, and these variables show same trend. From 1992 to 2004, the amount of food waste decreased, and especially since 1995 its decreasing rate was very sharp. The average amount of food waste and waste per capita is 13,889 M/T and 0.29 kg, respectively from 1992 to 2015. The highest values of them are 21,807 M/T and 0.49 kg in 1992, while their values are the lowest in 2011. Since the separate collection of food waste was implemented almost every municipality since 2005, the separation policy increased food waste. However, we need to distinguish whether the increase amount means the amount of separated food waste or total amount of food waste. Around 2013 and 2014 when the volume-based food waste fee system has been launched, we can find that there is upward trend. However, this also needs to be determined which factor increased the amount of food waste.

Figure 1. The amount of food waste in Korea, 1992-2015



Source: The Status of National Waste Generation and Treatment, Ministry of Environment, Korea.

Table 1 presents that the amount of food waste and its amount per person in each city from 2012 to 2015. Seoul and Gyeonggi show the biggest amount of food waste generated, while food waste per capita is relatively high in Guangju and Jeju. The Sejong city is a special administrative district where Korean government agencies have moved since 2012; thus, its waste amount was very small because the city was just built. Difference in the amount of food waste across districts represent that the amount of food waste may be influenced by several factors such as population in a province, residents' economic activities and education level, etc.

Table 1. The amount of food waste by province in Korea

	2012		2013		2014		2015	
	Food Waste (ton/day)	per capita (kg/day)	Food Waste (ton/day)	per capita (kg/day)	Food Waste (ton/day)	per capita (kg/day)	Food Waste (ton/day)	per capita (kg/day)
Seoul	3,319	0.32	3,085	0.30	3,213	0.31	3,223	0.31
Busan	778	0.22	760	0.21	851	0.24	844	0.24
Daegu	595	0.24	592	0.23	643	0.26	626	0.25
Incheon	693	0.24	671	0.23	646	0.22	742	0.25
Guangju	445	0.30	443	0.30	515	0.35	570	0.38
Daejeon	437	0.29	409	0.27	439	0.28	502	0.33
Ulsan	332	0.29	327	0.28	358	0.30	367	0.31
Sejong	23	0.21	35	0.28	31	0.13	31	0.15
Gyeonggi	2,938	0.24	2,826	0.23	3,053	0.24	3,627	0.28
Gangwon	306	0.20	297	0.19	351	0.23	445	0.28
Chungbuk	329	0.21	295	0.19	388	0.24	490	0.30
Chungnam	482	0.23	500	0.24	506	0.24	632	0.30
Jeonbuk	527	0.28	525	0.28	574	0.30	646	0.34
Jeonnam	400	0.21	392	0.21	478	0.25	568	0.29
Kyeongbuk	571	0.21	550	0.20	645	0.23	747	0.27
Kyeongnam	823	0.24	500	0.24	821	0.24	1,066	0.31
Jeju	212.5	0.36	207.3	0.34	196.9	0.32	215.8	0.34

Source: The Status of National Waste Generation and Treatment, Ministry of Environment, Korea.

This study uses a panel data model to analyze heterogeneous municipal behavior in a repetitive environment. Since food waste ("FW") is our variable of interest, panel data model can be described as equation (1) where X_{itj} is the -th observation on explanatory variables, β_j is the parameter vector, v_i denotes the unobserved individual-specific time-invariant effects, and ε_{it} is the residual disturbance term.

$$log(FW_{it}) = \alpha + \sum_{j=1}^{k} \beta_j X_{itj} + \beta_p Program + u_{it}, \qquad where\ u_{it} = v_i + \varepsilon_{it} \tag{1}$$

According to the nature of v_i, two models can be distinguished. Firstly in fixed effect model, where v_i are assumed as individual fixed parameters, it considers heterogenous effect between individuals. On the other hand, random effect model consider v_i as random variables (i.e., uncorrelated with ε_{it}). In these models, regressors X_{itj} are uncorrelated with individual effect,v_i. Thus, random effect model estimates consistent and efficient estimators using generalized least squares (GLS).

However, dynamic panel data models as shown in equation (2) are more useful when the dependent variable depends on its own past realizations:

$$log(FW_{it}) = \alpha + \gamma\, log\left(FW_{i,t-1}\right) + \sum_{j=1}^{k} \beta_j X_{itj} + \beta_p Program + v_i + \varepsilon_{it}, \quad (2)$$

where $u_{it} = v_i + \varepsilon_{it}$. In this model, X_{itj} are regressors, and v_i denotes fixed individual effects. As $log\left(FW_{i,t-1}\right)$ is correlated with because $log\left(FW_{i,t-1}\right)$ is a function of v_i; thus, both GLS and OLS estimators are biased and inconsistent.

Arellano and Bond (1991) provided a method that exploits all possible instruments. An alternative modeling to remove individual effects v_i is the so-called "first difference" transformation, written like equation (3) below. Using the Generalized Method of Moments (GMM), they obtained estimators using the moment conditions generated by lagged levels of the dependent variable with Δv_i. Arellano and Bond (1991) also proposed a test to detect serial correlation in the disturbances because the presence of serial correlation in the disturbances affects the validity of instruments. They suggested to use the first differenced values of lagged dependent variable and regressors.

$$\Delta log(FW_{it}) = \gamma \Delta\, log\left(FW_{i,t-1}\right) + \beta_j \Delta X'_{itj} + \Delta v_{it} \quad (3)$$

Table 2 presents the descriptive statistics of variables for our analysis. The dependent variable is the amount of food waste, while independent variables include the total number of population, annual amount of budget for waste management, and gross regional domestic product (GRDP). All variables take logarithmic transformation to remove trend. In addition, volume-based waste fee system and separate food waste disposal, which are policy dummy variables, are used to determine the effects of policy changes on the amount of food waste.

Population growth is considered as a major factor of food waste. Population growth may also move in parallel with the growth rate of food waste in most developed countries. The municipal budget for waste management would reduce food waste, for example, by establishing a new waste treatment facility in the resident or recycling facilities. GRDP is used as an indicator of the economic size of each province to analyze the income effect of food waste per province.

We verify the hypothesis that food waste rise as both population and GRDP increase, while the budget for waste management in each province may decrease food waste.

Table 2. Descriptive statistics of the variables for food waste analysis between 1992 and 2015

Variable	Definition	Mean	Std.	Min	Max
FW	Amount of food waste (ton per day)	13,888.73	2,724.99	11,236.6	21,807
FWPC	Amount of food waste per capita (kg per day)	0.29	0.07	0.23	0.49
POP	Total number of population (thousand)	48,799,233	2,273,323	44,995,365	52,335,488
BUD	Annual amount of budget for waste management (thousand KRW)	2,176,535,726	747,310,241.3	766,153,000	3,227,159,668
GRDP	Real gross regional domestic product (million KRW, 2010 price)	954,382.5	292,149.5	491,544.6	1,426,972
VBWF	VBWF=1 if volume-based waste fee policy is implemented in 1995, VBWF=0 otherwise.				
SPRT	SPRT=1 if separate collection of food waste is implemented in 2005, SPRT=0 otherwise.				

Source: Status of National Waste Generation and Treatment, Ministry of Environment

4 Empirical Results

Table 3 shows estimated parameters from a dynamic panel model. The result represents that the increase of food waste in previous year leads to the increase in the amount of current food waste. This implies that we need overall plan for food waste management, continuous awareness, and commitment among society and private organization. We also find that increasing population growth and GRDP could lead to increase in food waste but coefficients are not statistically significant.

It is our interest to focus on policy programs related to food waste. The introduction of volume-based fee system leads to reduce the amount of food waste. This result indicates that economic incentive system is effective to reduce food waste. In particular, food waste decreased by about 17% with the implementation of volume-based fee system. For the separate collection of food waste policy, the amount of food waste has been collected properly, rather than putting food waste into plastic bags with non-food waste. Thus, the estimation result shows that food waste increased about 10% after the separate food waste collection has been implemented. Two policies are successful policy programs to reduce food wastes. Particularly, an economic incentive system as volume-based food waste fee system is very effective to control food waste and the separation collection of food waste is also successful to reduce waste management expenses by separating soggy food wastes from solid wastes.

Table 3. Estimation results of food waste by dynamic panel analysis

	Constant	FW_{t-1}	Population	GRDP	VBWF	Separate Collection
Amount of Food Waste	1.710 (1.204)	0.612*** (0.101)	0.037 (0.051)	0.036 (0.062)	-0.173* (0.091)	0.099*** (0.033)
Arellano-Bond Test	Order 1			Order 2		
	Z = -2.8539 Prob > z = 0.0043			Z = 0.4479 Prob > z = 0.6542		

Note: (1) * and *** denotes significance at the 10% and 1% levels, respectively.
(2) Numbers in parenthesis are standard errors.

We should be careful when interpreting the empirical result of separation collection policy because the amount of food waste actually increases. The result is reasonable because food waste could not be included in solid waste statistics any more after the separate collection practice. Before the separation collection of food waste, food waste was discarded with general solid waste in plastic bags since 1995.

5 Conclusion

This study verifies that an economic incentive system called as volume-based food waste fee system can significantly reduce food waste. The Korean government has conducted various waste management policies, focusing on minimizing waste generation and recycling food waste into organic resources. Volume-based waste fee system for solid waste was implemented in 1995, which is the first nationwide program in the world. The volume-based fee system was introduced because increasing amount of waste was a serious problem during early 1990s due to population growth, over-prepared meals, and a large number of small dishes. Under this program, all households and small-sized private sectors are required to purchase government-issued plastic bags of different sizes. Each municipality determines the prices of plastic bags by size, and households should pay for waste disposal according to the amount of waste generated. This economic inventive system, volume-based fee system, was very successful; however, food waste was discarded with general solid waste in the plastic bag.

For efficient waste management, the government implemented a new policy, the separation of food waste from solid waste using food waste plastic bag since 2005. The Ministry of Environment also prohibited the direct disposal of food waste in a landfill since 2005. As a result, the recycling rate of food waste has increased very significantly from 3 percent in 1996 to 97 percent in 2015. In addition, the government announced the introduction of volume-based food waste fee system in 2010 and

implemented it over the nation by 2012.

To reduce food waste, we should prepare comprehensive plans above volume-based fee system and the separated collection of food wastes such as food expiration labeling and consumer education. Excessive purchases and discarding food before expiration date often result in avoidable food waste. Sometimes, overly strict food safety regulation can make food, which is actually safe, unacceptable in markets. In addition, consumers confuse to differentiate expiration date and the best use date. Thus, food labeling needs to be improved for consumers to easily understand and make a plan to purchase the right amount of food. Above all things, both private and public partnership is very important to reduce food waste because government policies to reduce food waste and food consumption guideline are not effective if the private sector would not be cooperative.

References

Arellano, M., and Bond S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies*, 58: 277-298.

Brinkman, H. J., De Pee S., Sanogo I., Subran L., and Bloem M. W. (2010). High Food Prices and the Global Financial Crisis Have Reduced Access to Nutritious Food and Worsened Nutritional Status and Health. *The Journal of Nutrition*, 140 (1): 153-161.

Buzby, J. C. and Hyman J. (2012). Total and per capita value of food loss in the United States. *Food Policy*, 37 (2012): 561-570.

FAO. (2009). How to feed the world in 2050. Rome, Italy: Food and Agriculture Organization of the United Nations (FAO).

FAO. (2015). Global initiative on food loss and waste reduction. Rome, Italy: Food and Agriculture Organization of the United Nations (FAO).

FAO, IFAD and WFP. (2015). The State of Food Insecurity in the World 2015. Rome, Italy: Food and Agriculture Organization of the United Nations (FAO).

Gustavsson, J., Cederberg C., Sonesson U., van Otterdijk R., and Meybeck A. (2011). Global Food Losses and Food Waste: Extent, Causes and Prevention. Rome, Italy: Food and Agriculture Organization of the United Nations (FAO).

Hong, S. (2015). The Impact of Unit Pricing System on the Demand for Solid Waste Disposal, Food Waste Disposal, and Recyclables. *Environmental and Resource Economics Review*, 24 (4): 747-761.

Jung, K., Seo J., and Hong J. (2007). The Effect of Unit Pricing System for Household Solid Waste: Focused on 6 Metropolitan Cities and 9 Provinces. *Korean Public Administration Review*, 41 (1): 175-201.

Kantor, L. S., Lipton K., Manchester A., and Oliveira V. (1997). Estimating and Addressing America's Food Losses. Food Review, 20: 3-11.

Kim, K. Y. and Kim Y. J. (2011). Volume-based Waste Fee System in Korea. 2011 Modularization of Korea's Development Experience, Korea Environment Institute.

Lipinski, B., Hanson C., Lomax J., Kitinoja L., Waite R., Searchineger T. (2013). Reducing Food Loss and Waste (Working Paper). World Resources Institute, Washington.

Lundqvist, J., De Fraiture C., and Modeln D. (2008). Saving Water: From Field to Fork – Curbing Losses and Wastage in the Food Chain. SIWI Policy Brief, Stockholm International Water Institute (SIWI).

Ministry of Environment (2006). Korea Environmental Policy Bulletin: Volume-based Waste Fee System in

Korea.

Ministry of Environment (Yearly). Status of National Waste Generation and Treatment.

OECD. (2006). Environmental Performance Reviews: Korea. OECD, Paris.

Park, M. (2015). An Analysis of Implementing the Volume-Rate Food Waste Disposal System in Korea: Focused on Policy Target Group Compliance. *The Korean Association for Governance*, 22 (1): 161-194.

Parfitt, J., Barthel M., and Macnaughton S. (2010). Food Waste within Food Supply Chains: Quantification and Potential for Change to 2050. Philosophical Transactions of the Royal Society, 365: 3065-3081.

Secondi, L., Principato L., and Laureti T. (2015). Household Food Waste Behaviour in EU-27 Countries: A Multilevel Analysis. *Food Policy*, 56: 25-40.

Segrè, A., Falasconi, L., Politano, A., and V.ittuari, M. (2014). SAVE FOOD: Global Initiative on Food Loss and Waste Reduction. Background Paper on the Economic of Food Loss and Waste (Working Paper). Rome, Italy: Food and Agriculture Organization of the United Nations (FAO).

Singhal, A. A., and Lipinski B. (2015). How Food Waste Costs our cities Millions. World Resource Institute, Washington.

UN Environment. Minimizing Food Waste, Retrieved from http://www.rona.unep.org/regional-priorities/minimizing-food-waste (accessed 8 June 2017).

Venkat, K. (2011). The Climate Change and Economic Impacts of Food Waste in the United States. *International Journal of Food System Dynamics*, 2 (4): 431-446.

Ventour, L. (2008). The Food We Waste. Banbury: WRAP, ISBN: 1-84405-383-0.

English Abstract

Effects of Food Wastes Management Policy in Korea

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Modern agriculture has increased food production significantly for the past several decades, but there are still many people in hunger and cannot afford them food properly. The number of people in undernourishment around world reported by FAO in2015 is about 795 million people. Thus, about one-ninth of people in the world did not access enough food. The majority of hunger people lives in developing countries where 12.9% of the population is undernourished. In order to achieve food security, agricultural policy makers have focused on increasing agricultural productivity, but have ignored the importance of food waste management. It would be impossible to supply proper food without controlling food wastes because more than 40 percent of food has wasted after production.

The objectives of this study are: (1) to identify the determinants of food and wastes; (2) to analyze policy impacts on food loss and wastes empirically. For these purposes, this study focused on two policy interventions, volume-based waste fee system and separate collection of food wastes. This study estimated a dynamic panel model to analyze two policy intentions. Empirical results indicate both policies are successful to reduce food wastes and waste management expenses, and also increase the recycling of food waste. In particular, an economic incentive policy is effective to minimize the amount of food wastes. Because food waste is closely related to food consumption behavior, we should prepare comprehensive strategies of government regulation and economic incentives as well as consumer education to change food consumption and waste behaviors.