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# The Food Crisis in the New Cold War Era and Korea's Response focusing on Food Recycling and Waste Management

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## Abstract

This paper reviews the causes and consequences of the recent world food crises, such as the 2007/2008 world grain price hike, and the subsequent food crises caused by extreme weather, the prevalence of infectious livestock diseases, the COVID-19 pandemic, and the Ukraine-Russian war. The food security situation in Korea is assessed and the measures to prepare for the anticipated food crisis are suggested. Korean Peninsula has been divided into South and North in 1945 and in the state of cease fire since Korean war. South Korea has achieved rapid economic growth over the past half century and its per capita income reached over $30,000. However, its grain self-sufficiency rate has fallen below 20%, making the country the most vulnerable food security nation among OECD countries. The Korea Food Security Research Foundation is urging that a stockpiling of 1.2 million tons of rice in preparation for the unification of the Korean Peninsula and that a free rice support system for low-income households be implemented first in South Korea. The Foundation is carrying out a campaign to reduce food waste and is continuing efforts to reduce food waste by half and increase the food energy self-sufficiency rate of Korea from 32% to 50%. Food recycling and waste management are important policy issues in Korea, and various ministries are taking interest and implementing various projects. This paper introduces examples of food recycling and waste management being implemented by the Korean government and food companies.

Keywords: Global food crisis, Korean food situation, food recycling, waste management

## Causes and consequences of global food crises during last two decades

The world food situation is worsening in the 21st century. The global food crisis is becoming more visible due to frequent and massive climate disasters caused by global warming, the spread of human and livestock infectious diseases and intensifying international conflicts (Lee, 2024).

### (1) The 2007/2008 World Grain Crisis

The 2007/2008 world grain crisis was triggered by the production and use of biofuel in the US encouraged by the US National Biofuels Development Act enacted in 2005. The amount of corn used for bioethanol production in US was increased from18 million tons in 2000 to 40 million tons in 2005, and 100 million tons in 2008, equivalent to one-third of all corn produced in the United States. The international corn prices soared from $100 per ton in 2006 to $170 per ton in 2007, and soared to $280 per ton in 2008. Accordingly, wheat price soared more than doubled from $200 per ton in 2007 to $440 in 2008. Soybean prices doubled from $280/ton in 2007 to $560/ton in 2008. In 2008, the change in rice prices was almost explosive, with Thai long-grain rice rising from $330 per ton to $1,000 per ton, and medium-grade rice from California soared from $600 to $1,100 per ton (Fig. 1). There was an assessment that these grain price fluctuations were partly aggravated by the intervention of international speculative funds. The grain price fluctuations led to restrictions on grain exporting countries, which in turn added to the suffering of poor grain importing countries (Lee 2024).

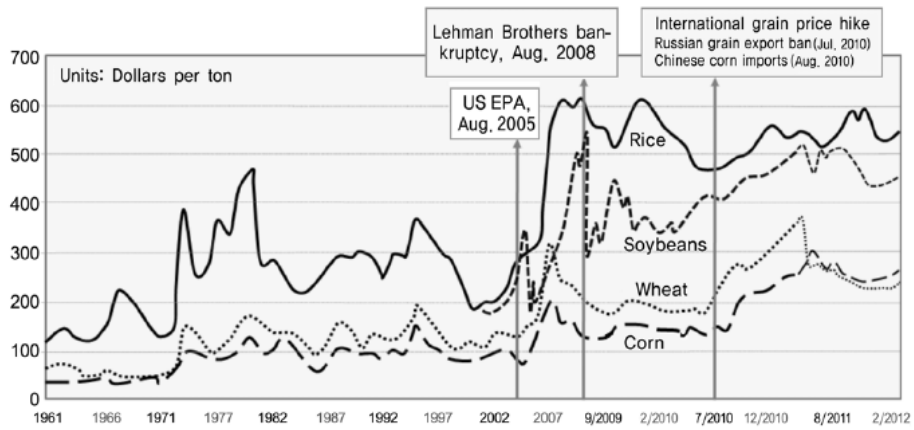



Figure 1. Changes in International Grain Prices (1961- 2012)

### (2) Extreme Weather Disasters in 2010/11

The extreme weather disasters caused by global warming continued after the grain price hike. Since September 2009, five provinces in southwestern China had not seen a single drop of rain for more than half a year. 500 rivers and 310 reservoirs were depleted, the affected area was twice that of the Korean peninsula, and the number of victims reached 20 million (Lee, 2013). In the summer of 2010, Russia's drought and massive forest fires raised international wheat prices from $200 to $300, and Russia imposed a wheat export ban. 13.3 million hectares of farmland (30% of Russia's total grain sown area) were damaged. The estimated damage alone was $1.38 billion. In the same year, a massive flood occurred on the other side of the globe. In July, Pakistan suffered its worst floods in 80 years, submerging 20% of the country and leaving over 20 million people homeless. In December 2010 and January of the following year large-scale flooding occurred in northeast Australia, known as the dry continent. In Queensland alone, 70 towns and cities were submerged, with more than 200,000 injured and 35 dead. The damage was so great that the Australian government collected flood taxes to support the victims. Australia's wheat cultivation was also devastated, rendering exports impossible (Lee, 2024).

Tunisia and Egypt were directly hit. These countries mainly imported wheat, their staple food, from Russia and Australia, but wheat import from these countries was blocked. In January 2011, after 23 years of iron-fisted rule in Tunisia, President Ben Ari escaped the country due to bloody protests from people angry at starvation and tyranny. In January 2011 anti-government protests shouting “bread, freedom and human rights” broke out in Cairo, Egypt, and the President Hosni Mubarak was resigned. Egypt’s coup led to anti-government protests in neighboring Arab countries. On February 12, the day after Mubarak's resignation, thousands of anti-government protests were held in Algeria and Yemen as well. Around 40 riots in Africa and the Middle East since 2000 occurred during a time when food prices soared. Figure 2 shows the countries where food riots occurred and the number of people sacrificed in the riots (Lagi et al., 2011). When food prices skyrocket, especially for the low-income classes, survival itself becomes difficult, so unrest develops more radically than any other kinds of political disturbance. Recently, the frequency and magnitude of meteorological disasters have grown more severe. Grain shocks caused by global meteorological disasters have occurred every seven to eight years, but this cycle has accelerated, occurring almost every year since 2010 (Lee et al., 2016).

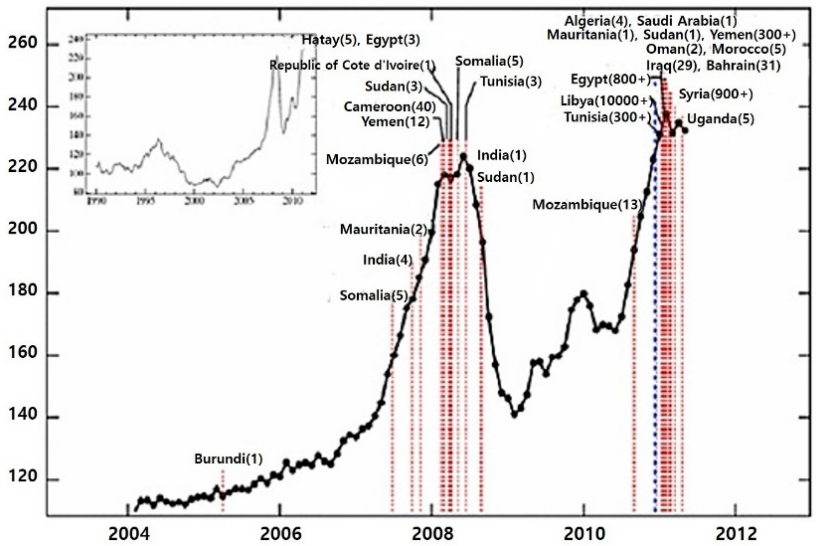



Figure 2. Changes in global food price indices and occurrence of food riots in developing countries (Lagi et.al., 2011).

( ) is the number of deaths

### (3) Prevalence of Livestock Infectious Diseases

One side effect of globalization is the prevalence of livestock infectious diseases. With increasing movement of people among regions and continents come highly contagious livestock diseases on a large scale, bringing enormous damage and economic loss. Representative examples include Foot-and-Mouth Disease (FMD), Avian Influenza (AI), African Swine Fever (ASF), and Bovine Spongiform Encephalopathy (BSE). These infectious diseases are zoonotic and have low transmission power but can infect humans, so they require thorough quarantining. Prevention methods include restrictions on access to and movement from affected areas, disinfection, and stamping out. In Korea all farm animals within a maximum radius of 10 km from the infected farm are subject to preventive slaughter. This method aims to stop the spread of infectious diseases by killing and eliminating all animals that may be virus hosts. Generally, tens to hundreds of thousands of animals are destroyed.

FMD first occurred in Korea in 1934. After 66 years, in 2000 FMD occurred again in May 2002 killing about 160,000 animals nationwide. From 2010 to 2011 as many as 3.5 million cattle and pigs were slaughtered, prompting declaration of a national disaster. The government's excessive stamping-out policy could not maintain South Korea's FMD-free country status.

AI outbreaks occurred in 2004 and 2006 in Korea but the situation calmed down without much

damage. However, in mid-November 2016 the H5N6 type highly pathogenic AI virus was detected and 26.14 million poultry were killed. In 2017 alone 33.8 million ducks died from AI. Since then outbreaks of avian flu have occurred almost every year.

Concerns about ASF inflow into South Korea through wild boars crossing the DMZ (demilitarized zone) increased when ASF broke out in North Korea May 30, 2019. In response the authorities imposed a thorough quarantine, but on September 2019 ASF was detected first at a pig farm in the northern border of South Korea. In May 2022, ten pigs in the northern border were judged ASF positive. According to stamping out regulations 5,614 pigs in the outbreak area were killed and buried. According to the information announced at a meeting in Korea, the numbers of livestock slaughtered as a preventive measure exceeded 70 million from 2011 to 2017. The amount of government compensatory payments was KRW 2.1971 trillion (USD 1.7 trillion) (Lee, 2024). Indeed, the amounts of wasted food are staggering and the economic loss has been enormous.

### (4) **Food crisis caused by the COVID-19 pandemic**

The coronavirus infection (COVID-19) that first occurred in Wuhan, China in December 2019 developed into a global pandemic in just three months, driving the world into an era of fear and a new normal. Concerns about the epidemic caused people to avoid travel, dining out, and public gatherings, disrupting normal work and service schedules. Food industries experienced difficulties in manufacturing, processing, distribution, and transportation. As some food exporting countries increased their own food by stockpiling, red flags signaled the endangered food supplies of importing countries. Concerns about the food crisis grew and attention focused on food security.

The COVID-19 pandemic caused significant changes in food production, supply, and consumption patterns, forcing people to live a new normal of social distancing and non-face-to-face contact. Main causes of the food crisis associated with COVID-19 are export restrictions in grain exporting countries and consumer stockpiling; logistical instability due to manpower supply disruptions; and, income reduction and poverty due to economic recession. The pandemic's most direct impact was production setbacks and logistics disruptions due to manpower shortages. Consequently, food supplies could not be efficiently delivered to places where they were needed. This is why malnutrition and starvation in developing countries and the plight of low-income, vulnerable groups with food shortages are becoming ever more serious. FAO has estimated that the world's number of undernourished people will increase by 15% from the previous year to 810 million in 2020, and that

the current number of undernourished people is 2.4 billion (FAO, 2021).

### (5) Ukraine war and food weaponization

Concerns about the global food crisis are becoming reality as the war between Russia and Ukraine continues longer than expected since Russian invasion of Ukraine in February 24, 2022. These nations are major food exporters accounting for 27% of global wheat exports, 19% of maize exports, and 80% of sunflower oil exports. When Ukraine and Russia went to war at the end of February 2022 world wheat prices rose by 37% and corn prices by 12% in one month. Year-over-year prices were 72.2% for wheat and 35.3% for corn. Soybeans rose by 18.1% (Table 1) (Lee, 2024). Russia suspended exports of sugar and major grains such as wheat and barley, along with the export of wheat, barley and corn to the Eurasian Economic Union (EEU: Russia, Kazakhstan, Belarus, Armenia, and Kyrgyzstan) until June 30, 2022. Ukraine banned exports of wheat, oats, sorghum and meat until the end of 2022. Responding to the food crisis, Egypt banned wheat, flour and soybean exports; Hungary immediately suspended all grain exports. Turkey also tightened grain export controls and Indonesia tightened restrictions on palm oil exports. The situation caused many countries around the world, including China, have hoarded grain and stopped exporting food, making it difficult to obtain grain in the world market. The shock was even greater because it occurred while food prices were rising for more than two years due to the Covid-19 pandemic.

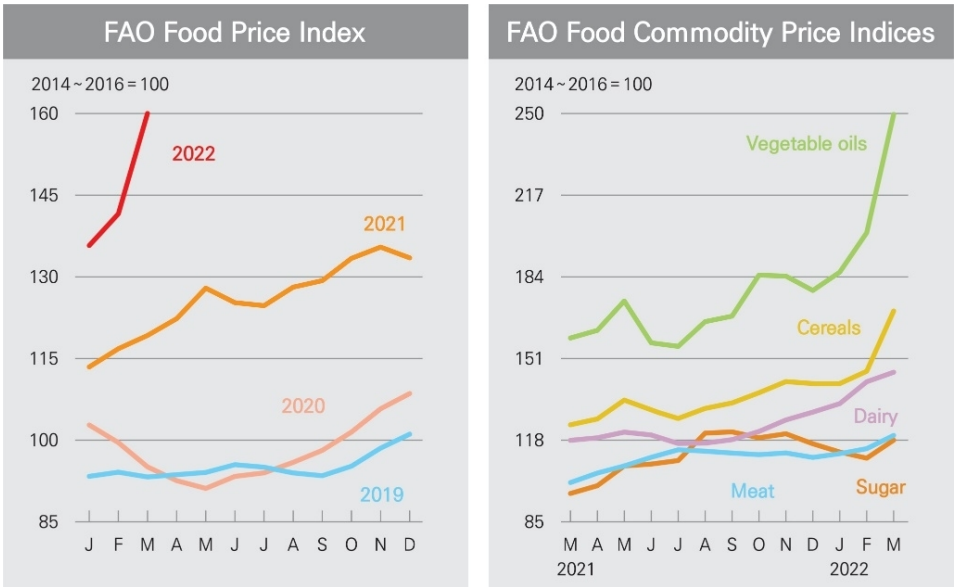
Table 1. Changes in grain prices due to war in Ukraine and drought in South America

(Unit: USD/ton)

| | **March 14, 2022** | Last Year | Average Year | Changes compared to | |
|---|---|---|---|---|---|
| | | | | Last Year | Average Year |
| Wheat | 403 | 234 | 180 | 72.2% | 123.9% |
| corn | 295 | 218 | 147 | 35.3% | 100.7% |
| Soybean | 614 | 520 | 361 | 18.1% | 70.1% |

Source: Chicago Futures Exchange (May) / 5-year average excluding average year maximum and minimum

Figure 3 shows the change in the world food price index announced by FAO. The overall food price index in Figure 3(A) rose from 100 to 135 during the COVID-19 pandemic, rising sharply again to




157 in March 2022 when war broke out in Ukraine. By item, the vegetable oil price index showed the greatest rise, from 200 to 250, followed by the grain price index from 150 to 170 (Figure 3B).

(A) Total food (2019-2022) (B) Food items (2021.3.-2022.3.)

Figure 3. Changes in global food price indices due to COVID-19 and the war in Ukraine

### (6) New Cold War and Trump's Tariff War

It is generally believed that the Old Cold War ended with the dissolution of Soviet Union in 1991 under the Mikhail Gorbachev's leadership. Russia's Boris Yeltsin regime accepted wrong advice from the IMF and the national economy collapsed. Subsequently, Vladimir Putin was elected as official president of Russia. Although Russia was expected to fall, the nation recovered with high oil prices while the US drained its power in the war against terrorism under George W. Bush. In 2008 the US that drove her capitalist tide became the epicenter for a financial crisis that rocked the world. Subsequently, it suffered a downgrade in its national credit rating. Cracks arose in the confidence of a country that had once trumpeted *laissez-faire* capitalism founded in neoliberal economic theory. Exposure of these loopholes in the liberal democratic system was a chance to revive the positions of anti-democratic states China and Russia. While the Barack Obama administration in the United States focused on overcoming the aftermath of the Great Recession triggered by the subprime mortgage crisis and checked Russia rigorously from 2014 onwards, it rather neglected China's growth. Xi Jinping in China began rebelling against the West using China's economic growth and an authoritarian New Order. The prevailing view is that the new Cold War began with the end of the post-Cold War

period which began in 1991 and ended in 2008. Conventionally, the end of the post-Cold War is divided into two possibilities, namely the Beijing Olympics, the war in South Ossetia, and the Great Recession of 2008, and the start of the US-China trade war in 2018. The critical limit is the war in Ukraine, which began in 2022. The tension in the North Atlantic Ocean since 1940s is now moving to North Pacific region due to the conflict between US and China which is allied with Russia and North Korea. Korea and Japan will be situated at the center of the turmoil, and severe food crisis is anticipated in the two countries where most of food is imported from the US and China.

Some define the new Cold War as a world structure that has changed from the previous ideological struggle between liberal democracy and communism to systemic competition between a civilized society of autonomy and diversity (or inclusive political system) and an anti-civilized society of control and rigidity (exploitative political system) (Acemoglu and Robinson, 2012: Lee, 2013). However, it seems clear that today's world situation, in which the authority of the superpower is weakening and Trump's America First policy is heading toward a tariff war, will aggravate the uncertainty about the future and Korea's food security.

## Food security situation in Korea

Korean Peninsula has been divided into South and North after the World War II in 1945, and the liberal democratic South Korea and communistic North Korea have been confronting each other in the state of cease fire by the Armistice Agreement since Korean war (1950-1953). The area of the Korean Peninsula is 223,404 $km^2$, and about 70% is mountain area. The area of South Korea is 100,449 $km^2$, and the agricultural land area is 1.52 million hectares, which is 15.1% of the total land as of 2023. To achieve the government's grain self-sufficiency rate target of 32% by 2020, at least 1.75 million hectares of arable land was needed. However, it decreased to 1.565 million hectares. Notably, the decrease in farmland use, from 140% in 1975 to 107% in 2020 due to the rice production control policy, indicates that farmers' desires to increase food production has declined significantly (Figure 4) (MAFRA, 2023; Lee 2024).

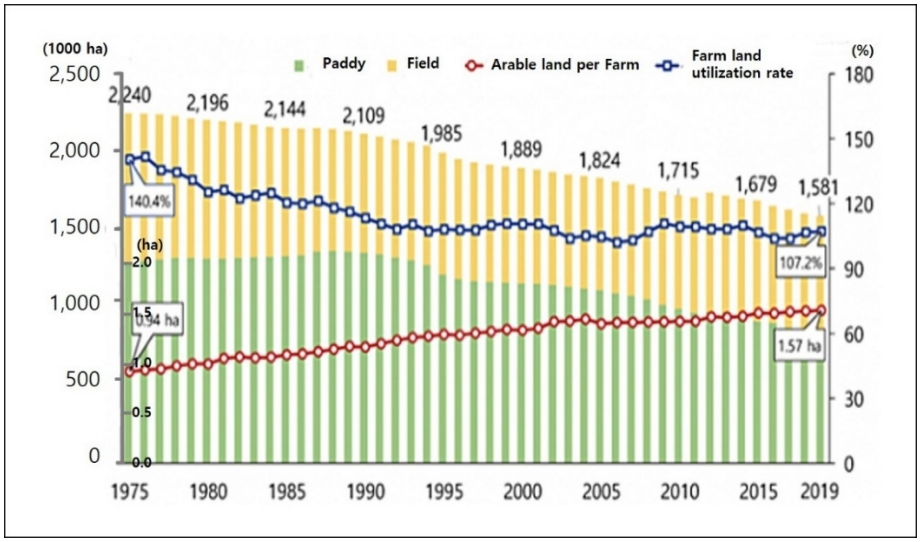



Figure 4. Changes in arable land area (paddy, field), arable area per farm household, and arable land utilization rate in Korea

Source: Korea Agricultural Newspaper (2021.3.3.)

The average agricultural area per person in South Korea is 0.04 hectares, which is only 16% of the world average of 0.24 hectares. It is significantly lower than that of China (0.10 ha/person) or the United States (0.66 ha/person). On the other hand, the population of Korea is 51.71 million as of 2023, and the farming population is only 4% of the total. Korea's population density is 515.4/km2, the highest among OECD countries. As of 2021, Korea's grain self-sufficiency rate is estimated to 18.5%, and its food energy self-sufficiency rate is 32.0%. The daily nutrient supply of Korean is estimated to be Energy 3,156 kcal, Protein 113.3g, and Fat 123.6g per person as of 2021 (Table 2) (MAFRA, 2023).

Table 2. Food Security Situation in Korea

Total area of Korean Peninsula – 223,404 $km^2$ (North 123,138 $km^2$, South 100,449 $km^2$)

Agricultural land in South Korea (2023)- 1.52 million ha. (15.1% of total land)

Arable land per capita (2023)- 0.04 ha (World average 0.24 ha. China 0.10 ha, USA 0.66 ha)

Population in South Korea (2023)- 51.71 million (Farm household population 2.09 million, 4%)

Population density (2023)- 515.4/$km^2$ (Highest among the OECD countries)

Nutrient self-sufficiency rate (2021)- Energy 32.0%, Protein 41.3%, Fat 19.4%

Daily Per capita Nutrient supply (2021)- Energy 3,156 kcal, Protein 113.3g, Fat 123.6g

Grain self-sufficiency rate (2021)- 18.5% (Rice 84.6%, Wheat 0.7%, Maize 0.8%, Soybean 5.9%)

Grain import, million M/T (2022)- Wheat 4.405 (1.717), Maize 11.809 (9.489), Soybean 1.302 (0.984)*

Food Security Index (2021)- 71.6 (rank 32 from the top) (Source: Economist 2021)

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*( ) for animal feed, Source: MAFRA, 2023

Figure 5 shows trends in food self-sufficiency rates in Korea and Japan. In 2000 Korea's grain self-sufficiency rate was 29.7% and Japan's was 28%. By 2016, after 15 years, the Japanese grain self-sufficiency rate increased by 1% to 29% (Ko JM et al., 2017), while South Korean grain self-sufficiency decreased to 21.8% in 2018, and further decreased to 18.5% in 2021. In terms of changes in calorie self-sufficiency rates the difference between Korea and Japan is more evident. Japan endured 15 years of almost no change from 40% in 2000, maintaining 39% in 2016, down 1%. However, in South Korea the rate fell from 51% in 2000 to 35.1% in 2018, and further decreased to 32% in 2021.

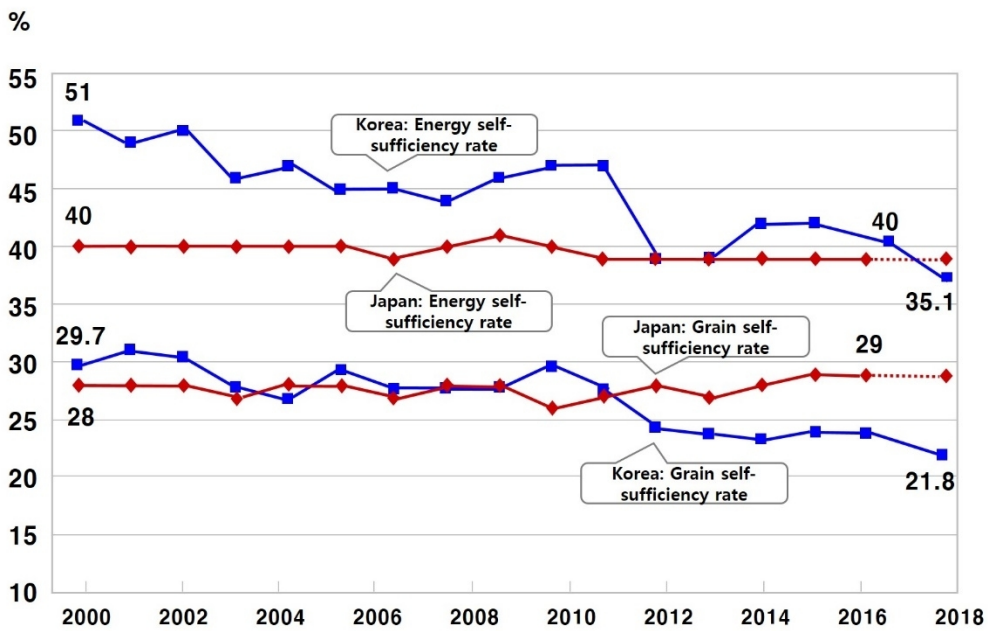


Figure 5. Changes in food self-sufficiency rates in Korea and Japan (2000-2018)

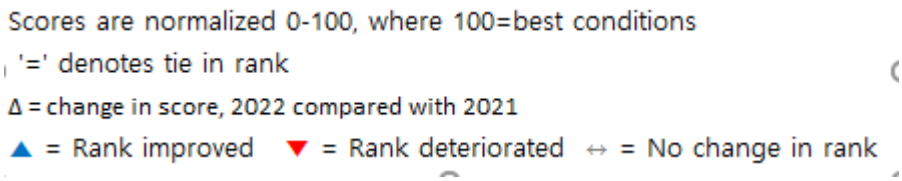
Source: Food supply and demand tables in Korea and Japan (Ko JM. et al., 2017)

Korea's rice production is sufficient to meet domestic demand, but the self-sufficiency rate does not exceed 90% due to the WTO mandatory import amount (400,000 tons per year). The self-sufficiency rate of major grains other than rice is less than 5%. Korea's annual rice production is about 3.8 million tons, while imported grains amount to 4.4 million tons of wheat, 11.8 million tons of corn, and 1.3 million tons of soybeans. Most of the imported grains are used as feed (Table 2).

Despite this uneconomical and vulnerable food structure, according to 2022 EIU report Korea's food security index ranking was 39$^{th}$ in 113 countries and the food security environment overall Score was 70.2 (Table 3) (Economist Intelligence Unit, 2022).

Table 3. 2022 Global Food Security Index Ranking (Economist Intelligence Unit, 2022)

| FOOD SECURITY ENVIRONMENT | | | | | FOOD SECURITY ENVIRONMENT | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Rank / 113 | | | Score | Δ | Rank / 113 | | | Score | Δ |
| 1 | ↔ | Finland | 83.7 | +1.0 | 21 | ▼1 | Poland | 75.5 | +0.5 |
| 2 | ↔ | Ireland | 81.7 | +0.1 | 22 | ▲15 | Australia | 75.4 | +4.7 |
| 3 | ▲5 | Norway | 80.5 | +2.1 | 23 | ▲3 | United Arab Emirates | 75.2 | +1.6 |
| 4 | ▲5 | France | 80.2 | +1.9 | 24 | ▲3 | Israel | 74.8 | +1.7 |
| 5 | ▼2 | Netherlands | 80.1 | +0.2 | =25 | ▼2 | Chile | 74.2 | -0.2 |
| 6 | ▼2 | Japan | 79.5 | 0 | =25 | ▲14 | China | 74.2 | +3.6 |
| =7 | ▼3 | Canada | 79.1 | -0.4 | 27 | ▼2 | Italy | 74.0 | -0.1 |
| =7 | ▲4 | Sweden | 79.1 | +1.4 | 28 | ▲1 | Singapore | 73.1 | +0.3 |
| 9 | ▼3 | United Kingdom | 78.8 | -0.5 | 29 | ▲3 | Bulgaria | 73.0 | +0.8 |
| 10 | ▲7 | Portugal | 78.7 | +1.7 | 30 | ▼9 | Qatar | 72.4 | -2.2 |
| 11 | ▼1 | Switzerland | 78.2 | +0.2 | 31 | ▼1 | Greece | 72.2 | -0.3 |
| 12 | ▼1 | Austria | 78.1 | +0.4 | 32 | ▲5 | Kazakhstan | 72.1 | +1.4 |
| 13 | ▼6 | United States | 78.0 | -0.7 | 33 | ▲9 | Uruguay | 71.8 | +2.6 |
| =14 | ▲1 | Denmark | 77.8 | +0.5 | 34 | ▲11 | Hungary | 71.4 | +2.9 |
| =14 | ↔ | New Zealand | 77.8 | +0.4 | 35 | ▼4 | Oman | 71.2 | -1.1 |
| 16 | ▲2 | Czech Republic | 77.7 | +1.1 | 36 | ▼1 | Slovakia | 71.1 | +0.1 |
| 17 | ▲5 | Belgium | 77.5 | +3.0 | 37 | ▼10 | Peru | 70.8 | -2.3 |
| 18 | ▼7 | Costa Rica | 77.4 | -0.3 | 38 | ▲2 | Bahrain | 70.3 | +1.0 |
| 19 | ▼4 | Germany | 77.0 | -0.3 | 39 | ▲5 | South Korea | 70.2 | +1.3 |
| 20 | ▼2 | Spain | 75.7 | -0.9 | 40 | ▼16 | Panama | 70.0 | -4.2 |




The Korean GFSI ranking is decreasing every year. Compare to 2012 GFSI ranking of Japan 16th, Korea 21st, and China 38th, 2022 ranking is Japan 6th, China 14th, and Korea 39th. The reason for the Korea's downward ranking is mainly due to the inconsistency in Korea's food policy.

## Proposals for the enactment of Food Security Law in the Republic of Korea

The Korea Food Security Research Foundation (KFSRF) conducted research on the development of a model for the National Food Security Law and announced the drafting of the Special Law on Food Security in October 2022 (KFSRF, 2022; Lee, 2024). Since food security is a matter of national security comparable to national defense, related ministries must be led consistently by the National Food Security Committee under the Prime Minister's office. The Foundation proposed the following action plan on top of this strengthened food security system.

(1) Free rice support system for crisis management of the low-income vulnerable class
(2) Legislation of 1.2 million tons of rice stockpiling in preparation for the Korean unification
(3) Expansion of grain storage facilities and construction of food complexes
(4) Reinforcing government support to expand raw material inventory of private companies
(5) Support for food self-sufficiency and target responsibility system
(6) Reinforcing support for overseas grain distribution business by private companies
(7) Reinforcement of overseas agricultural cooperative projects with private companies
(8) Research support and utilization of biotechnology
(9) Fostering of the food industry and advancement of Food Tech
(10) National movement to reduce food waste

## Food recycling and waste management in Korea

### (1) The state of food waste in Korea

As the world experiences repeated food crises, there is growing global consensus on the importance of a stable food supply and the need to reduce food waste. In Korea, which relies heavily on imported food, food self-sufficiency and food security cannot be discussed without improving the current intemperate eating behavior in which 1/3 of food supplied is discarded as waste. Looking at Figure 6, before 1970 when food was scarce, the actual energy intake surveyed in the National Nutrition Survey was higher than the per capita food energy supply. This is because when food is scarce, much food that is not caught in statistics is procured from the surroundings and eaten. Since 1970, however, this has reversed, with intakes less than supplied. In other words, as food imports become consistent and food shortages were resolved, the phenomenon of food waste appeared. The gap between supply and intake gradually widened; in the 2000s, daily energy supply per person was 3000 kcal, but the calorie intake was only 2000 kcal. This indicates that one-third of food supplied is wasted (Lee, 2024).

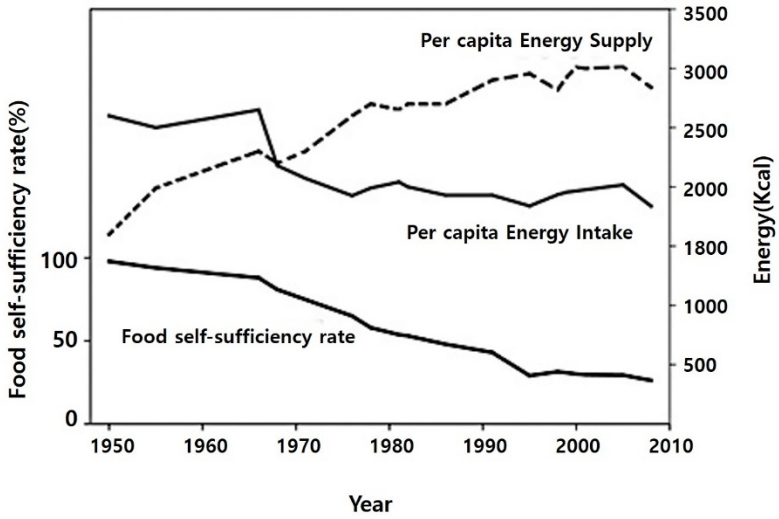



Figure 6. Annual changes in energy supply and actual energy intake per person per day and changes in food self-sufficiency rate

Food loss and waste occurs in the entire process from production to storage, processing, distribution, and consumption, and can be reduced only with the interest and efforts of the people involved in all of these processes. As of 2019, the annual amount of agri-food waste in South Korea is estimated at 5 million tons, and the amount of waste generated during distribution and cooking is the largest at 57% of the total amount, and the amount of waste due to leftover food accounts for 30%.

The amount of agri-food waste discarded during storage due to expiration dates or freshness issues accounts for 9%, and the amount of waste discarded due to uneaten food accounts for approximately 4% (Hong et al. 2021).

The average daily amount of agri-food waste is estimated at 14,314 tons, and the amount of waste per person is estimated at 270g/day. The annual amount of agri-food waste per person is estimated at 110 kg, with 71 kg being discarded at home, 26 kg at food service establishments, and 13 kg at retail store. These figures are not much different from the OECD average. The annual per capita food waste in Japan and China is reported to be 88 kg and 126 kg, respectively (Hong et al. 2021).

### (2) Korean government's action

The characteristics of Korean food culture, which considered the abundance of side dishes and the abundance of soup dishes as virtues, resulted in not only food waste but also the problems of bad odor and pollution, and the Ministry of Environment has continued its efforts to solve these problems. In particular, stronger regulations were required to solve the problems of bad odor and leachate, and a provision prohibiting direct landfill was established in the Waste Management Act in 1997, and in 2005, separate disposal system was implemented nationwide, resulting in an increase in the amount of recyclable food waste that was separated and disposed of (Table 3) (Chae et al., 2016; Hong et al. 2021) . In order to suppress the increase in food waste generated by separate disposal, it was decided to implement a volume-based waste fee system in the household sector starting in 2009. In order to suppress the generation of food waste in non-household businesses (restaurants and cafeterias), guidelines on reduction methods were distributed for each sector, and various waste reducing programs were operated in cooperation with other ministries (Ministry of Public Administration and Security, Ministry of Agriculture, Forestry and Fisheries, Ministry of Food and Drug Safety, and etc.). The Basic Law on Resource Circulation was enacted in 2016, and implemented by the first basic resource circulation plan (2018-2027).

Table 3. Korean government's action to reduce food waste

1997 Enactment of the Waste Management Act

1998 Ministry of Environment's Food Waste Reduction and Recycling Basic Plan

2002 Establishment of Standards for manufacturing and use of food waste for feed products

2005 Nationwide Implementation of waste separation and disposal system

Prohibition of direct landfill of food waste

2008 Establishment of measures to convert waste resources and biomass into energy

2009 Volume-based disposal fee system for household food waste

Guidelines for reducing food waste in restaurants and catering establishments

2013 Nationwide implementation of Food waste volume-based disposal fee system

2016 Prohibition of ocean discharge of wastewater and sewage

Enactment of Basic Law on Resource Circulation

2018 The First Basic Resource Circulation Plan (2018-2027)

2024 Implementation of consumption date (Use-by) labeling system (KFDA)

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Looking at the methods of food waste disposal, as of 2016, landfilling was reported to be 2.5%, incineration was 7.3%, and recycling was 90.1% (Joint Ministry, 2016). Food waste recycling methods are divided into feed, composting, and biogas production (Figure 7). It is estimated that animal feed accounts for 42%, composting accounts for 35%, and other methods such as biogas production account for 22% (as of 2019). Food waste feed is divided into wet feed and dry feed. According to the Feed Management Act, wet feed cannot be given to poultry such as chickens and can only be used as feed for pigs. Feeding wet feed to poultry is only allowed if it is dried to a moisture content of 14% or less.

In the case of food waste feed, a strict management system at the certification level is needed to manage the entire process from discharge to feeding to livestock. Animal welfare groups are against the act of bringing food waste directly and feeding it to livestock. The use of wet food waste feed has been banned since the outbreak of African swine fever in 2022.

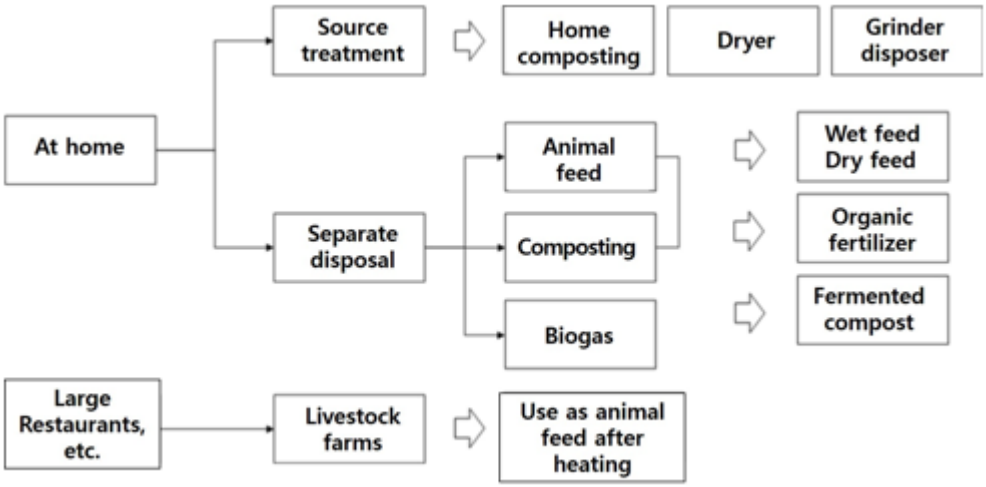


Figure 7. Food waste recycling method in Korea

The existing policies that have been promoted so far have been limited to a post-facto approach focused on the issue of food waste disposal. It is necessary to emphasize on the food waste reduction policy (Hong et al., 2021). For example, the expiration date labeling (sell-by) system, which encourages unnecessary waste of food, is being changed to a consumption date (use-by) labeling. After a long period of discussion, the Ministry of Food and Drug Safety revised the Food Act in 2022 to change the expiration date labeling of food to a consumption date labeling, and it went into effect on January 1, 2024.

### (3) Private sector activities to reduce food waste

Food companies are expanding their efforts to use low-value agricultural products as raw materials for processing, and are actively recycle processing waste to create new food products and raw materials (upcycling). Activities to change consumer awareness and meet social demands to reduce food waste include (a) efforts by large restaurants and catering businesses to reduce food waste, (b) upcycling of food processing by-products and new product development using waste (upcycling) by food manufacturers, (c) discount sales of ugly fruits and vegetables and foods with an impending expiration date by distributors, and (d) activation of food bank.

#### (a) Efforts by large restaurants and catering businesses to reduce food waste

Large restaurants and catering companies are expanding their efforts to reduce food waste in collaboration with national and public agencies. For example, a Korean catering company, CJ Freshway, has been working with the World Food Programme (WFP), a United Nations relief agency,

on the Zero Waste, Zero Hunger (ZWZH) campaign since 2019. In April 2020, the average amount of leftover food at the employee cafeteria at Lotte World, Seoul, was reduced by 16%, and in particular, on Tuesdays when the event was held, the amount of leftover food was reduced by 35% (Food and Restaurant Economy, 2020.06.15).

**(b) Upcycling of food processing by-products**

Recycling food industry byproducts for other food making may have negative perceptions as "reusing discarded products" and trigger unnecessary safety concerns. A representative example is the "garbage dumpling" incident that occurred in Korea in June 2004. A policeman accused dumpling producers who use dried radish slices made from the by-products of pickled radish factory as food adulteration, and the news media reported it as "garbage dumpling incident". After a thorough investigation by the food hygiene authorities, the case was found not guilty. But many dumpling producers went bankrupt already and one business owner committed suicide (Lee, 2005). In this way, the food industry is very cautious about upcycling byproducts. Nevertheless, cases of upcycling food processing byproducts have been increasing recently. OB Beer Company uses beer waste in various products, including yeast extract, energy bars and cosmetics. OB Beer alone produces approximately 60 tons of beer waste annually, and upcycling reduces the environmental burden of billions of won (KRW) annually in processing this waste. Pulmuone, the largest tofu producer in Korea, is also developing new products to upcycle soybean residue and washing water. In addition, many companies manufacture and sell juices, seasonings, snacks, etc. using ugly fruits and vegetables or processed byproducts.

**(c) Discount sales of ugly fruits and vegetables and foods with an impending expiration date**

There are increasing cases of substandard or ugly agricultural products being sold at half price at large retail stores. Most of Korean on-line markets, for example Coupang, CJthemarket, Kirly, Gmarket, have special corner for ugly fruit and vegetables. Uglyus is an online store specializing in eco-friendly, ugly vegetables (www.uglyus.co.kr). They sell eco-friendly produce that, while of the same quality, are out of standard shape or size or lack marketability, in small packages delivered immediately after harvest to the consumer at low prices. Purchasing products of near use-by date or wonky fruit and vegetables at retail stores at less than half the price is becoming a new trend.

**(d) Activation of food bank**

Food banks in Korea began in four regions, including Seoul, following the 1998 IMF foreign exchange crisis. Under the supervision of the Ministry of Health and Welfare and local governments, national and regional food banks operate, with 280 food banks and 127 food markets as of 2015. These food banks primarily receive donations of surplus food from food manufacturing and distribution companies and individuals, and provide food assistance to low-income groups in Korea, such as children who go hungry, elderly people living alone, and people with disabilities, who are struggling due to food and daily necessities shortages. The largest group of food bank users are recipients of basic livelihood security (4,625) and those in the near-poorest bracket (3,368), in that order as shown in Figure 8 (Chae et al., 2016).

A system is needed to protect food donors from food-related accidents caused by donated food (Article 8 of the Food Donation Promotion Act). Recently, "Spoiler Alert," developed at MIT, is attracting global attention as a system that reduces food waste by connecting food donors and recipients in real time using cutting-edge information and communication technologies (ICT) such as the web, smartphone apps, and online markets. http://fortune.com/2015/05/01/how-tech-can-stop-the-looming-food-crisis/

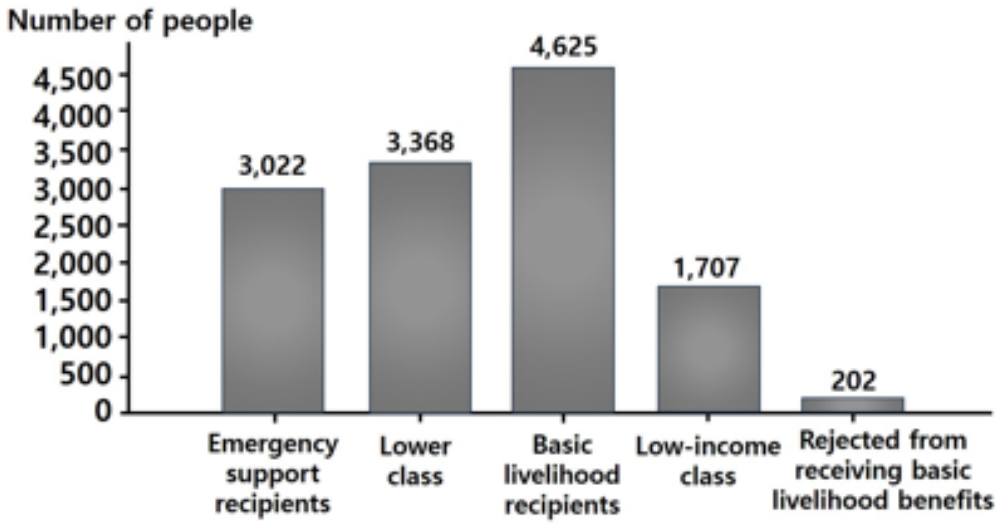


Figure 8. Status of Korean Food Bank Users (2015) http://www.foodbank1377.org

### ⑷ National movement to reduce food waste in Korea

In a country that imports most of its food, the suffering of the impending food crisis will be

severe unless the huge trend of food waste is not corrected. The Korea Food Security Research Foundation has organized a food waste reduction national movement promotion committee in 2019 and is conducting a food waste reduction campaign centered on the food industry. The committee developed working plans for each sector including food supply, processing, distribution, service, waste utilization, regulations and systems, and education and communication. Committee members started a campaign on social media to announce "my food action" to reduce food waste. The purpose statement, the proposal to the government and the national code of action was uploaded on the Foundation homepage (www.foodsecurity.or.kr) (Lee, 2024). The following is the national movement's code of action.

**<National Code of Action to Reduce Food Waste>**

1. Recognizing the importance of food, let us be grateful to those who produce, store, process, cook, and sell food
2. Break the habit of buying or cooking more food than necessary.
3. Know how to store food and keep it at low temperature as possible.
4. Do not throw away sell-by date expired food, because use-by date is longer than sell-by date.
5. When cooking or eating, do not leave leftovers and clean the back seat after eating.
6. From the president to elementary school children, let's everybody decide his/her own 'food action' to reduce food waste and practice it everyday life.

The committee urged the government to participates in this project and to organize a joint task force (TF) of related ministries (MAFRA, Ministry of Environment, Ministry of Education, Ministry of Health and Welfare, Ministry of Commerce, Industry and Energy, Ministry of Food and Drug Safety, etc.) to revise various laws that encourage food waste and to enhance upcycling of food processing by-products. Devising preemptive measures to reduce amounts of waste generated by breaking away from the current business method is necessary. Reducing food waste by one-half can increase the food (calorie) self-sufficiency rate of Korea to 50% (KFSRF, 2022).

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