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Assessing the Contribution of Food Donation to GHG Reduction: Insights for Sustainable Business Practices

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Abstract

This study aims to assess the contribution of food donation to GHG (Greenhouse Gas) reduction to provide insights for sustainable business practices. We measure the effect of carbon emission reduction by avoiding the disposal of fresh and processed food donated through food banks and preventing additional fresh and processed food that would have been produced and grown without the donation. The analysis uses data on the quantity and donation value of 24,627 fresh and 733,222 processed food items donated by food banks in 2022. The result shows that the effect of carbon emission reduction through food bank donations of fresh food totaled 3,081 tons CO_2-eq, and the impact of carbon emission reduction through those of processed food totaled 65,103 tons CO_2-eq. As the socio-economic costs of food waste in Korea are increasing, redistributing surplus food products to the socially vulnerable is expected to become a representative alternative to reducing food waste.

Keywords : Food donation, Food redistribution, Food waste reduction measures, GHG reduction, Carbon emission reduction

JEL Classification Code: Q18, Q51, Q52

1. Introduction

Food donation activities have traditionally been considered a social (S) dimension of environmental, social, and governance (ESG) activities. ESG management refers to a company's commitment to protecting the environment, fulfilling its social responsibility to the community, and complying with laws and ethics in its business operations. There are more than 600 standards for evaluating ESG at home and abroad, and to reduce confusion, the Ministry of Trade, Industry and Energy released the 2021 K-ESG Guidelines. In the K-ESG Guidelines, the social aspect consists of labor, diversity and gender equality, occupational safety, and shared growth, and donations are also included in this category. The environmental aspects, as it were, consist of environmental management goals, greenhouse gases (GHGs), energy, water, waste, pollutants, environmental violations, environmental labeling, and more (Ministry of Trade, Industry and Energy, 2021, December).

However, food donation activities to pursue corporate social value can also be viewed as having a positive impact on the environment in that it reduces food waste by reutilizing goods that would have otherwise been discarded and avoids carbon emissions by preventing additional production. In other words, food donation activities can be expanded from the social (S) to the environmental (E)

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dimension of ESG. Food waste is not only associated with a variety of social issues, including the economic costs of waste disposal and food access gaps, but it is also an important environmental issue that needs to be addressed. About 1.3 billion tons of food, equivalent to one-third of the world's food production, is wasted every year without reaching the table, and the economic cost of food waste in Korea is estimated to be KRW 20 trillion in 2018. In addition, the amount of GHG emissions from food disposal by domestic households is estimated to be 8.8% of GHG emissions from food consumption (Hong et al., 2021).

Matching and redistributing surplus food to those who need it before disposing of it can be an alternative to solving social and environmental problems caused by food waste. The severity of food waste is a problem that is shared globally, and target 12.3 of the UN Sustainable Development Goals (SDGs) sets a goal of reducing food waste at the retail and consumption stages by 50% by 2030 as part of an international effort. EU member states have established food waste prevention programs to prevent food waste in advance and are making policy efforts to redistribute surplus food. In France, for example, medium or large supermarkets with a floor space of more than 400 square meters are required to sign donation agreements with charities for surplus food products.

In South Korea, there are food banks, which are the representative organizations responsible for receiving food donations and redistributing them to vulnerable people. Food donations through food banks have been steadily increasing since 2016. As of 2022, the total amount of donations to food banks was KRW 250 billion, of which food products accounted for about 80%. The amount of food donations increased steadily from 2016 to 2022, but decreased by 11.7% in 2020, when the impact of the pandemic was severe (Hong et al., 2023). This redistribution of surplus food to food banks not only prevents food waste, but also reduces the environmental footprint in terms of avoiding additional food production.

Given the growing interest in the positive environmental impacts of food donations, there is a strong need to quantitatively analyze the GHG reduction from the food donations of food banks. Accordingly, this study aims to assess the contribution of food donation to GHG reduction to provide insights for sustainable business practices.

2. Literature Review

2.1. ESG Management of Food Companies

Research related to ESG management in Korea focuses on the development direction of ESG management in general companies and consumer perception surveys (Kim & Kang, 2021; Seo et al., 2022), and literature related to ESG management in the food manufacturing industry is still lacking. Kim et al. (2022) studied the impact of ESG evaluation on service usage for companies offering food subscription services and found that consumers are more likely to continue to use the company if they make a positive evaluation of the environment and society during ESG evaluation. Suh et al. (2022) analyzed the ESG strategies of four domestic and international retail companies (Walmart, Amazon, E-Mart, and Coupang) and found that while retail companies pay attention to environmental aspects (E), investments related to social responsibility (S) are insufficient, and governance (G) is evaluated differently depending on the country or online and offline operations.

Looking at international research on ESG management in food companies, Ksiazek (2022) studied the application of the UN SDGs to the food and grocery sector, developing a methodology to analyze the correlation between SDGs and ESG assessment and demonstrating that long-term SDGs can improve ESG assessment. Drapinski et al. (2022) identified how ESG strategies can be used and how to align ESG strategies to reduce the associated risks in terms of the portfolio management of food companies through collaboration with Kellogg’s. Sandberg (2022) analyzed the relationship between ESG ratings and financial performance (return on assets and return on equity) in the European food industry from 2017 to 2020 and found that higher ESG ratings were associated with better financial performance.

2.2. Food Waste and GHG Emissions

Food waste is generated during the process of delivering food products to end consumers in raw or processed form and during consumption by the consumers. According to Hong, Park, Lee and Yun (2021), the proportion of food products that are discarded without being consumed in Korea was estimated to be about 14%, and the socioeconomic cost of this was about KRW 20 trillion. Looking at international studies, Vilariño et al. (2017) examined the limits of waste reduction by patterning food waste in countries around the world. The study concluded that food loss and waste accounts for about 8% of global GHG emissions, with direct economic costs estimated at about $1 trillion per year in 2017. Cerutti et al. (2018) estimated the carbon emissions generated by school lunches in senior secondary schools in Torino, Italy, and found that the average carbon emissions of a meal served to a single person was 1.67 kg CO_2-eq.

As the economic, social, and environmental impacts of food waste are at a serious level, research to solve the problem is receiving wide attention, but there has not been much research in Korea on developing food waste reduction measures. Reynolds (2019) reviewed the literature on food waste prevention interventions at the consumption/ consumer stage of the supply chain from 2006 to 2017 and found that interventions to change the size or type of plates were effective in reducing food waste in hospitality settings by up to 57%. It was also reported that changing nutrition guidelines in schools could reduce vegetable waste by up to 28%, and information campaigns were also effective in reducing food waste by up to 28%. Mbow et al. (2019) estimated that GHG emissions are expected to increase by up to 50% from the current level by 2050 in the absence of policy interventions on factors such as population growth, income growth, and changes in people's dietary habits. They argued that to reduce carbon emissions, demand-related behaviors such as changes in food choices and efforts to reduce food waste should be implemented across the board. As part of this effort, Hong et al. (2021) identified the actual situation and factors of food waste that occur during the distribution and consumption stages of food products and drew precautionary measures to compensate for the limitations of existing food waste reduction policies that focus on post-treatment measures. The analysis revealed the economic benefits of donating unserved food and utilizing goods that are getting close to their expiration date, which are alternatives related to redistributing food products, have significant economic benefits.

2.3. Functions of Food Redistribution

2.3.1. Ensuring Food Accessibility

Food redistribution has been recognized as a major alternative to reducing food waste, but there is a lack of domestic research on this topic. However, many studies on food banks, which are organizations that redistribute food products to the vulnerable in Korea, have been conducted on the actual situation and case studies of food banks since the enactment of the Food Donation Promotion Act in 2006, providing a legal basis for food bank operations (Kang et al., 2012; Kim & Lee, 2013). Lee (2012) measured the business performance of the food bank project in Cheongju City through the satisfaction evaluation and cost-benefit analysis of the project. The results of the analysis showed that about 60% of the participants were satisfied and 95% were willing to use the service again. In addition, the cost-benefit analysis was conducted assuming that Cheongju City would continue the food bank project as a scenario, and the benefits were found to be KRW 13 for every KRW 1 of cost, confirming that the food bank project has a positive impact on increasing social welfare.

Overseas studies on food banks had focused on food bank practices, similar to those in Korea (Youn et al., 1999; Cotugna & Beebe, 2002; Wie & Giebler, 2013). Youn et al. (1999) and Cotugna and Beebe (2002) summarized the historical background and characteristics of food banks in the United States, and Wie and Giebler (2013) examined the functions and limitations of food banks in California. However, recent studies have focused on the perceptions of food bank users, with limited food choices at food banks (Fallaize et al., 2020) and shame about using food banks (McNaughton et al., 2021) as major problems. There is also a growing body of research that criticizes the institutional weaknesses of food banks and suggests policy implications. Arcuri (2019) pointed out the representation of the recent anti-food waste/pro-donations law in Italy, highlighting the need to explicitly explore trade-offs between different frames of the food redistribution problem at hand when designing policy instruments. Warshawsky (2023) identified supply chain disruptions, increased costs due to the rapid increase in demand for relief food, decreased inventory of donated goods, and volunteer shortages as key operational limitations faced by food banks during the pandemic, emphasizing the importance of organized food donation management and volunteer scheduling to address these challenges.

International research has recognized food redistribution as a key component of food security issues and a means to alleviate food insecurity, particularly in developed countries (Garrone et al., 2014), but is also criticized as a band-aid solution that does not address the underlying socioeconomic causes of poverty (Caraher & Davison, 2023).

2.3.2. Environmental Role

Recent studies have focused on the environmental role of food redistribution (Herszenhorn et al., 2014; Cicatiello et al., 2016; Papargyropoulou et al., 2019). Van der Haar and Zeinstra (2019) studied the impact of the ‘Too Good to Go’, a food-sharing service utilizing a digital platform in Europe, on food waste reduction and found that the service played a positive role in reducing food waste at both the restaurant and consumer levels. Several studies have measured the carbon emissions avoided through food redistribution. Reynolds et al. (2015) analyzed the environmental impacts of food rescue activities of Australian charities and found that the total resources avoided by the food rescue in 2008 were over 131 million m3 of water, 789 TJ of energy, and 148 Gg CO_2-eq of GHG. Bergström et al. (2020) estimated the impacts of various food donation programs in Sweden and found that the 'food bag' program, which provides weekly grocery bags to vulnerable people, had the largest environmental impact, with reduced carbon emissions of 1.2 kg CO_2-eq per kilogram (kg) of donated food. Damiani et al. (2021) analyzed the potential environmental impacts of food donations in Italy and showed that the carbon emission reduction from food donations was 1.9 kg CO_2-eq per kg of food.

3. Data and Methods

In this study, we aimed to measure the effect of carbon emission reduction by avoiding the disposal of fresh and processed food donated through food banks and preventing additional fresh and processed food that would have been produced and grown without the donation.

3.1. Data

3.1.1. Fresh Food

To analyze the effect of carbon emission reduction by reducing fresh food waste, we used the status data of donated goods in 2022 from the Food Management System (FMS) of the Korean Association of Social Workers, agricultural product distribution information from the Korea Agro-Fisheries & Food Trade Corporation (aT), and unit price data from the Korea Price Research Center. The status data of donated goods includes donor, date of donation, product name, food product classification, donation quantity (in kg), and amount. This study analyzed data on 24,627 donated fresh food items.

In addition, this study categorized the status data based on the amount of money by item and then converted the amount to kg using agricultural product distribution information from the aT and unit price data from the Korea Price Research Center. The average price of food products in the aT's agricultural products distribution information used in the analysis is the average value of three years excluding the highest and lowest prices of agricultural products (excluding 2023), and wholesale prices (selling prices of middlemen) were used in the analysis considering that the prices of donated items registered in the FMS are producer prices.

3.1.2. Processed Food

To analyze the effect of carbon emission reduction by reducing processed food waste, 733,222 items of processed food donated to food banks from the status data of the FMS were utilized, including substitute meals (bread), beverages, other processed foods, snacks, ready-to-eat/convenience foods, seasonings, dairy products, health foods, fish/soft foods, processed livestock products, processed fishery products, powders, pickled/fermented foods, and paste and cooking oils, for which raw materials and the proportion of raw materials used can be identified through the Survey on Raw Material Consumption in Each Food Industry Sector from the aT.

3.1.3. GHG Emission Coefficient

The GHG emission coefficient mutually used for the analysis of fresh and processed food were based on the information of GHG emission coefficient published by the Foundation of Agri, Tech, Commercialization & Transfer in Korea and the Agro Chain greenhouse gases Emission (ACE) calculator of the Wageningen University (Table 1). The calculator utilizes Porter et al. (2016) and FAO's crop emissions intensity data to publish GHG emissions by food classification. To calculate GHG emissions for some cereals, meats, root and tuber crops, vegetables, and processed foods, we used the coefficient from the Foundation of Agri, Tech, Commercialization & Transfer (2012). To calculate GHG emissions for fruits, we utilized emission values using the ACE calculator and emission values opened by Porter et al. (2016).

Table 1: GHG Emissions at the Production Stage by Food Items

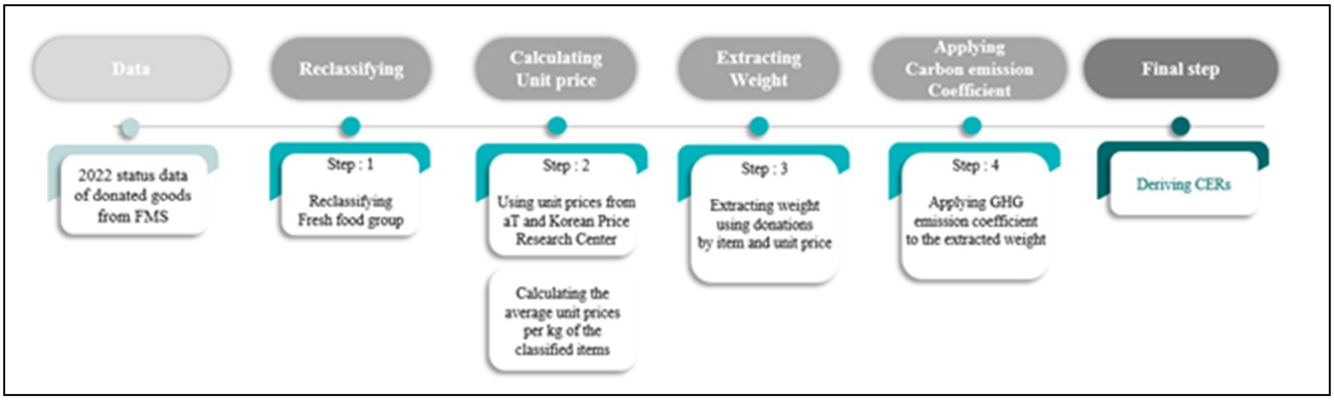
Food item	Sub-item	Weight	GHG emissions at the production stage ($kgCO_2$-eq/kg)		Note
Grains & Legumes	Paddy rice	0.8669	0.4750	0.7683	3)
	Sticky rice	0.0546	0.4750		Equivalent to paddy rice
	Barley	0.0279	0.630		2)
	Legume	0.0387	0.530		3)
	Other grains	0.0120	1.090		3)
Meats	Beef	0.3570	44.710	6.6117	1)
	Pork	0.4361	3.260		1)
	Chicken	0.1811	3.100		1)
	Other meats	0.0258	6.0356		3)
Fish and shellfish & Seaweeds			2.7700		2)
Milk			0.2099		2)
Eggs			2.0100		
Fruits	Apple	0.0717	0.1700	0.3524	2)
	Pear	0.0922	0.3500		2)
	Peach	0.0767	0.3500		2)
	Grape	0.0722	0.6200		2)
	Persimmon	0.0504	0.3500		2)
	Citrus	0.2056	0.1700		2)
	Korean melon	0.0996	0.3500		2)
	Watermelon	0.0930	0.3500		2)
	Strawberry	0.0534	0.3500		2)
	Banana	0.1562	0.3500		2)
	Other fruits	0.0928	0.3500		2)
Root and tuber crops & Vegetables			0.3800		3)
Oil-plants			1.1000		2)

Note: 1) Percentage of consumption that is expenditures of the Household Survey in Korea converted to weight (using raw data from Ju et al., 2020). 2) Average value of sub-items within the same item. 3) GHG emissions data from the Foundation of Agri, Tech, Commercialization & Transfer (2012).
Source: Written by authors based on FAO (2019); Foundation of Agri, Tech, Commercialization & Transfer (2012); Ju et al. (2020); Porter et al. (2016).

3.2. Methods

3.2.1. Fresh Food

The analysis was conducted in the following steps to derive the GHG emissions avoided through donated fresh food. First, we reclassified individual donated food products in the FMS by the middle classification of food products. Then, we calculated the unit price per kg for the wholesale price (unit price) of each food item using the unit price of aT and the Korean Price Research Center. We converted the weight of each donated item into kg by dividing the donation amount for each donated item in the FMS by the unit price per kg. Finally, the GHG emission coefficient for each donated item were applied to the weight of each donated item to calculate the GHG emissions of each donated item (Figure 1).

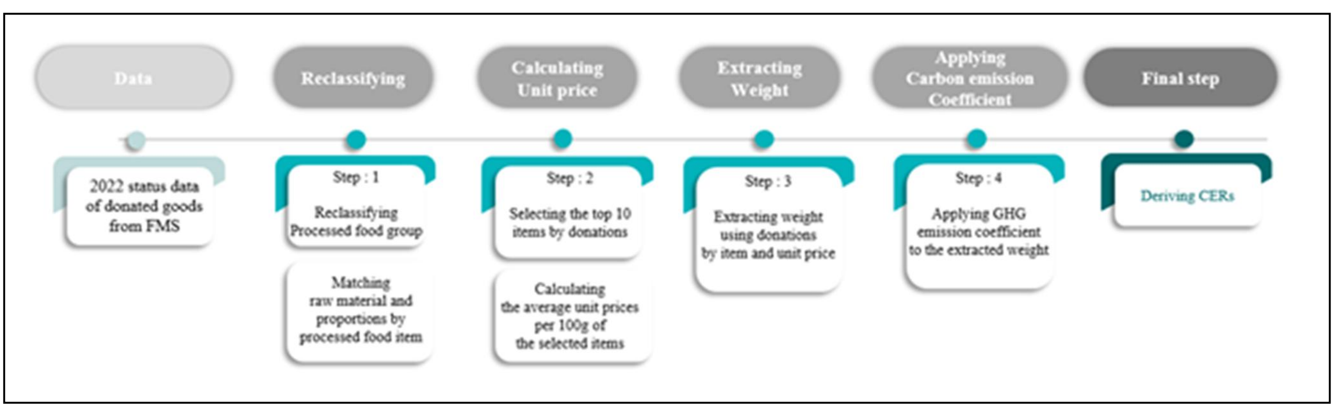


Source: Written by authors

Figure 1: Steps to draw GHG Reduction Effects from Fresh Food Donations

3.2.2. Processed Food

To determine the carbon emission reduction effect of donated processed food, we first matched the items donated to the food bank with the item classification of the Survey on Raw Material Consumption in Each Food Industry Sector and categorized the main input materials by item classification. To extract the average unit price of each item, the top 10 donated items were counted based on the donation amount (book value), and the average unit price per 100 grams (g) of the 10 items was calculated using the recommended retail price and weight of each item (Appendix 1). Next, the total donation amount (the sum of the book value) per item was divided by the average value of the unit price per 100g of each item derived earlier to derive the weight of the donated amount in kg. The weight in kg of processed food items was reclassified according to the weight of input raw materials, and the carbon emission coefficient values were applied to each input raw material to calculate the effect of carbon emission reduction by donating the processed food items (Figure 2).



Source: Written by authors

Figure 2: Steps to draw GHG Reduction Effects from Processed Food Donations

4. Analysis Results

4.1. The Effect of Carbon Emission Reduction by Reducing Fresh Food Waste

The effects of carbon emission reduction by donating fresh food to food banks were calculated, and a total of 3,081,307 kgCO_2-eq of carbon emission reduction was derived. Among them, the amount of carbon reduced through the donations of meats was 1,122,293 kgCO_2-eq, accounting for 36.4%, the largest share, followed by grains (878,768 kgCO_2-eq), root and tuber crops and vegetables (549,161 kg CO_2-eq) (Table 2).

Table 2: Calculated Results of the Effect of Carbon Emission Reduction by Fresh Food Item

Unit: kgCO_2-eq

Item	The effect of carbon emission reduction
Meats	1,122,293
Fruits	531,085
Grains	878,768
Root and tuber crops & Vegetables	549,161
Total	**3,081,307**

Source: Written by authors

When looking at meats in detail, beef donations accounted for the highest GHG reduction at 445,480 kg CO_2-eq. The reason why beef has the highest GHG reduction among meat items is due to its high GHG emission coefficient (16.649 kgCO_2-eq/kg), even though the weight of beef donated (26,757 kg) is lower than other items. When breaking down grains, the GHG reduction from the donation of paddy rice is the highest at 778,191 kgCO_2-eq. The GHG emission coefficient of paddy rice is similar to that of other grain items, but the weight of the donation is large enough to account for about 85% of the total (Table 3).

Table 3: Detailed Results of the Effect of Carbon Emission Reduction in Fresh Food

Unit: KRW(unit price), kg(weight), kgCO_2-eq/kg(GHG emission coefficient), kgCO_2-eq(Carbon emission)

Category		Unit price	Weight	GHG emission coefficient	Carbon emissions
Meats	Beef	64,350	26,757	16.649	445,480
	Pork	6,103	181,458	0.9746	176,849
	Chicken	3,556	469,790	0.4835	227,144
	Egg	1,808	316,515	0.5808	183,832
	Other meats	18,954	14,744	6.0356	88,988
	Total	-	1,009,265	-	1,122,293
Fruits	Apple	4,950	17,779	0.17	3,022
	Pear	4,002	23,445	0.35	8,206
	Peach	3,573	16,076	0.35	5,626
	Grape	4,073	10,094	0.62	6,258
	Persimmon	1,904	169,014	0.35	59,155
	Citrus	4,949	20,970	0.17	3,565
	Korean melon	2,771	10,064	0.35	3,522
	Watermelon	2,802	16,100	0.35	5,635
	Strawberry	13,750	520	0.35	182
	Banana	1,602	944,449	0.35	330,557
	Other fruits	4,210	301,017	0.35	105,356
	Total	-	1,529,527	-	531,085
Grains	Paddy rice	2,020	984,056	0.7908	778,191
	Legume	4,606	38,713	0.37	14,324
	Other grains	3,313	133,642	0.6454	86,253
	Total	-	1,156,411	-	878,768

Category		Unit price	Weight	GHG emission coefficient	Carbon emissions
Root and tuber crops & Vegetables	Beet & Basil	2,987	1,061	0.3	318
	Lettuce	2,716	264,137		79,241
	Spinach	2,987	1,899		570
	Eggplant	4,422	1,139		342
	Sweet potato	4,422	19,692		5,908
	Peppers & Chili leaf	4,615	5,381		1,614
	Radish	631	210,562		63,169
	Carrot	1,712	11,669		3,501
	Taro	631	647		194
	Cucumber	1,526	17,419		5,226
	Wild Herb	2,987	246,475		73,942
	Chinese cabbage & Kale	2,987	413,372		124,012
	Onion	721	300,374		90,112
	Spinach	2,987	16,203		4,861
	Tomato	1,912	58,325		17,498
	Garlic	6,323	1,365		410
	Mushroom	1,994	19,430		8,829
	Bell pepper & Paprika	3,770	16,121		4,836
	Potato	1,399	50,686		15,206
	Corn	1,500	30,059		9,018
	Outer leaf	2,987	144		43
	Sesame seed & sesame leaf	8,384	4,370		1,311
	Water parsley & Bok choy	2,987	2,607		782
	Peanut	13,629	2,275		682
	Broccoli	2,963	23,150		6,945
	Red cabbage	1,006	35		10
	Pumpkin	2,264	12,469		3,741
	Ginger	7,189	976		293
	Soybean	5,638	612		26,548
	Total		1,732,654	-	549,161

Note: Extracted from agricultural distribution information of the aT. For detailed items that do not have a published unit price, the unit price of similar varieties of vegetables was used for analysis.
Source: Written by authors

4.2. The Effect of Carbon Emission Reduction by Reducing Processed Food Waste

The effect of carbon emission reduction by donating processed food totaled 65,103,281 kgCO_2-eq. Of this total, 61,215,623 kgCO_2-eq of carbon emission reduction were attributable to the donation of substitute foods (bread), accounting for more than 90% of the total reduction. Processed livestock products (1,173,421 kgCO_2-eq) accounted for about 2%, and processed fishery/soft foods (673,875 kgCO_2-eq) accounted for 1.0% (Table 4).

Table 4: Calculated Results of the Effect of Carbon Emission Reduction by Processed Food Item

Unit: kgCO_2-eq

Item	The effect of carbon emission reduction
Substitute foods (bread)	61,215,623
Beverages	264,614
Other processed foods	564,461
Snacks	347,716
Ready-to-eat/convenience foods	542,711
Seasonings	94,450
Dairy Products	85,294

Item	The effect of carbon emission reduction
Health foods	4,137
Fishery/soft foods	673,875
Processed livestock products	1,173,421
Processed fishery products	53,391
Powders	7,654
Pickled/fermented foods	74,378
Pastes and cooking oils	1,556
Total	**65,103,281**

Source: Written by authors

In detail, the carbon emission coefficient of substitute foods (bread) is similar to that of other items, but its weight of 71,338,067 kg is high enough to account for about 94% of the total weight of 75,227,324 kg of processed food donated, so the GHG reduction effect is also significant. Processed livestock products, which accounted for 2% of the carbon emission reduction of processed foods, had a lower donated weight (239,229 kg) than other categories, but the reduction amount was higher due to the high GHG emission coefficient of the input raw material. In particular, the GHG emission of beef is 22.089 $kgCO_2$-eq/kg, which is more than 20 times higher than that of other raw materials (white sugar, 0.836 $kgCO_2$-eq/kg) (Table 5).

Table 5: Detailed Results of the Effect of Carbon Emission Reduction in Processed Food

Unit: KRW(unit price), kg(weight), $kgCO_2$-eq/kg(GHG emission coefficient), $kgCO_2$-eq(Carbon emission)

Category①	Category②	Unit price	Weight	Input raw material	ratio (%)	GHG emission coefficient	Carbon emissions	Total carbon emissions
Substitute foods (bread)	breads	1,653	71,338,067	Wheat flour (flour)	63.4	1.009	45,635,389	61,215,623
				White sugar	8.7	0.836	5,188,560	
				Egg	5.4	2.010	7,743,034	
				Red bean paste	3.4	1.092	2,648,640	
Beverages	Beverages	2,448	421,214	White Sugar	26.9	0.836	94,724	264,614
				Fructose	23.9	0.836	84,160	
				Concentrated fruit and vegetable juices	11.3	0.836	39,791	
				Apple	8.9	0.17	6,373	
				Soybean oil	7.9	1.189	39,565	
Other processed foods	Other processed foods	3,705	764,485	Starch syrup	42.3	0.836	270,343	564,461
				Peanut	19.6	1.092	163,624	
				Palm oils	10.7	1.189	97,260	
				White sugar	5.2	0.836	33,234	
Snacks	Snacks	2,645	577,748	Wheat Flour(Flour)	30.0	1.009	174,884	347,716
				White sugar	20.2	0.836	97,566	
				Potato	8.9	0.156	8,021	
				Rice bran	6.1	0.836	29,463	
				Palm oils	5.5	1.189	37,782	
Ready-to-eat/ convenience foods	Ready-to-eat foods	2,751	455,445	Rice	42.3	0.470	90,547	542,711
				Pork	16.2	3.258	240,382	
				Chicken	15.0	3.100	211,782	
Seasonings	Seasoned foods	4,495	114,113	Rice	20.9	0.470	11,209	94,450
				Dried Chili Pepper	17.9	3.430	70,062	
				Refined salt	9.8	0.201	2,248	
				Wheat flour(flour)	5.6	1.009	6,448	
				White sugar	4.7	0.836	4,484	

Category①	Category②	Unit price	Weight	Input raw material	ratio (%)	GHG emission coefficient	Carbon emissions	Total carbon emissions
Dairy products	Processed dairy products	2,047	188,049	Raw milk	91.0	0.201	34,396	85,294
				Cheese	2.1	11.260	44,466	
				Soybean oil	1.4	1.189	3,130	
				Glucose	1.2	0.836	1,887	
				White sugar	0.9	0.836	1,415	
Health foods	Health functional food	29,812	31,718	Alcohol	44.3	-		4,137
				Ginseng	13.2	-		
				Glucose	6.4	0.836	1,697	
				Starchy sugars	4.6	0.836	1,220	
				Oligosaccharides	4.6	0.836	1,220	
Fishery/soft foods	Soft foods	504	646,857	Soybeans	95.4	1.092	673,875	673,875
Processed livestock products	Processed meat products	2,115	239,229	Pork	42.3	3.258	329,690	1,173,421
				Chicken	34.6	3.100	256,597	
				Beef	10.5	22.089	554,855	
				Duck	2.0	6.036	28,880	
				White sugar	1.7	0.836	3,400	
Processed fishery products	Dried processed fishery products	4,654	55,275	Laver(raw)	55.4	0.389	11,912	53,391
				(Water)squid	15.7	2.901	25,175	
				Dried laver	10.8	0.389	2,322	
				Pollock (including dried pollock)	8.9	2.790	13,725	
				Sea salt	2.3	0.201	256	
Powders	Flours/ Powders	18,998	9,042	Wheat	55.4	1.009	5,055	7,654
				Corn	35.4	0.645	2,065	
				Wheat flour	4.2	1.009	383	
				Rice	1.8	0.470	76	
				White sugar	1.0	0.836	76	
Pickled/ fermented Foods	Pickles	571	383,631	Radish	86.2	0.120	39,683	74,378
				Sea Salt	3.0	0.201	2,313	
				Synthetic vinegar (glacial acetic acid)	2.6	0.460	4,588	
				Cucumber	1.4	4.339	23,304	
				White sugar	1.4	0.836	4,490	
Pastes and cooking oils	Pastes	1,021	2,451	Soybeans	25.1	1.092	672	1,556
				wheat malt (flour)	22.2	1.009	549	
				Starch syrup	12.5	0.836	256	
				Refined salt	9.0	0.201	44	
				Sea salt	7.0	0.201	34	

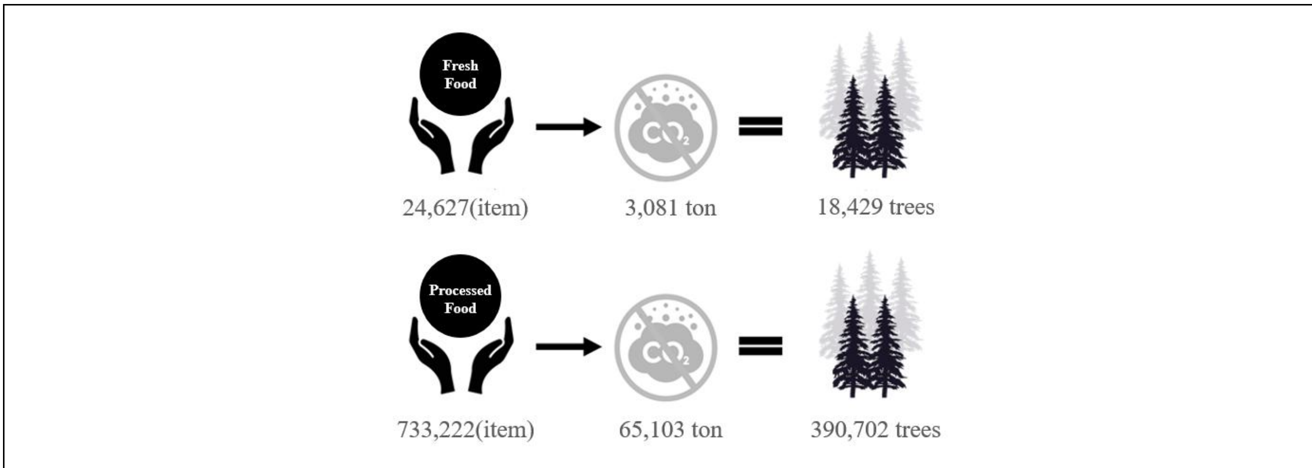
Source: Written by authors using the status data of donated goods from the FMS (category①), 2022 Survey on raw material consumption in each food industry sector (category②, input raw material ratio), Foundation of Agri. Tech. Commercialization & Transfer (2012) (carbon emission coefficient).

5. Conclusion

This study measured the carbon emission effects of donating fresh and processed food to food banks by utilizing the status data of donated goods in food banks as of 2022. The effect of carbon emission reduction through food bank donations of fresh food is 3,081 tons CO_2-eq, which is equivalent to planting 18,429 trees. The carbon reductions from donating processed food to food banks resulted in 65,103 tons CO_2-eq of carbon reductions, which is equivalent to planting 390,702 trees (Figure 3).

As such, the carbon emission reduction analyzed in this study show that carbon emissions have been consistently avoided through the redistribution of donated food since the establishment of food bank.

The proportion of domestically produced agricultural products that are not ultimately consumed is estimated to be around 14% of all food products, and the socio-economic cost of this has emerged as a serious social issue. In order to reduce food waste and carbon emissions, there is a need to move towards 'pre-treatment' practices that prevent food waste from occurring in the first place. Redistributing surplus food products to socially vulnerable populations is one such alternative. In particular, efforts to revitalize and expand food donations are needed to address social integration issues caused by food access gaps and environmental issues related to food waste and GHG. These efforts are expected to be more effective when there is a linkage and collaboration between the relevant ministries, namely the Ministry of Agriculture, Food and Rural Affairs, the Ministry of Health and Welfare, and the Ministry of Environment.



Source: Written by authors based on Hong, Park, Joo, and Yun (2023).

Figure 3: The Effect of Carbon Emission Reduction of Item Production by Donating Fresh and Processed Food

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Appendixes

Appendix 1: Example of Calculating Unit Price per 100g by Item (Calculating the Average Price of Substitute Food(Bread))

Top 10	Item (item, weight)	Recommended retail price (KRW)	Weight (g)	Price per 100g (KRW)	Average price per 100g (KRW)
1	Item1, 60g	2,100	60	3,500	1,653
2	Item2, 360g, four pieces	19,900	2,160	921	
3	Item3, 360g, four pieces	19,900	2,160	921	
4	Item4, 360g, four pieces	19,900	2,160	921	
5	Item5, 380g, four pieces	19,900	2,160	921	
6	Item6, 200g	8,580	540	1,589	
7	Item7, 1kg	8,500	2,000	425	
8	Item8, 78g	24,730	750	3,297	
9	Item9, 270g	10,990	540	2,035	
10	Item10, 300g	5,990	300	1,997	

Note: For the recommended retail price, the author used the price listed on the official website of the item if available, and the retail price listed on Naver Shopping if not available.
Source: Written by authors