Korea Unification and Food Security

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Korea Food Security Research Foundation (www.foodsecurity.or.kr)

KFSRF is an independent research institute established in April 2010 to assess global food problems, forecast their impact on Korean food security, and lead the policy-making and national campaign to raise people's awareness on the issue in preparation for a global food crisis. The foundation makes strenuous efforts to develop new food policies and considers the agro-fisheries and food industry as the principal agents of stability in the country's food supply. The foundation is working to strengthen the food security function of the food industry in particular and encourages the industry to fulfill its social responsibility. It develops and carries out research projects on food security, publishes books and collects and shares relevant data with the support of voluntary sponsors. As the driver of the National Movement for Food Self-sufficiency, the foundation fosters a national campaign to pass down a society free from food shortage to the next generation. *Sikanyeon* is the publishing house of the foundation.

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145 Anamro, Sungbukku, Seoul, 136-713 Republic of Korea
Phone. 82-2-929-2751 / Fax. 82-2-927-5201
Email. foodsecurity@foodsecurity.or.kr
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Korea Unification and Food Security

Foreword

Unification of the Korean peninsula has long been the Korean people's desired goal. Recently, several signs of hope have spurred predictions within South Korea as well as globally regarding an impending unification. In light of this, we South Koreans must revisit our preparations for unification. To date, there have been debates over estimates of the cost of a unification or post-unification administrative organization, but specific research is lacking regarding food supply or food security plans, which are fundamental to national management.

In its 1997 publication "North and South Korean Agricultural Planning and Programs for the Preparation of Unification," the Korea Rural Economic Institute (KREI) raised issues of short-term food supply and demand that could arise in the case of abrupt unification, assuming the year 2000 as the year of unification. It also projected a change in long-term food supply and demand in 2010. The report estimated the amount of shortage in crops in the first year of unification (2000) at 2 million tons (assuming unification in January) or 1.7 million tons (unification in June), depending on the time of unification, and a shortage in the second year of unification at 2.3 million tons (January) and 2.5 million tons (June).

In May 2011 the Korea Food Security Research Foundation conducted a year-long study with a research team formed by six experts, "Food Security and Food Industry Development Strategy after Unification of the Korean Peninsula." Assuming the year of unification as 2015, their research forecast the prospects of food production and food supply and demand on the Korean peninsula immediately after unification and 10 years after unification by analyzing the current food and nutrition statuses in the North and South. Unlike previous studies, which were limited to agriculture, this research estimated the food demand and potential production capacity after unification by including food industries with agriculture and fisheries.

Today, the world is facing a severe food crisis. Since the 2007-2008 hike in global crop prices, grain prices have remained high. As of 2004, the FAO food price index reached 240% in 2010, and the trend is likely to continue. According to FAO Reports, the world's undernourished population reached 1 billion among a total population of 7 billion after increasing by 100 million in 2009-2010, and the figure increased by 44 million in 2010-2011. Particularly the poor countries in Africa and Asia are suffering from severe food shortages. The extreme weather disasters caused by global warming resulted in global crop demand far exceeding supply, thereby reducing global food stock. With an explosive demand for animal food in emerging economies such as China and India and the misuse of food resources, such as for biofuel production, the global grain market is expected to have little food that is purchasable even with cash. There are even signs of food wars as major crop-exporting countries are likely to limit the volume of exports for fear of a potential food shortage. At this moment, South Korea has become one of the top 5 global grain importers, as 70% of grain consumption for 49 million people depends on its economic strength to import sufficient food, whereas North Korea is one of the poorest countries in the world with its 24 million people suffering from starvation in absolute poverty.

It is clear that food-related issues will be one of the top priorities in a post-unification government. It is necessary to establish concrete policies for food security after unification in order to help reduce the dependency on food imports in South Korea and to reverse the food shortage in North Korea. It is also necessary to propose a direction for long-term food policies in order to manage the changes in food trends and ultimately secure food sovereignty on the Korean peninsula in a post-unification era. This book was written with the aim of providing useful data that will contribute to such policymaking. It compiles the research reports of the Korea Food Security Research Foundation and includes reports of the discussion panels from the "Seminar on Food Security and Food Industry Development Strategy after Unification of the Korean Peninsula" held on July 3, 2012.

I would like to extend my deepest gratitude to Dr. Moon Huhn-Pal, Dr. Kim Se-Kwon, Dr. Kim Yong-Taek, Dr. Park Tae-Kyun, and Dr. Kwon Ik Boo who participated in the research and the discussion panels of the seminar. I also would like to give my appreciation to Dr. Rhee Sook Jong and Dr. Lee Jang-Eun of the Korea Food Security Research Foundation, who were responsible for data collection and project management, to Dr. Lee Ggot-Im and Mr. Kim Yu-won for taking charge of editing this book, and to the members of Hanrimwon Co., who contributed to printing this book. Special thanks go to Diana Evans for editing this book for publication in English. Last but not least, I would like to say many thanks to the members of the Board of Trustees and voluntary sponsors of the Korea Food Security Research Foundation who supported the research and publication of this book.

May 2015

Lee Cherl-Ho, Chairman,

Korea Food Security Research Foundation

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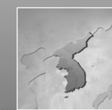
01 Introduction



1.1. Conditions for Korean Unification

Korean unification is not an event to be achieved by lopsided efforts at diplomacy. Given the political and socioeconomic situation, wherein the two Koreas have existed in mutual confrontation for more than six decades under opposing ideologies, visions of a united Korea are murky. There remains, therefore, the high probability that Korean unification will be achieved under an abrupt and inevitable change of conditions. These include the possibility of the following:

(1) Full-scale war and forced unification under heightened tension between the South and North; or

(2) Collapse of the communist system due to the North's financial difficulties, and the consequent South Korea-led unification by absorption; or

(3) North Korea-led communist unification by communist revolutionary forces and split public opinion in the South

Most South Koreans do not want forced unification by a full-scale war or communist unification led by their northern counterparts. A war on the Korean peninsula would mean the destruction of the hard-won economic growth of South Korea over half a century and repeating the tragedy of the Korean War of 1953. For these reasons the South has tried to avoid war at any cost. This explains South Korea's tepid response to the North blowing up the Cheonan warship and shelling Yeonpyeong Island in 2010.

Meanwhile, North Korea continues to face severe economic hardship and an exodus of its people under the hereditary dictatorship that has been maintained for over half a century. Yet North Korea has gained the upper hand by threatening the world with its nuclear missile development and has even drawn concern over a potential revolution in the South by pro-North followers, should they manage to enter the South Korean National Assembly in large numbers and neutralize the National Security Act in order to legalize communist activities. Indeed, the North appears poised to wage all-out war with a nothing-to-lose attitude.

In this regard, it might sound naïve to discuss food security in a post-unification scenario. However, there remain many other variables in the calculus of Korean unification. Among them are the dynamics of the countries that border the peninsula, global economic actors who invest in South Korea in large amounts, humanitarian groups for global peace, and supporters of peaceful national unity.

The united Korea that we pursue is a country that promotes the freedom, survival, welfare, and prosperity of its people. The approach of the South Korean government to unification is to achieve it gradually, step by step, based on national consensus formed in a democratic and peaceful way. The South Korean policy for the gradual phase-in of unification was formulated in 1989 as the "Korean National Community Unification Plan," which, after improvements, became the "Unification Plan for One National Community" in 1994, and it remains in effect today. This policy provides a strategy for step-by-step, gradual unification by establishing a united country of common origin, a single nation, a single system, and a single government after passing through phases of reconciliation and co-operation that would lead to a South Korea-North Korea Alliance (Ministry of Unification, ROK, 2012).

North Korea has taken a "liberation" and "revolution" approach. The North released the proposal "Koryo Confederal System" in 1973, brought forth the "Proposal for a Democratic Confederal Republic of Koryo" in 1980, and promoted a confederacy based on a single ethnic entity, a single nation, two systems, and two governments in 1991. The North introduced a "low-level confederal system" in the 2000s, explaining it as a two-government system in which the North and South governments would maintain their current functions and authorities. North Korea has suggested certain "prerequisites" for independent, peaceful unification: withdrawal of U.S. troops from South Korea; permanent suspension of joint military exercises with foreign forces; breaking out from under the U.S. nuclear umbrella; abolition of the National Security Act of South Korea; and legalization of the Communist Party. North Korea has officially selected a strategy known as the "National Liberation People's Democratic Revolution," under which "the South Korean revolution shall be carried out by revolutionary forces in the South." This indicates that a National Liberation People's Democratic Revolution would be implemented in the first phase, followed by a socialist revolution in the second phase, as "phase-in revolutionism." North Korea has consistently promoted its unification strategy in an attempt to intensify the contention inside South Korean society and expand underground organizations there in order to foment division in public opinion and even social chaos, so that a people's revolution might be incited from within the South.

The unification strategies of the two Koreas clearly differ. South Korea promotes strengthening coordination with the U.S. and Japan so it may gain the benefits of national defense and economic growth in an international political landscape led by powerful nations, meanwhile working to help North Koreans see the advantages of the South's system. To lead such an approach to unification, South Korea must properly provide wealth distribution and economic justice and have few opponents to the current system. When politicians and economists embrace morals and ethics, followership is created in society. There should be a belief that the North Koreans can join the South Korean community as one people without discrimination and enjoy economically better lives in the South. Of course a critical assessment of realities in the South is necessary: If southern society is not a place where North Koreans want to live, then its strategy for unification will end in failure.

Recently, the idea that a North-South economic community is imperative to the sustainable growth of South Korea is gaining ground. Many say that a weak domestic market, high dependency on foreign countries, low birth rate, and an aging population make it difficult for South Korea to achieve further economic growth. Therefore, some say the formation of a North-South economic community is essential for South Korea's sustainable economic development, regarding it as a process of unification and a "de facto unification." The most urgently required issue for a de facto unification is to offer assistance in protecting fundamental human rights, particularly regarding the food shortage in the North. Some argue for an annual food aid program of 600,000 tons of grain for 10 years from the perspective of legitimacy and morality that embrace the whole Korean peninsula. If the economically developed South leads the unification process, embraces the North Korean leadership, and wins the hearts of North Koreans through humanitarian aid, it might be possible to achieve a peaceful unification led by the South rather than unification by absorption.

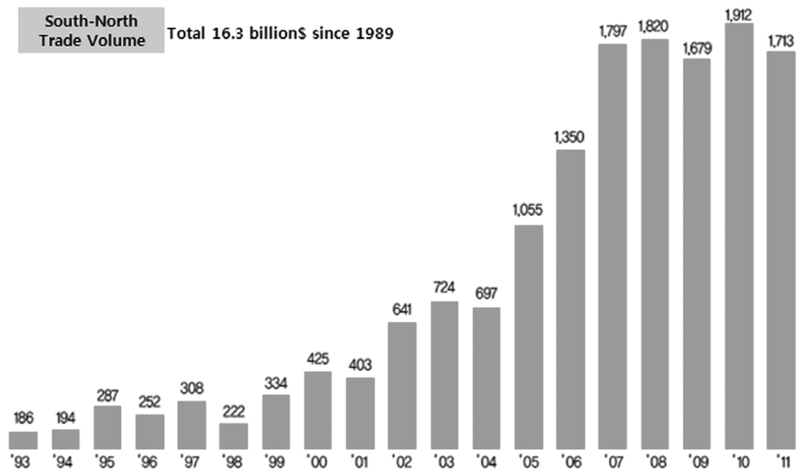
To foster a peaceful, democratic unification, the people of the South would do well to minimize their own internal contradictions and focus more on social justice in order to create a more harmonious society. Further aids to achieving democratic unification include preventing the spread of pro-North Korea leftists, bridging the divide in public opinion concerning unification, and gaining improved historical consciousness. The South must engender a future-oriented vision for unification in order to shed the mindset of "settling the past." Though it is inevitable that the divided nation will reunify, the South's current imperative is to restore the right to live and all other human rights of our northern compatriots, many of whom are starving to death. It is also necessary to promote sustainable economic growth, reduce the South's overinflated defense budget, which is much larger than the cost of unification, and take a leap forward to join the ranks of advanced countries so that 70 million people can have equal opportunity to lead happy lives.

1.2. Food Aid to North Korea

On July 7, 1988, North and South Korea released the "Special Declaration for National Self-Determination and Prosperous Unification" (known as the July 7 Declaration), which announced that the two countries would tear down the walls of national division and exchange with each other in every sector. The "Guideline on Inter-Korea Exchange and Cooperation" followed in 1989, and an inter-Korea exchange was vitalized with such firsts as connecting a North-South railway between the Donghae Line and the Gyeongui Line, developing the Kaesong Industrial Complex, and launching a sightseeing program in Mt. Geumgang. The annual volume of traffic between the two Koreas reached 100,000 in 2006. In terms of the accumulated traffic volume, by 2011 the number of South Korean visitors to the North (exclusive of tourists to Mt. Geumgang and the Kaesong Complex) was 980,731, and the number of North Koreans visiting the South amounted to 7,881 (Ministry of Unification, 2012).

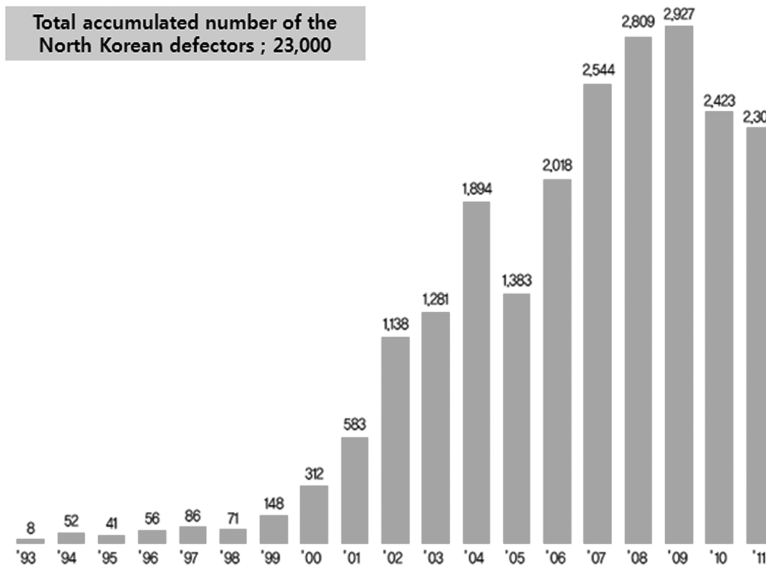
Annual trends in inter-Korea trade showed a moderate rise from the starting year of 1988 to the early 2000s and exceeded 1 billion dollars for the first time in 2005 when Kaesong Complex became fully operational. It reached 1.797 billion dollars in 2007, 1.82 billion dollars in 2008, 1.679 billion dollars in 2009, 1.912 billion dollars in 2010, and 1.713 billion dollars in 2011 (Figure 1-1). The accumulated trade volume amounts to approximately 16.3 billion dollars from the beginning of the inter-Korea trade to 2011.

Figure 1-1. North-South Trade Volume from 1993 to 2011



Due to the food shortage that began in the mid-1990s, the number of North Koreans escaping their country surged, and the number entering South Korea started to increase. Their route to the South varied, and group escapes comprised of family members were commonplace. The volume of North Korean defectors entering the South increased to 100 persons or more per year in the late 1990s from the relatively small number of around 10 annually in the early 1990s and more than 50 in the mid-1990s (Figure 1-2). In particular, the annual number of North Korean defectors entering South Korea surpassed 1,000 in 2000 and 2,000 in 2006. Since then, more than 2,000 North Koreans arrive in the South every year, making the total accumulated number of North Korean defectors entering South Korea 23,000 as of the end of December 2011 (Ministry of Unification, 2012).

Figure 1-2. Trend in North Korean Defectors Entering South Korea from 1993 to 2011



According to a study on the origin of North Korea's food crisis by Lee Seok of the Korea Development Institute (Lee Seok, 2004), the food crisis in North Korea dates back to the economic crisis of 1984 to 1988. From the time socialist collective farming was completed in the late 1950s to early 1960s, productivity continued to decrease. In 1973, the standard food ration decreased by an average of 13%, to 608 g (annually 222 kg) per person from 700 g (annually 256 kg) under the name of wartime rice reserve, and fell again to 547 g (annually 200 kg) with a 10% deduction called "patriotic rice." In the late 1980s, North Korea was hit by a severe economic downturn as trade with communist countries deteriorated due to the collapse of the Soviet Union. Abnormal weather such as heavy floods in 1995 plunged North Korea into its worst food crisis, one that awoke the world to the hunger issue plaguing the North. Grain production rapidly dropped, rationing was virtually paralyzed, and the importation of commercial food became almost impossible. At that time, North Korea's grain production volume per capita was only 120 to 160 kg per year, which falls short of the basal metabolic requirement. The North Korean authority asked for emergency food aid from South Korea and Japan in early 1995 and appealed to international organizations such as the United Nations for humanitarian food aid. North Korea's food situation improved in the 2000s but the nation remains in absolute poverty, with the capacity to produce only 65% of the population's grain demand (700 g per person per day).

The food crisis in North Korea has continued for some time due to complex structural problems such as an inefficient farming system, lack of fertilizers and agricultural chemicals, and an ineffective economic system. South Korea has offered humanitarian aid to the North through the government, the public sector, and international organizations. Since its initial 155,000 tons of fertilizer donated in 1999, South Korea provided a total of 2.555 million tons of fertilizer until 2007, with an annual aid volume of 200,000 to 300,000 tons.

In terms of food aid, South Korea provided 150,000 tons of rice to the North in 1995. From 1995 to 2007 the volume of food aid from South to North Korea totaled 2.85 million tons, including 2.65 million tons of rice and 200,000 tons of corn. Since 2000 South Korea has offered food resources in the form of a loan (deferment for 10 years and repayment in 20 years, at a 1% annual interest rate). When

Red Cross authorities from North and South Korea adopted the "Agreement on Delivery Procedures of Relief Supplies" in Beijing in 1997, the method of assistance shifted from indirect, through the international Red Cross, to direct aid between the two countries. In addition to the two Koreas agreeing on the delivery of relief aid through the Red Cross of both countries and direct delivery of relief aid, they expanded delivery routes and relief areas, gained permission to specify the supporter and designated donation, and improved transparency of distribution.

Since the launch of President M.B. Lee's government, large-scale food and fertilizer aid to North Korea has been suspended due to the generally poor inter-Korea relations and transparency issues, though some assistance continued for purely humanitarian purposes to the most vulnerable population, including infants and children, or as emergency relief in response to natural disasters. From 2008 to 2010, aid to North Korea focused on the vulnerable classes, including young children, and was provided by the South Korean government, independent agencies, and international organizations. On a governmental level, the South Korean authority gave medicines and hand sanitizers to the North as the country suffered from swine flu in 2009. The South also offered rice, cement, and cup noodles as flood relief supplies to Sinuiju province in North Korea in 2010, but halted some assistance after North Korea provocatively attacked Yeonpyeong Island in the South.

On the level of independent groups and international organizations (WHO, UNICEF) as well, assistance had continued for vulnerable people such as infants, children, and pregnant women since 2008, but was suspended after the attack against the warship Cheonan and shelling on Yeonpyeong Island in 2010. The South Korean government has adopted the principle that pure humanitarian assistance will continue unconditionally and thus assisted the infants and children's project for vulnerable people (for nutrition improvement and health care) through UNICEF in 2011.

1.3. Circumstances of Korean Unification

The issue of unification is continually discussed in every sector of society as well as outside the country and will continue to be a hot topic of debate. Since President M.B. Lee's remarks on the unification tax issue on August 15, 2010, more robust action on the issue has been taken. Recently, there have been an increasing number of seminars, conferences, and discussions related to the issue of unification. Overseas figures who led the German unification all say that unification achieved in any form will entail many difficulties and consultations and advise that only those who are prepared to pay the price of unification will rejoice in it. The former U.S. ambassador to South Korea, Christopher Hill, once argued that a united Korea with 70 million people would become an economic power in the world on a par with any of the major developed countries. U.S. investment firm Goldman Sachs projected the economy of a united Korea would become the 8th largest in the world, surpassing Germany and Japan in 30 to 40 years. Further, according to Goldman Sachs, North Korea should be viewed as an asset to a united Korea rather than a risk, taking into account the abundant and competitive workforce, the synergistic effect of natural resources, the demographic structure, and the high growth potential of North Korea.

The Russian think tank Institute of World Economy and International Relations (IMEMO) recently released the document “Strategic Global Outlook 2030,” which accepts the collapse of the North Korean government as an inevitable fact and concludes that a South-led Korean unification would benefit Russia (IMEMO, 2011). A survey conducted by KBS (Korea Broadcasting Station) showed that 30.9% of Koreans expect unification in 11 to 20 years, and in various related seminars unification has been predicted to happen by 2026.

Germany suffered severe after-effects of sudden unification in October 1990, such as heightened social tensions, price gaps in land, and job transfers. Unification was an event undreamed-of even 6 months before, when the Berlin Wall fell on October 29, 1989. Learning the lessons of German unification, South Korea wants to be prepared, particularly when it comes to finances. In Germany the proportion of economic strength, West to East, was two-thirds to one-third at the time of unification, Korea will face greater post-unification challenges given that the economic power ratio of South to North is 13 to 1.

Experts on matters of North Korea estimate, by adopting the German (Western) method of calculation that applies a per capita requirement ($250) to the population, that the cost of unification will be exorbitant. Unification cost should be estimated by the calculation of net cost: the equation must subtract the unification benefits from the total cost, which combines every expense necessary for unification. If the benefits outweigh the costs, the gap can be referred to as unification benefit. Unification cost in a narrow sense is required to include only the expendable cost rather than the investment cost. This would be a more realistic calculation than the current unification cost if it were comprised of only the emergency management cost in the early stages of unification or only the cost of assistance with the privatization of North Korea and repayment of its foreign debt.

In his book *Unification is a Jackpot* Shin Chang-min (2012) analyzes the practical costs of unification, estimating the size of a fund that would be required to cover the following areas:

① Crisis management costs for emergency situations in which procurement of food, clothes, medicine, and medical supplies are needed to overcome the chaos in the face of a state of emergency that might occur soon after unification,

② System unification costs required to unify each system in every sector, including politics, administration, military, education, and culture, and

③ Investments required to adjust the inter-Korean income gap by raising real production capital toward the goal of increasing the income level of the people in the North to 50% of that in South immediately following unification, and then combining the economies of the two Koreas into a single, united economy.

Table 1-1 indicates the estimated cost of real capital costs, crisis management costs and system unification costs, combined, after assuming the period for post-unification inter-Korean income adjustment to be 10 years, based on the factors mentioned above. During the 10 years predicted for income adjustment, it is estimated that South Korea will spend 1.1165 trillion to 1.8237 trillion dollars, accounting for 5.80 to 6.57% of GDP, on unification costs (Shin Chang-min, 2012).

Table 1-1. Summary of Unification Cost Estimates

Inter-Korea Income Adjustment Period	Billions of Dollars (2011 value)	Portion of South Korean GDP (%)
2021-2030	1,116.5	5.95
2026-2035	1,252.5	5.80
2031-2040	1,603.4	6.54
2036-2045	1,823.7	6.57

Source: Shin Chang-min, *Unification is a Jackpot* (2012). Basis for data estimates: South Korean GDP 1.164 trillion USD in 2011, South Korean GDP per capita 22,483 USD in 2011; North Korean GDP per capita 1,074 USD in 2010, North Korean population 24.187 million in 2010 (Ministry of Unification, "Understanding Unification 2012").

Before further examining the costs and benefits of unification, it is necessary to understand the cost of division. The largest tangible cost of division is the enormous amount of defense budget used by South Korea in its military confrontation with North Korea. Total tangible and intangible costs incurred by the division are astronomical, but the financial burden of military deadlock would be offset by unification. The benefits would take effect immediately, relieving the burden of unification costs by diverting military funds to unification efforts. Currently, the cost of division far outweighs the projected price of unification. While the cost of division is a wasted expense to be borne permanently as long as the two Koreas are divided, the cost of unification comprises only a temporary burden in the form of an investment.

The effect of unification is expected to transform the South Korean economy from export-oriented to domestic demand-oriented. The initial stages of investment in this process are projected to entail risks: In particular, if the Koreas choose a sudden unification that integrates labor hours, currency, and social security systems and provides freedom of movement as in the German unification, North Korea would see a surge in income, but a contraction of investment and large-scale unemployment.

One of the primary ways to ease the burden of unification costs entails the persuasive "speed adjustment theory," in which a step-by-step, gradual unification is assessed to reduce fiscal costs overall by providing a more favorable environment for the industrialization of North Korea. For example, at first, North Korea will need electricity from the South, given the current state of electricity in North Korea. It would take six to seven years for the North to generate power on its own, making it necessary for the South to invest in operating electricity generators across the North. The gradual approach to unification has been offered as a way to avoid the economic pain Germany endured for 20 years following its rapid and complete unification.

Kwon Tae-jin of the Korea Rural Economic Institute (KREI) emphasizes the need to employ the speed adjustment theory for agricultural reforms too. He believes the North Korean system of collective farming must ultimately be converted to South Korea's individual private system, but that it ought to be reformed in phases rather than breaking it up at an early stage of unification. Kwon argues that continuing the operation of collective farms in North Korea for a certain period would guarantee employment and income for rural residents, who comprise 38% of the total population of North Korea, while reducing rural migration into cities (Kwon Tae-jin, 2004).

Once unification is achieved, the top priority for North Koreans will be their food supply. Farming and food processing are the principal low-investment, high-efficiency industries that would supply the primary necessities for North Koreans. The food processing industry in South Korea employs 260,000 people, so the North Korean food industry would require vitalization to absorb the large labor force in North Korea.

1.4. Changes in Demography and the Industrial Structure of North and South Korea

When the North Korean people suffered starvation in 1995-1996, nutritional deficiencies caused the labor productivity to fall by as much as 20%. The lack of nutrients took a heavy toll on normal physical and cognitive development, resulting in a difference in appearance between the young people of North Korea and their southern neighbors. Given that securing a sufficient supply of nutrition is the driving factor for industrial development, the agriculture and food processing industries must lead in the post-unification era (Lim and Chang, 2003).

While unification may aggravate the food security issue by touching off a population increase via an expected rise in inter-Korean marriage and an ensuing baby boom, it may relieve the low birth rate and increasingly aged population of South Korea to some degree. Currently, North Korea's population increase rate is low. Figure 1-3 compares the population composition of the two Koreas by age.

Figure 1-3. Population Composition by Age of North and South Korea

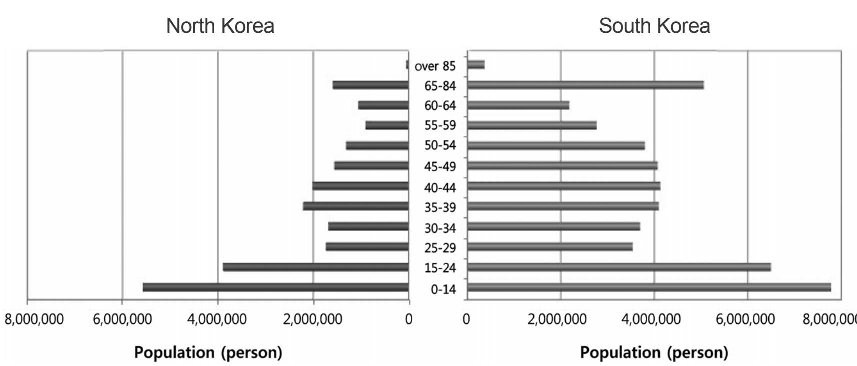


Table 1-2 below contains data compiled on the population composition of the two Koreas as of 2010. The population ratio of South to North Korea was 1.98 to 1, with a combined population of 72 million, a combined population growth rate of 0.34%, and population density of 314/km^3. In 2010, South Korea had a farming population of 3,062,956 and a farming population ratio of 6.4% (out of 47,990,761 total persons). In 2008, the farming population was 3,187,000, or 6.6% of the total population. In 2008, North Korea's farming population was 8,573,000, or 36.8% of total population, indicating that North Korea is a de facto agricultural country. The total workforce in South Korea's food industry (in 2008) was 1,738,652 (160,584 in the food manufacturing industry, 1,578,068 in food services). Although the absorption of the North Korean farming population in a post-unification period could serve to reduce food shortages, a prerequisite to unification would be to provide training for crop cultivation and proper supply of fertilizers, agricultural chemicals, and tools to North Korea.

Table 1-2. Comparison of Population Composition, National Income, and Farming Population between North and South Korea

	South Korea	North Korea
Population (persons) (Male/Female)	47,990,761 (male 23,840,896 female 24,149,865)	24,187,000 (male 11,790,000 female 12,397,000)
Population growth rate (%)	0.26	0.41
Population density (persons/km^2)	485.6	196.4
Per capita income ($)	20,562	980
Farming population (persons)	3,062,956	8,573,000 (2008)
Farming population rate (%)	6.4	36.8 (2008)

Source: KOSTAT, "Major Statistical Data of North Korea," 2011.

In the 1940s and 1950s North Korea shifted from a farm-centered class structure to a socialistic class structure focusing on workers and farmers. The post-Korean War era saw land reform, nationalization of major industries, and agricultural cooperation. In the 1970s North Korea undertook a technological revolution, heralding a significant change in occupational structures in the 1980s.

In terms of the production value of North Korea by industry, agriculture, forestry, and fisheries accounted for 27.6% in 1995, approximately 4.5 times higher than that of South Korea, and the service industry made up 30.3%, a very low figure compared to the 50.6% of South Korea. The mining and manufacturing industry and the electricity, gas, and water supply and construction industries accounted for 30.5% and 11.5%, respectively, with little difference in South Korea.

In the production structure of North Korea in the 2000s by industrial output, the proportion of agriculture, forestry, and fisheries decreased at an annual rate of about 1%, from 30.4% in 2001 to 20.9 % in 2009, while the ratio of the mining and manufacturing industry increased annually by approximately 1%, from 26.0% to 34.8% (Table 1-3). There were no distinct changes in other industries. In South Korea, the production rate of agriculture, forestry, and fisheries shrank by more than half, from 4.4% to 2.6%, while the mining and manufacturing industries were on the rise. Thus agriculture still plays a very important role in the industrial output of North Korea.

Table 1-3. Comparison of Industry Production Structure between North and South Korea

	Constitution of industries in North Korea								
	2001	2002	2003	2004	2005	2006	2007	2008	2009
Agriculture, forestry and fisheries industry (%)	30.4	30.2	27.3	26.7	25.0	23.3	21.2	21.6	20.9
Mining and manufacturing industry (%)	26.0	25.7	26.8	27.2	28.9	29.6	31.3	34.6	34.8
Electricity, gas and water supply industry (%)	4.8	4.5	4.5	4.4	4.3	4.5	4.6	3.4	4.1
Construction industry (%)	7.0	8.0	8.7	9.3	9.6	9.0	8.8	8.3	8.0
Service industry (%)	31.8	32.8	32.8	32.3	32.2	33.6	34.1	32.2	32.1

	Industry constitution of South Korea								
	2001	2002	2003	2004	2005	2006	2007	2008	2009
Agriculture, forestry and fisheries industry (%)	4.4	4.0	3.7	3.7	3.3	3.2	2.9	2.5	2.6
Mining and manufacturing industry (%)	26.9	26.5	26.0	28.0	27.8	27.4	27.5	28.3	28.0
Electricity, gas and water supply industry (%)	2.6	2.6	2.6	2.4	2.3	2.3	2.2	1.8	1.8
Construction industry (%)	7.1	7.2	8.0	7.8	7.6	7.5	7.4	7.0	6.9
Service industry (%)	59.0	59.8	59.6	58.1	59.0	59.7	60.0	60.3	60.7

Source: KOSTAT, "Major Statistical Data of North Korea," 2011.

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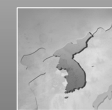
02 Food and Nutritional Status of North and South Korea



2.1. Comparison of Health and Nutritional Status between North and South Koreans

2.1.1. Food Situation on the Korean Peninsula before Division

Section eight (*Jeongjoji*) of the encyclopedia *Imwon Sipyukji*, written approximately 180 years ago by Seo Yu-gu in 1827, is a good reference for the dietary life of Koreans in the Joseon dynasty (1392-1910). Chapter one (*Sikgamchalyo*) contains information similar to food material science found in modern days. It categorizes foods systematically in a manner comparable to the FAO Food Balance Sheet (Lee, C.H. et al., 1988). *Sikgamchalyo* lists 11 kinds of water at the top of vital food materials and enumerates various vegetable foods, including 36 kinds of grains, 72 kinds of vegetables, and 48 kinds of fruits; and while excluding dairy products, fat and oil, the list instead includes condiments as important food elements. This and other food data published in the eighteenth to nineteenth centuries reveal the dietary patterns of Koreans in the late Joseon period: their basic food comprised cooked rice or porridge as a staple, and soup, stew, kimchi, and pan-fried food or vegetables as side dishes;

supplementary food included noodles, dumplings, or rice cake; and favored flavors of beverages or alcohol and confections and sweets are also indicated. This period is characterized by the large consumption of various kinds of grains, vegetables, and fruits, including wild plants classified today as famine foods.

An Overview of Food in Joseon, by Kim Ho-jik (1944), lists 17 kinds of grain, 25 vegetables, 304 wild herbs, 7 types of seaweed, 81 mushrooms, 11 fruits, 204 kinds of fish and shellfish, and meat and eggs, including beef, pork, dog, roe deer, chicken, pheasant, and a variety of eggs. Dairy products were rarely used in Korean diets at that time. The characteristics of this period are the consumption of various kinds of wild plants and famine foods, which are not included in today's food classifications.

The "Joseon Food Industry Development Report" (Joseon-Manchu Industry Investigation Committee, 1922) shows that there were 492 food industries run by the Japanese on the Korean peninsula at that time: rice milling (208 units), flour milling (8), confectionaries (44), agar manufacturing (3), noodle making (21), brewing (172), soft drink manufacturing (6), ice manufacturing (2), salt making (21), and canning (19). From this it is clear that the basic facilities necessary for food manufacturing were established before the Korean War across the Korean peninsula, including factories for rice-polishing, flour-milling and noodle-making, rice-wine brewing, and canning (Lee, C.H. et al., 1988).

The list of food materials published in the Statistics Yearbook of the Japanese Government-General of Joseon includes 15 kinds of grains, 6 kinds of legumes, 13 kinds of vegetables, 5 kinds of fruits, 3 kinds of livestock, and various kinds of fishery products, which comprise in all much less than the amount of food materials recorded in the *Imwon Sipyukji* or *An Overview of Food in Joseon*. The staple food supply per person per day, estimated by averaging the amounts listed over a span of three years in the Statistics Yearbook of the Japanese Government-General of Joseon, indicates a sudden plunge of grain supply from the 1920s to the 1930s, compared to the early days of Japanese annexation (Table 2-1). This confirms the historical record of severe exploitation by Japan, in that one-third of Korean-produced rice was extorted and shipped to Japan in those decades.

The total energy supply per person per day estimated from the food supply from 1913 to 1915 amounted to 2,089 kcal, with plant materials accounting for 97.5% of the total energy supply. The total protein intake was 80.7 g, with vegetable protein making up 91.8% of the total. As a result, it is assumed that the Korean dietary pattern mostly depended on foods of plant origin, and that energy intake consisted of 74.1% carbohydrates, 15.4% protein, and 10.5% fat. This is similar to the energy composition of the 7-dish meal recorded in *An Overview of Food in Joseon* (Lee, Cherl-Ho, and Ryu, Si-sang, 1988).

Table 2-1. Changes in Staple Food Supply per Person per Day during Japanese Colonial Period and Early Days of the Republic of Korea

(unit: g)

	1913-15	1922-24	1930-32	1937-39	1946-48	1956	1962
Grains	454.2	414.4	372.0	436.5	334.9	381.1	477.6
(Rice)	(248.9)	(196.1)	(162.4)	(222.0)	(247.9)	(295.3)	(331.4)
(Wheat)	(29.5)	(31.3)	(26.0)	(37.4)	(15.6)	(23.8)	(34.0)
(Barley)	(65.7)	(61.5)	(65.0)	(75.0)	(51.0)	(48.5)	(104.3)
(Misc.)	(110.1)	(125.5)	(118.6)	(102.1)	(20.4)	(13.5)	(7.9)
Sweeteners (sugars)	-	-	-	-	-	-	4.7
Starchy roots (root and tuber crops)	36.4	70.3	70.5	90.1	37.7	46.3	98.1
Pulses (beans)	94.6	76.8	65.7	52.0	23.2	25.5	16.3
Tree nuts (nuts)	-	-	-	-	-	-	0.2
Oil crops (seeds nuts)	-	-	-	-	-	-	0.2
Vegetables	95.3	102.7	134.7	127.4	85.2	92.9	99.0
Fruit	0.6	2.6	8.3	12.6	7.0	12.0	15.1
Meat	13.4	15.7	14.2	11.8	5.6	9.8	12.9
Eggs	-	-	-	-	-	-	4.4
Milk	-	-	-	-	-	-	0.4
Fish and shellfish (seafood)	26.3	37.6	73.5	84.0	22.6	31.4	40.2
Oils and fats	-	-	-	-	-	-	0.8
Total	720.8	720.1	738.9	814.4	516.2	599.0	769.9

Source: Lee, C.H. et al., *Statistics Yearbook of the Japanese Government-General of Korea (1912-1940)* (1998).

The data indicate that the food supply of South Korea was not different from that of North Korea immediately after liberation and the Korean War (Table 2-1). The Korean peninsula was liberated during an extreme food shortage due to Japanese exploitation, resulting in 500g of food supplies per person per day from 1946 to 1948, and the subsequent war put everyone on the starvation line. At the time of Korean division in 1945, the dietary pattern of the people in both Koreas was not different from the traditional pattern that mainly comprised grains and vegetables in the late Joseon period, but most people were deemed to be undernourished because of an extreme food shortage.

The nutrition supply estimated from South Korea's food balance sheet from 1946 to 1962 was very low, at 1,380 to 1,940 kcal of total energy and 41 to 52 g of protein, whereas the real nutritional intake reported by several researchers amounted to one and a half or two times the nutrition supply (Lee, C.H. et al., 1988). This is attributable to several errors in the data, including inaccurate statistics and unrepresentative research subjects, but the crucial factor leading to discrepancies in the data was the intake of various kinds of wild herbs and famine foods during the absolute famine that are not included in the administrative statistics.

After the Korean War (1950-1953), the gap between the two Koreas in food and nutrition widened, although they had begun with the same severe food shortage. There is no doubt that the gap was widened by the South's continuous and rapid economic development and the North's closed socioeconomic structure.

2.1.2. Changes in Food and the Nutritional Status of South Korea

The population density of South Korea increased rapidly when in the midst of the national division people fled from the communist regime in the North. The number of refugees who moved south was estimated at about 2 million, or 10% of the South's population of around 20 million. Flour and non-fat powdered milk were given to hungry Koreans during the war as U.S. food aid, and people who had not included milk in their diet started consuming milk. Flour-based foods such as noodles, bread, and confections also became common in people's diets. Western confectionaries were introduced in this period across the country, promoting industrialized production in the post-war era. Flour consumption continued to rise, barley supply amounted to one-third of the rice supply, and the industrial production of sugar began in the 1960s (Table 2-1). In addition to that, nuts, seeds, eggs, milk, and fats and oils started appearing in food statistics in the 1960s. Because sugar, milk, and oil products had been introduced to the nation during the Korean War, these food items were widely accepted after the war as well.

1) Food and Nutritional Situation of South Korea during the Early Economic Development Period

The per capita GDP of South Korea in the post-war era was $72 in 1954 and less than $100 until 1962. It increased to $130 in 1966 when the first 5-Year Economic Development Plan (1962-1966) ended, to $288 in 1971 at the conclusion of the second economic development plan, and to $797 in 1976 at the close of the third economic development plan. GDP reached $1,719 in 1981, when the fourth plan ended, and $2,296 in 1986 when the fifth plan concluded (Table 2-2). During this period, the proportion of the farming population decreased to less than 20% from 60% of the total with a massive inflow into urban centers. Moreover, Engel's Coefficient, which indicates the proportion of the amount spent on food to total income, decreased from 73-41 in 1954 to 29-36 (farmer to urban worker) in 1984, indicating a significant improvement in quality of life and a reversal of the standard of living in urban and rural areas. This also reflects the poor standard of living of the urban workers who flowed in from rural areas during this period.

Table 2-2. Changes in Food Situation during the Period of the Economic Development Plan in South Korea

Year	GDP (USD per person)	Engel's Coefficient		Farming population (%)	Food self-sufficiency (%)
		Farmer	Urban worker		
1954	72	73.6	41.2	71.0	-
1962	90	55.9	43.2	64.0	90.3
1966	130	50.2	49.5	54.0	94.7
1971	288	47.3	41.4	45.1	80.5
1976	797	45.7	49.4	35.7	74.8
1981	1,719	37.7	41.5	25.8	43.2
1986	2,296	-	37.5	19.7	44.5

Sources: Lee, C.-H. et al., "Agriculture and Forestry Statistics (1954-1986)" (1988).

The Ministry of Health and Society devised tentative nutrition standards for Koreans in 1960, and the Korean FAO Association released the recommended daily intake for Koreans for the first time in 1962. The recommended daily intake for an adult man (25 years old) was 2,900 kcal and 70 g of protein, which was unrealistically high given the real food supply in this period. Research on the national nutritional status conducted by several researchers indicated that the concentrations of vitamin B1 and B2 in the blood and in urine were within the normal range but at a very low level. Further, a clinical survey found that deficiencies of vitamins A and B2, protein, and calcium were prevalent among the people (Lee, C.H. et al., 1988).

Until the 1960s, South Korea suffered an era of food shortage where people experienced what was known as the “barley-hump” (seasonal food shortage), surviving with food produced in the country because of the absence of purchasing power to import food from overseas. However, in the 1970s, when the second 5-Year Economic Development Plan ended, the food items in shortage were prioritized for importation, thereby reducing self-sufficiency from 90% to below 80%. In the 1980s, imports of feed under the policy for livestock development caused a rapid decrease in food self-sufficiency, to less than 50% (Agriculture and Forestry Statistics, 1954-1986).

Meeting the demands of the 1960s when the national priority was sufficient nutritional supply, the first revised edition of the recommended daily intake for Koreans was published in 1967, revising the daily energy intake for an adult man upward to 3,000 kcal and 80 g of protein, while the second revised edition in 1975 considerably cut the energy intake standards, to 2,700 kcal. In addition, nationwide nutrition surveys for Koreans were conducted by the government for the first time in 1969 and continued periodically each year thereafter.

The food supply of South Korea in the 1970s indicates that grains were sufficiently supplied, hovering over 500 g per person per day, with a great increase in the supply of flour and barley (Table 2-3). In this period, South Korea achieved a green revolution, producing rice to the level of self-sufficiency, and the term “barley-hump” disappeared as the daily rice supply per person exceeded 300 g. The supply of sugar, vegetables, fruit, meat, eggs, milk, and fishery products enormously increased. The total food intake also surpassed 1 kg per person per day, making it almost two times the intake at the time of the division of the Korean peninsula.

Table 2-3. Changes in Daily Supply of Staple Food per Person during the Period of Economic Development of South Korea (unit: g)

	1968	1974	1976	1980	1986	1990
Grains	526.5	543.7	530.4	505.5	509.8	480.7
(Rice)	(322.7)	(351.4)	(330.6)	(363.0)	(351.1)	(330.9)
(Wheat)	(76.1)	(70.3)	(83.7)	(80.3)	(86.3)	(81.4)
(Barley)	(117.1)	(110.5)	(107.5)	(38.4)	(19.2)	(6.7)
(Misc.)	(10.7)	(11.6)	(8.7)	(23.9)	(53.2)	(61.8)
Sweeteners (sugars)	12.0	15.8	16.4	28.1	35.5	42.0
Starchy roots (roots and tubers)	147.6	81.6	99.3	58.8	41.4	30.2
Pulses (beans)	17.6	19.0	26.4	26.5	28.4	28.1
Tree nuts (nuts)	0.2	0.3	0.5	1.2	2.0	1.3
Oil crops (seeds and nuts)	0.2	0.9	3.8	1.1	1.3	1.8
Vegetables	146.3	178.6	186.4	329.5	314.0	363.3
Fruit	24.4	35.6	35.9	44.4	72.0	79.3
Meat	22.2	25.2	26.4	37.9	47.0	64.6
Eggs	5.6	10.6	11.2	16.0	18.9	21.6
Milk	3.8	10.2	14.5	29.5	71.6	87.1
Fish and shellfish (seafood)	45.3	76.2	81.4	73.7	114.6	99.1
Oil and fat	3.4	6.2	8.4	13.8	25.6	39.1
Total	955.2	1004	1041.1	1166.1	1280.1	1338.3

Source: "Food Balance Sheet" (1968-1990).

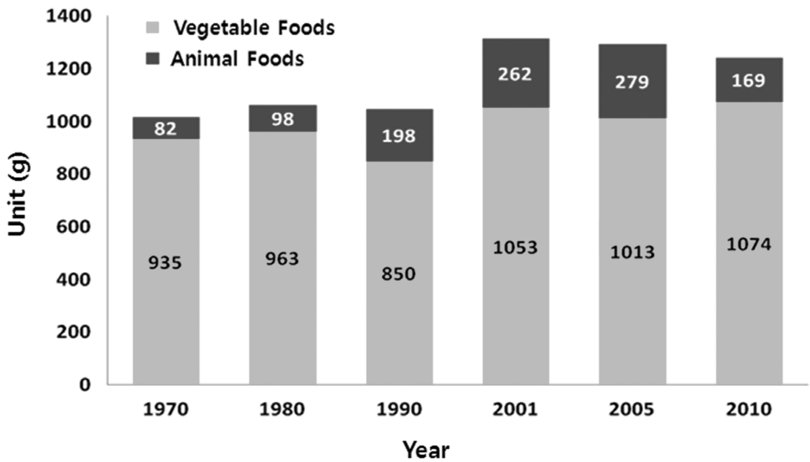
2) Advances in the Food Industry and Growth in Animal Food Consumption

With the economic development brought about by industrialization in the 1970s, food production became industrialized on a large scale, breaking away from the conventional handicraft level. Growth in food production derived largely from processed carbohydrates that satisfied the population's sweet tooth, such as sugar, glucose, starch, flour, and instant noodles, which then necessitated a basic condiment industry of sauces and glutamate, as well as the "favorite food" industry of powdered milk, gum, and soft drinks. A survey of changes in food consumption patterns during this period (1965-1970) shows that consumption increased 2.4 times for condiments, 3.8 times for processed foods, and 6 times for confections and soft drinks; there was also a significant increase in Western-style food consumption, including certain preparations of meat, fish and shellfish, flour-based food, processed food, coffee, and margarine (Lee, C.H. et al., 1988).

In the 1980s, the South Korean food industry experienced rapid development. Between 1977 and 1986, the production supply increased 8 times for sausage, twice for powdered milk, 1.5 times for ice cream, 6 times for market milk, 18 times for yogurt drinks, 3.5 times for canned fish products, 21 times for soybean oil, 1.5 times for instant noodles, 3 times for starch, 8 times for coffee, 2 times for soft drinks, 4 times for cola, 1.5 times for juice, and 3 times for beer. The production of food products that were oily or high in protein such as dairy, sausage, and soybean oil surged, and the production of "favorite foods" also significantly increased, though items such as coffee and soft drinks were irrelevant to the nutrition supply (Lee, C.H. et al., 1988).

With the rapid development of the food industry after 1980, the South Korean dietary life changed significantly: daily intake of animal products per person almost doubled in 5 years, from 98 g to 183 g. There was a significant increase in meat consumption, from 79 g to 119 g, and milk consumption rose from 10 g to 43 g. During the same period (1980-1986), the number of medical treatments reported by health insurers increased 1.8 times, whereas the number of patients with cancer increased 2.3 times; with diabetes, 5.3 times; with hypertension, 2.6 times; and with heart disease, 3.3 times. From 1978 to 1986, grain intake decreased to from 500 g to 400 g, and food intake increased 3 times for legumes, twice for meat, twice for eggs, 4 times for milk, and twice for fish and shellfish, resulting in strong growth in animal food consumption. Along with these changes in food consumption patterns, degenerative diseases such as diabetes, hypertension, and heart disease started to become important health issues. This period, then, marks the beginning of an era of surplus in which people exceeded the optimal patterns of food consumption (Figure 2-1).

Figure 2-1. Changes in Korean Food Intake and Composition of Animal and Vegetable Foods



Source: Ministry of Health and Welfare, "National Food Consumption Survey Report, ROK."

Animal food consumption continued to grow, reaching 230 g in 1995 and 279 g in 2005. The average food intake for Korea was also on the rise: daily food intake per person was estimated to have increased 30% in 25 years, from about 1 kg in 1980 to 1.3 kg in 2005. The increase in food intake, especially excessive animal food intake, caused a deterioration of national health due to the attendant increase in obesity and degenerative diseases. A recent (2010) slight decrease in total food intake and animal food consumption indicates that people have become aware that excessive food intake causes health problems.

3) Decrease in Rice Consumption and Deterioration of National Health

Until the early 1980s, average rice consumption in South Korea was 130 kg/person/year, but this decreased by almost half, to 74 kg, by 2010 (Table 2-4). On the other hand, wheat, which began to be consumed broadly in the form of flour provided by U.S. food aid during the Korean War, and later depended entirely upon imports, became the second staple food with the advent of instant noodles in the 1970s. Currently, annual wheat consumption per person amounts to 32 kg. The consumption of barley, which had been second only to rice until the 1970s, dropped rapidly and currently stands at almost zero. Taking up some of the slack is the soybean (a pulse), with an annual consumption per person of 8 kg.

Table 2-4. Trends in Food Crop Consumption per Person in South Korea

(unit: kg)

	1970	1980	1990	1995	2000	2002	2003	2004	2005	2006	2007	2010
Grains	219.4	195.2	167.0	160.5	153.3	144.0	138.0	133.4	135.5	134.4	132.5	125.4
(Rice)	136.4	132.4	119.6	106.5	93.6	87.0	83.2	82.0	80.7	78.8	76.9	74.0
(Wheat)	26.1	29.4	29.8	33.9	35.9	34.6	32.7	34.1	31.8	33.3	33.7	31.4
(Barley)	37.3	13.9	1.6	1.5	1.6	1.5	1.0	1.1	1.1	1.2	1.1	1.2
(Corn)	1.1	3.1	2.7	3.3	5.9	5.7	6.2	5.6	4.9	4.6	4.6	4.0
Pulses	5.3	8.0	8.3	9.0	8.5	8.4	8.0	8.6	9.0	8.9	8.9	7.6
Roots and tubers	10.2	6.3	3.3	3.0	4.3	3.4	3.2	3.1	4.2	3.5	3.3	3.4
Misc.	3.0	2.1	1.7	3.3	3.5	3.4	3.7	4.0	3.8	4.1	4.0	3.8

Source: KOSTAT, "Main Statistics of Food, Agriculture, Forestry and Fisheries" (2011).

The trend of South Korean nutrient intake by year indicates that energy intake stood around 2,000 kcal without any large fluctuation for the past 30 years (Table 2-5). Protein intake gradually increased from a range of 60-70 g in the 1970s to a range of 70-80 g in 1980, where it remained, and fat intake increased almost 1.5 times. Intake of other nutrients is on the rise except for calcium and vitamin A.

Table 2-5. Trends in Nutrient Intake per Person in South Korea (National Nutrition Survey 1971-2009)

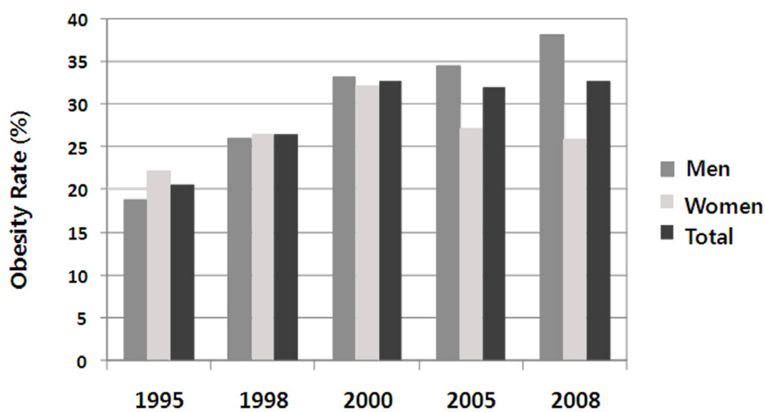
	1971	1976	1981	1986	1991	1995	1998	2001	2005	2008	2009
Energy (kcal)	2072	1926	2040	1930	1930	1839	1933.5	1975.8	2016.3	1837.9	1585.4
Protein (g)	67.0	60.4	69.9	74.2	73.0	73.3	73.2	71.6	75.8	65.9	55.8
Lipids (g)	13.1	20.0	20.3	28.1	35.6	38.5	40.1	41.6	46.0	39.2	32.1
Carbo-hydrates (g)	422	380	394.2	343	325	295	315.5	315.0	306.5	292.1	268.0
Calcium (mg)	404	402	559	593	518	531	500.5	496.9	553.1	476.0	432.4
Iron (mg)	13.1	12.0	15.8	17.0	23.0	21.9	12.5	12.2	13.6	12.8	11.8
Vitamin A (I.U.)*	962	1293	1804	2226	550*	443*	609.5	624	782.1	720.0	694.9
Thiamin (mg)	1.22	1.20	1.78	1.24	1.27	1.16	1.3	1.27	1.30	1.2	1.05
Riboflavin (mg)	0.78	0.80	1.24	1.19	1.24	1.20	1.1	1.13	1.20	1.1	1.02
Niacin (mg)	14.7	16.0	20.1	27.2	17.5	16.7	15.5	16.9	17.1	14.8	12.7
Vitamin C (mg)	83.7	75.0	67.2	84.3	92.2	98.3	123.7	132.6	98.2	96.0	95.5

Source: Ministry of Health and Welfare, "National Food Consumption Survey Report," each year.

In comparison to the Korean recommended daily allowance (RDA), energy intake stands at around 90%, and protein intake remains at around 150%, with a rapid increase in the 2000s. The only nutrient that failed to meet the standard is calcium; otherwise, nutrient intake is reported to be sufficient in general. Since 2005, the excessive intake of protein, iron, and vitamins has been remarkable.

The ratio of obesity in South Korea was 18.8% in men and 22.2% in women in 1995, making the average obesity ratio 20.5% of the population. It increased to 26.4% in 1998 and 32.7% in 2000, of which 38.1% were men and 25.9% were women (Figure 2-2).

Figure 2-2. Changes in South Korean Obesity Rate



Changes in causes of death indicate that the number of people who died of cancer increased by 27% from 1989 to 2009, wherein the number of patients who died of breast cancer doubled, and deaths from colon cancer increased 3.3 times (Annual Health Insurance Statistics, 2009; Table 2-6). It is well known that breast and colon cancers are correlated to the excessive intake of meat, which is again confirmed in the statistics for Koreans. During the same period, the number of those who died of diabetes increased 2.5 times. This is linked to the excessive intake of food energy and lack of exercise. Such excessive food intake, particularly of animal products, hampers efforts towards national self-sufficiency in food and is responsible for threatening food security and for the deterioration of national health.

Table 2-6. Changes in Causes of Death in Koreans (death toll per 100,000 persons)

	1989	1998	2006	2009	Rate in 2009 compared to 1989 (%)
Cardiovascular disease	161.5	123.7	111.8	109.3	-32.3
Cancer	105.0	110.8	134.0	140.5	33.8
stomach cancer	31.7	23.9	22.0	20.4	-35.6
liver cancer	23.6	20.0	22.4	22.6	-4.2
breast cancer	1.6	2.1	3.3	3.8	137.5
colon cancer	3.9	7.0	12.8	14.3	266.7
Diabetes	9.4	21.1	23.7	19.6	108.5

Source: "Annual Health Insurance Statistics," 2009.

4) Era of Food Waste

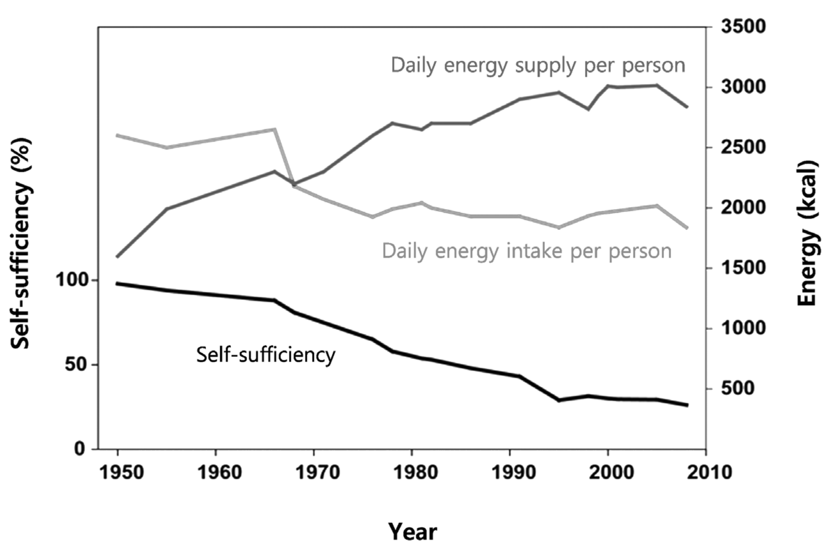
With the advent of economic growth, South Korea was able to import without limit food that had previously been in short supply, and thus began an era of severe food waste. Before the 1970s, when there was an acute food shortage, the calorie intake estimated by the national food consumption survey surpassed the calorie supply calculated by the national food balance sheet (Lee, C.H. et al., 1988;

Figure 2-3).

The real intake may exceed the supplied amount because people consumed various famine foods during food shortages. When sufficient food was imported, energy supply exceeded energy intake, and intake was estimated to be 70% of the supplied amount in the late 1980s. The gap between the food supply and real intake indicates the amount of food loss, mostly by food waste. The severe food waste in South Korea results in about 30% of food being thrown away.

It is estimated that almost one third of the food supply, most of which is imported, goes to waste. As a result, dietary patterns in South Korea have become uneconomical and wasteful, thus endangering national food security and ultimately threatening national health.

Figure 2-3. Changes in Daily Energy Supply and Intake per Person in South Korea



2.1.3. Changes in the Food and Nutritional Status of North Korea

It is understood that North Korea normalized food rations until 1972 by relatively quickly achieving food self-sufficiency in the wake of the peninsula's division after the Korean War. The daily food ration of grain was 700 g for an adult office worker, 900 g for heavy workers, and 1,000 g for pregnant women. Although North Korea focused on cultivation, reclamation, and terracing to expand arable land in the 1970s and 1980s, the regime experienced a disastrous failure due to repeated landslides and lack of water caused by the removal and damaging of forest lands (Lee Seok, 2004).

1) Food Shortage and Changes in the Food Supply of North Korea

The North Korean food shortage was first noticed in the early 1970s. The food ration standard of 700 g of grain per day for an adult office worker (256 kg per year) had been maintained for 20 years, but was reduced 13% to 608 g per day (222 kg per year) in the name of "wartime rice reserves" in 1973. The standard was reduced again in 1987, this time by 10% in the name of "patriotic rice," which brought rations to 547 g per day (200 kg per year). In 1992, food rations for non-military residents were again diminished by 10%, resulting in rations of 492 g per day (179 kg per year). However, since 1994 the regime has failed to meet even this lowered standard and now faces the collapse of their food rationing system (Lee Seok, 2004; Table 2-7).

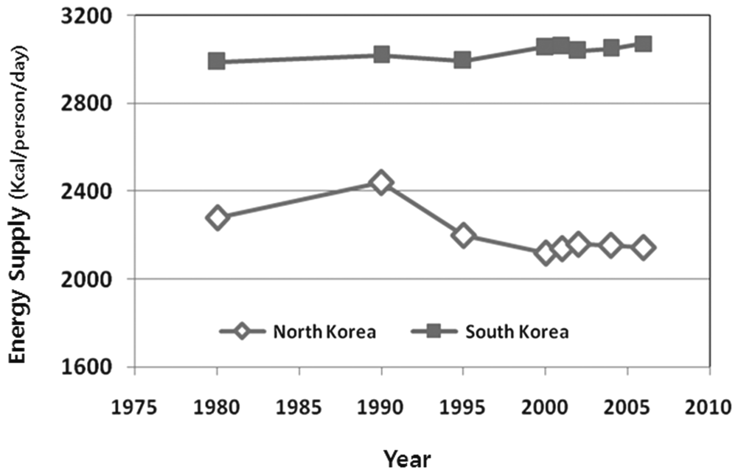
Table 2-7. Changes in Daily Food Supply and Intake per Person in North Korea (Lee, Seok, 1999)

Period		Food Rations for Adult Office Workers
1955-72	Normal Food Ration: from max 900 g/day (heavy worker) to 1,000 g/day (infant)	700 g/day, 256 kg/year
1973	Deduction of 4 days' rations from 30 days' rations under "wartime rice reserve" (average 13% decrease)	608 g/day, 222 kg/year
1987	10% deduction in the name of "patriotic rice"	547 g/day, 200 kg/year
1992	10% deduction for non-military residents	492 g/day, 179 kg/year
After 1994	No change in the standard of rations, but actual amount of rations has always been below the standard	-

Source : NBN News, "Sourcebook on Reality of North Korea," 1995, 241; Oh Gyeong-chan, *North Korean Food Crisis Can be Resolved* (Seoul: Daewangsa, 1997), 145.

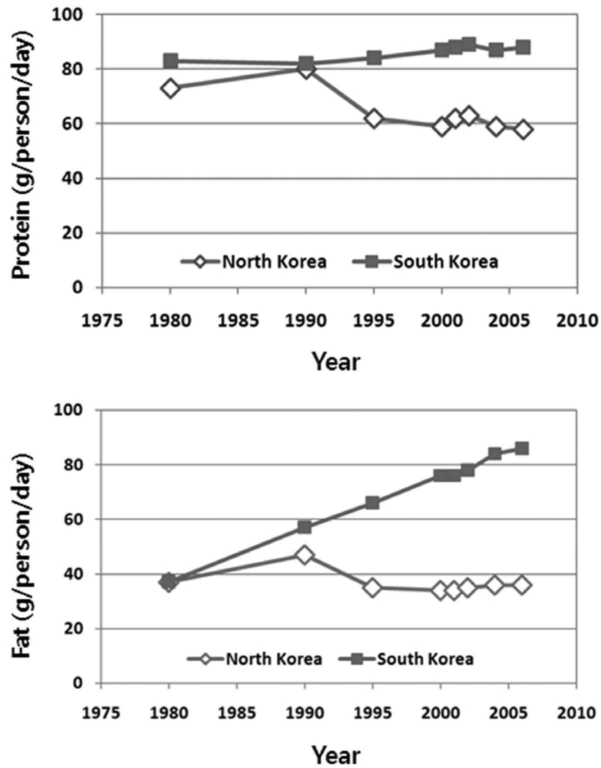
By comparing the food energy supplies of the North and South from the 1980s to today based on the FAO Statistical Yearbooks (1980-2010), the North Korean food energy supply has amounted to 2,200-2,300 kcal per person per day, only two-thirds that of South Korea. Yet North Korea's food balance sheet is likely to be inflated, given the propensity of the North Korean regime to exaggerate internationally released statistics. The true energy intake of North Koreans also probably differs from the statistics released since the balance sheet shows energy supply only. According to the food balance sheet in 1988, the energy consumption per person in North Korea continued to grow until it peaked in 1988 and then dropped to 2,326 kcal from 1994 to 1996, although these statistics are considered to be exaggerated (Figure 2-4).

Figure 2-4. Changes in Daily Food Energy Supply per Person in North and South Korea



According to a report by an FAO/WFP special assessment mission published in 1998, the food energy supply of North Korea was estimated at 1,578 kcal, based on the daily food rations of 406 g. However, after interviewing North Korean defectors and comparing their physiques, the average daily energy intake of North Koreans was estimated to be about 1,600 kcal (Lim and Nam, 2003). The food protein supply in North Korea has rapidly declined since 1990 and is estimated to be at the level of 60 g per person per day today, and the fat supply falls short of even 40 g (Figure 2-5).

Figure 2-5. Changes in Daily Protein and Fat Supply per Person in North and South Korea



2) Food Requirements of North Korea and Trends in Requirements by Usage

In 2010, FAO estimated the total grain requirement of North Korea at around 5.22 million tons for 24.3 million people, consisting of 4.05 million tons for food, 300,000 tons for feed, 170,000 tons for seed, 120,000 tons for processing, and 570,000 tons for other (FAO Statistical Yearbook; Table 2-8).

Table 2-8. Grain Demand Estimate for North Korea in 2010 Crop Year

(unit: 000 ton polished grains)

Population (millions)		WFP standard
		24.3
Purpose	Food	4,058
	Feed	300
	Seeds	170
	Processing	122
	Other	570
	Total	5,220

Source: FAO, 2010.

In addition, a special report by WFP/FAO/UNICEF (2011) reported that based on a daily calorie consumption per person of 1,640 kcal for the total population of 24.42 million, the minimum calorie intake by WFP (75% of 2,310 kcal and added food calories other than grain), the total food requirement was estimated at 5.33 million tons, with a deficiency of about 1.06 million tons against the domestic production of 4.25 million tons, indicating a 20% shortage in food (Table 2-9). The food shortage by category includes about 280,000 tons of rice – one of the top two staple grains – about 1 million tons of maize, and 30,000 tons of soybeans. Given the commercial import of about 200,000 tons of grain, the absolute deficiency was estimated at 880,000 tons.

Table 2-9. Trends in Food Supply and Demand in North Korea (2010/11)

(unit: 000 ton)

	Total	Rice	Maize	Barley	Other grains	Potatoes	Soybeans
Total Supply	4,252	1,577	1,683	180	19	414	154
- Production	4,252	1,577	1,683	180	19	414	154
Total Consumption	5,338	1,858	2,680	180	19	414	186
- Food	4,250	1,466	2,253	141	15	230	147
- Feed	150	0	75	0	0	55	20
- Seed	219	56	23	21	3	113	5
- Loss	541	237	252	18	2	113	15
Stock	177	100	77	0	0	0	0
Surplus or Deficiency	1,086	281	997	0	0	0	32
- Imports	200	66	110	12	-	-	12
Absolute Deficiency	886						
- Expected Aid	44						

Note: See grounds for estimates below.

① Post-harvest loss in North Korea: maize 15%, grain 10%, potatoes 4%.

② Population estimate in 2010: 24.42 million (24.05 million in 2008, increase rate 0.6%).

③ Food consumption per capita: 174 kg (grain 168 kg, beans 6 kg); consumption here refers to a 1,640 kcal daily calorie intake per person, and consumption levels of other meat, fish, vegetables, and fruit remain to be added.

④ Seed consumption 220,000 tons: rice 85,000 tons (570,000 ha × 150 kg/ha), maize 22,000 tons (500,000 ha × 45 kg/ha).

⑤ Feed requirement: 150,000 tons (180,000 tons in 2008).

⑥ Milling rate: 65% (CFSAM 2010).

Source: Rapid Food Security Assessment Mission to the DPRK (2011.3.24), WFP/FAO/UNICEF.

Table 2-10 tracks the result of the food deficiencies in North Korea as estimated by the WFP daily recommended food intake and trends in the North Korean food supply during the crop years 1993/94 to 2005/06. The amount of food consumption was estimated using the following year's population data for North Korea in the South Korean Statistical Year Book (KOSTAT). Based on the WFP recommended calorie consumption of 2,130 kcal/person/day, annual food consumption was estimated at 222 kg/person/year, and total demand was estimated at 6.16 million tons in the 1993/94 crop year and 6.68 million tons in the 2005/06 crop year. Food production estimates for North Korea released by the Rural Development Administration (Republic of Korea) reported an annual shortage of about 2.44 million tons of grain, averaged from 2.09 million tons to 2.85 million tons in 1993/94 and 2005/06, respectively,, equaling about 60% of the annual grain production of 3.963 million tons in North Korea. In response to this deficiency, North Korea has been heavily dependent on food imports and foreign aid each year. North Korea, then, has suffered from an absolute shortage of 1.27 million tons of food (grains) annually.

Table 2-10. Trends in Total Food Supply and Demand in North Korea (based on the WFP recommended consumption of 2,130 kcal)

Year	Population (000 person)	Consumption (000 ton)	Production (000 ton)	Surplus or Deficiency (000 ton)	External introduction (000 ton)		Total supply (000 ton)	Absolute deficiency (000 ton)
					Imports	Food aid from South Korea		
93/'94	21,353	6,162	3,884	2,278	1,093	-	4,977	1,185
94/'95	21,543	6,217	4,125	2,092	490	-	4,615	1,602
95/'96	21,684	6,258	3,451	2,807	962	150	4,563	1,695
96/'97	21,810	6,294	3,690	2,604	1,050	-	4,740	1,554
97/'98	21,942	6,332	3,489	2,852	1,630	-	5,119	1,213
98/'99	22,082	6,373	3,896	2,477	1,112	-	4,998	1,375
99/'00	22,175	6,400	4,222	2,178	1,070	-	5,292	1,108
00/'01	22,253	6,422	3,590	2,832	1,225	500	5,315	1,107
01/'02	22,369	6,456	3,946	2,510	1,400	-	5,346	1,110
02/'03	22,522	6,500	4,134	2,366	1,005	400	5,539	961
03/'04	22,709	6,554	4,253	2,301	809	400	5,462	1,092
04/'05	22,936	6,619	4,311	2,308	697	300	5,308	1,311
05/'06	23,165	6,685	4,540	2,145	450	500	5,490	1,195

Note: Surplus or Deficiency = Consumption - Production; Total Supply = Production + External Introduction; Absolute Deficiency = Consumption - Total Supply.

① Population refers to the population of the given year (Statistics Korea, Comparison of Social Aspects between North and South Korea, 2005).

② Food Items: Rice, Maize, Barley and Wheat, Legumes, Other grains, Roots and Tubers (grain conversion).

③ Based on the estimates of the Rural Development Administration.

④ Imports: statistics released by KOTRA.

⑤ Minimum Requirement: Minimum food ration/person/day (500 g) + other requirements (150 g).

⑥ Recommended Consumption: 2,130 kcal/person/day (608 g/person/day: 222 kg/year) + 30% of other foods (182 g).

Source: WFP/FAO/UNICEF, "Rapid Food Security Assessment Mission to the DPRK," (Mar 24, 2011).

Table 2-11 shows analysis results on the surplus or deficiency of food in North Korea when annual consumption per capita is set at 167 kg, based on a daily calorie intake per person set at the minimum requirement of 1,640 kcal/person/day, which is 75% of the WFP recommended intake during the same period. In this case, the total food requirement lacks about 1.32 million tons on average annually against domestic production, accounting for around 54% of the WFP recommended intake. In the case of minimum consumption, the requirement can be met if it includes domestic production and imports. Therefore, it is estimated that the North Korean food supply averages 1,640 kcal per person per day, which indicates consumption of approximately 167 kg of food (grain) annually.

Table 2-11. Trends in Food Supply and Demand in North Korea (Based on 75% of WFP Recommended Calorie Intake)

Year	Population (000 person)	Consumption (000 ton)	Production (000 ton)	Surplus or Deficiency (000 ton)	External introduction (000 ton)		Total supply (000 ton)	Absolute deficiency (000 ton)
					Imports	Food aid from South Korea		
93/'94	21,353	5,066	3,884	1,182	1,093	-	4,977	89
94/'95	21,543	5,111	4,125	986	490	-	4,615	496
95/'96	21,684	5,145	3,451	1,694	962	150	4,563	582
96/'97	21,810	5,174	3,690	1,723	1,050	-	4,740	434
97/'98	21,942	5,206	3,489	1,717	1,630	-	5,119	87
98/'99	22,082	5,239	3,896	1,343	1,112	-	4,998	241
99/'00	22,175	5,261	4,222	1,039	1,070	-	5,292	+31
00/'01	22,253	5,280	3,590	1,690	1,225	500	5,315	+35
01/'02	22,369	5,307	3,946	1,361	1,400	-	5,346	+39
02/'03	22,522	5,343	4,134	1,209	1,005	400	5,539	+196
03/'04	22,709	5,388	4,253	1,135	809	400	5,462	+74
04/'05	22,936	5,442	4,311	1,131	697	300	5,308	134
05/'06	23,165	5,496	4,540	956	450	500	5,490	6

Note: Surplus or Deficiency = Consumption - Production; Total Supply = Production + External introduction; Absolute Deficiency = Consumption - Total Supply

Source: WFP/FAO/UNICEF, "Rapid Food Security Assessment Mission to the DPRK," (Mar 24, 2011),

3) Nutritional Status of North Koreans

According to a report on the nutritional status of North Koreans based on a survey of food consumption by household (KREI, "North Korean Agriculture Trends," 2004), the severely vulnerable have been identified as 70,000 malnourished children, 980,000 pregnant or breast-feeding women, and 2.3 million children under 5 years old, totaling 3.35 million. In addition, a total of 7,668,400 people are included in the vulnerable group, which consists of 3,400 orphans, 4.3 million school-age children, 2.6 million seniors, 665,000 physically or mentally disabled, and 100,000 tuberculosis patients (Table 2-12). The assessment by FAO and WFP of the North Korean food situation in 2003 showed that 70% of households depending on public food rationing were undernourished and failed to consume the calories necessary for normal activity.

Table 2-12. Survey of the Nutritional Condition of North Koreans

Severely vulnerable group	(unit: persons)	
Malnourished children	70,000	
Pregnant or breast-feeding women	980,000	
Children under 5 years	2,300,000	Total 3,350,000
Vulnerable group		
Orphans	3,400	
School-age children	4,300,000	
Seniors	2,600,000	
Disabled persons	665,000	
Tuberculosis patients	100,000	Total 7,668,400

Source: KREI, "North Korean Agriculture Trends," 2004.

The joint survey on the nutritional status of North Korean children by WFP, UNICEF and the EU in September and October, 1998 showed similar results. Two-thirds of North Korean children between 6 months and 7 years of age were in a state of chronic malnutrition, and 16% of them were reported to be dangerously malnourished. In addition, 1 in 3 orphans of 1 to 2 years old were in a state of severe malnutrition.

Table 2-13. Nutritional Condition of North Korean Children

	1998 (3,984 persons)	2002 (6,000 houses)
Children underweight	61%	21%
Children wasting	16%	9%
Children stunting	62%	42%

Source: UNICEF and WFP, "North Korea Joint Research Report," 2002.

UNICEF, WFP and the North Korean regime jointly conducted a survey on the nutritional condition of children under 7 years old and their mothers from 6,000 randomly selected households in 10 out of 12 cities across North Korea in October, 2002. The survey found that the nutritional condition of children had improved considerably over the previous 4 years (Table 2-13). Above all, malnutrition was significantly reduced. Among the 6,000 subject children, those noticeably underweight compared to children of the same age group accounted for 21%; children wasting, or those noticeably underweight for their height, made up 9%; and children stunted, or those of noticeably short height compared to children of the same age group, comprised 42% of the total. The UNICEF, WFP, and EU survey on the nutritional status of 3,984 North Korean children under 7 in 1998 showed the ratio of each category as 61%, 16%, and 62%, indicating that children's nutritional status was remarkably improved (Table 2-13). The proportion of overall severely malnourished children was 2.7% in the 2002 survey, showing a great improvement from 16% in 1998. However, the proportion of stunted or underweight children for their age still amounted to more than 20%. In this regard, experts argue that the nutritional status of North Korean children is still in a fearful state.

Although children's nutritional status has improved, the condition of mothers is still dire. Almost one-third of the mothers were identified as suffering from malnutrition and anemia. Moreover, the survey found a huge gap in child nutrition status by region. The proportion of underweight children was 15% in Nampo and Pyongyang but 25% in North and South Hamgyeong provinces and Ranggang province. The proportion of stunting children was less than 30% in 2 of the 10 target cities, Nampo and Pyongyang, 48% in South Hamgyeong province, and more than 40% in other regions. The proportion of wasting children was only 4% in Nampo and Pyongyang, but 12% in South Hamgyeong province. Mostly, the children in mountainous areas were reported to be in much worse condition compared to children in urban areas (UNICEF and WFP, "North Korea Joint Research Report," 2002; Table 2-13).

4) Physical Health Condition of North Koreans

Height is an element that reflects health and nutritional conditions during a growth period. As the quality of life improves, the average height of the populace also increases. The cases of North and South Koreas are a particularly good example of this phenomenon. Research on the physique of Koreans in the 1930s showed that the average height of the residents in northern provinces (North Hamgyeong, South Hamgyeong, North Pyeongan) was 166 cm, much taller than that of southern provinces (Jeolla, Gyeongsang, Chungcheong), which was measured at 162.5 cm (Kyeongsung Imperial University of Japanese colonial period, 1983). However, in 2005, the average height of North Koreans (men: 165.6 cm, women: 154.9 cm) was much shorter than South Koreans (men: 172.5 cm, women: 159.1 cm). Since 1930, the average height of North Koreans has changed very little (Korea Center for Disease Control and Prevention, 2005; Table 2-14).

The occurrence rate of tuberculosis in North Korea was 344 per 100,000 persons in 1997, and the rate remains at this level. This figure is 3.8 times higher than that of South Korea (90 per 100,000 persons). The death rate of tuberculosis in North Korea decreased to 25 per 100,000 in 2009 from 115 in 1998, still twice the level of South Korea (Figure 2-6).

Table 2-14. Changes in Average Height of North and South Koreans

(unit: cm)

Category	1930		2005	
			South Korea	North Korea
Area	Northern provinces (North Hamgyeong, South Hamgyeong, North Pyeongan)	166.00	Male 172.5 Female 159.1	Male 165.6 Female 154.9
	Middle provinces (South Pyeonggan, Gyeonggi, Hwanghae, Gangwon Province)	163.37		
	Southern provinces (Jeolla, Gyeongsang, Chungcheong)	162.51		
Reference	• Kyeongsung Imperial University, "Biometry of Koreans, 1,528 persons," 1938.		• Korea Centers for Disease Control and Prevention, North Korean defector survey, 2005. • Ministry of Health and Welfare, National Nutrition Survey Report, age 20-39, 2005.	

Based on the data, it is clear that the gap in food and nutritional conditions between the two Koreas mirrors the gap in economic power. Since the 1970s, South Korea has achieved remarkable economic development, with a GDP of 20,000 dollars per capita in 2010, whereas the GDP of North Korea has remained at the level of the 1980s - 1,000 dollars - until recently (Figure 2-7).

Figure 2-6. Occurrence and Death Rate of Tuberculosis in North and South Korea

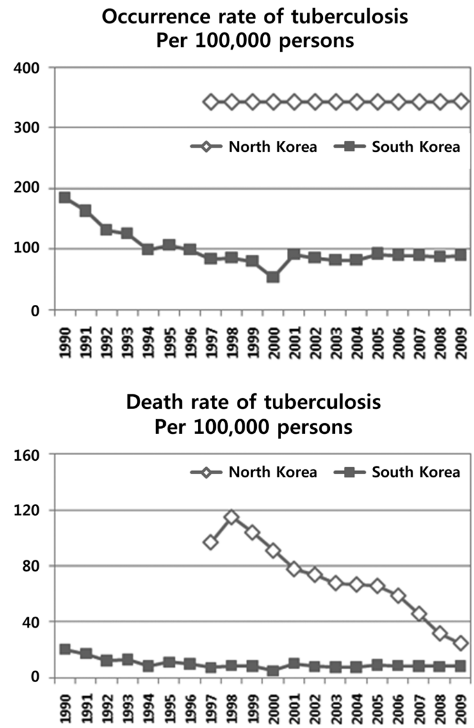
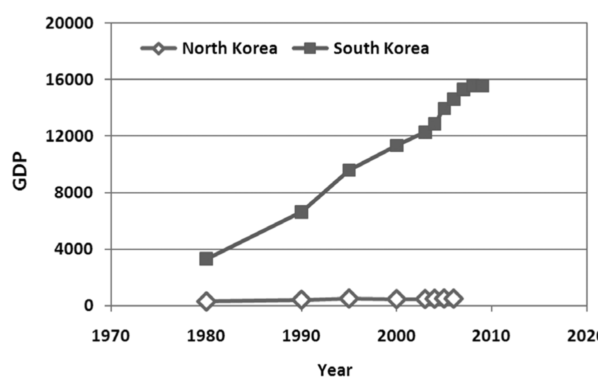


Figure 2-7. Changes in GDP per person in North and South Korea



2.2. Structure and Status of Food Supply in North and South Korea

2.2.1. Structure and Status of Food Supply in South Korea

1) South Korea's Food Self-Sufficiency

South Korea's food self-sufficiency has continuously decreased since 1970, from 79% for food grain except for feed in 1975 to 55.7% in 1995 and 51% in 2006. Self-sufficiency in grain, including feed, plunged to 29.1% in 1995 and 26.7% in 2009, from 73% in 1975. Self-sufficiency calculated with a calorie base has dropped to less than 50% since 2000, making half of the total food consumption of South Korea dependent on imports (Table 2-15).

Table 2-15. Comparison of Self-sufficiency in South Korea by Type

(unit: %)

Category	1995	1998	2000	2003	2006	2009
Self-sufficiency in grain[1)]	29.1	31.4	29.7	27.8	26.6	26.7
Self-sufficiency in edible grain[2)]	55.7	57.6	55.6	53.3	51.3	56.9
Self-sufficiency in calories	50.6	54.2	50.6	45.6	45.6	50.1

Notes: 1) and 2) released by the Ministry of Food, Agriculture, Forestry, and Fisheries.

Source: Ministry of Food, Agriculture, Forestry, and Fisheries, "Statistics of Food, Agriculture, Forestry, and Fisheries," 2007 and Korea Rural Economic Institute, "2006 Food Balance Sheet," 2007.

As demand for meat and milk grew from the mid-1970s, the importation of feed grains increased, plunging the total grain self-sufficiency to 56% in the 1980s. During the Uruguay Round negotiations, which started in the mid-1980s and concluded in 1994, industrialized nations, including European countries and Japan, made efforts to increase their food self-sufficiency in preparation for the free trade of farm produce that would soon unfold. Upon the launch of the WTO, traditional grain importers in Europe, including the UK and Germany, achieved self-sufficiency, and Japan desperately defended 30% of its grain self-sufficiency. However, South Korea did not prepare any counteractions during the preparatory period, so grain self-sufficiency dropped from the range of 50-60% to 29.1% and decreased to 26.7% in 2009. South Korea achieved self-sufficiency in rice, but imported almost all of the wheat and maize it consumed (Lee, 1999, Lee, 2012; Table 2-16). Self-sufficiency in soybeans decreased from 35% in 1980 to less than 10% after the launch of the WTO, and decreased again to less than 7% in 2000. Around 2006 when a government purchase policy was launched for soybeans grown in paddy fields, the rate increased to 13% but dropped again to less than 10% when the policy was abolished in 2008. Self-sufficiency in vegetables and fruits has declined continuously since the launch of the WTO, to less than 90%. The sufficiency rate of milk and meat has also dropped since the launch of the WTO, standing at 70.5% for milk and 77.5% for meat in 2009. Self-sufficiency in these food items are expected to further decrease due to the bilateral free trade agreements (FTAs) with Chile, the EU, and the US.

Table 2-16. Changes in Self-sufficiency (%) in Staple Foods, South Korea

Category	1970	1980	1990	1995	2000	2003	2006	2009
Grains	80.5	56.0	43.8	30.0	30.8	28.1	27.6	30.2
Grains except feed	86.2	69.6	70.3	55.7	55.6	53.3	51.3	57.0
Rice	93.1	95.1	108.3	91.1	102.9	90.3	95.2	101.1
Wheat	15.4	4.8	0.1	0.3	0.1	0.3	0.2	0.5
Pulses	86.1	35.1	20.1	9.9	6.8	7.3	13.6	9.8
Vegetables	100.2	100.2	98.9	99.2	97.7	94.7	92.2	92.6
Fruit	100.2	98.6	102.5	93.2	88.7	85.0	82.6	89.5
Milk	-	109.7	92.8	93.3	81.2	81.0	72.4	70.5
Meat	100.0	97.8	92.9	89.2	83.9	81.2	78.7	77.5
Eggs	99.2	100.0	100.0	99.9	100.0	100.0	99.4	99.8

Notes:

① Rice, wheat, and soybeans are based on total self-sufficiency in grains, including feed.

② Vegetables, fruit, milk, and eggs are based on the "Food Balance Sheet."

Source: Ministry of Food, Agriculture, Forestry, and Fisheries, "Statistics of Food, Agriculture, Forestry, and Fisheries," 2007; Korea Rural Economic Institute, "2009 Food Balance Sheet," 2010.

The changes in self-sufficiency by nutrient show that energy self-sufficiency dropped from 79.5% in 1970 to 48.3% in 2008; that of protein decreased from 80.1% to 49.4% during the same period; and that of fat plunged from 77.2% to 22.6%. Because of the lack of oil resources South Korea is heavily dependent on foreign palm oil, beef tallow, and pork tallow.

2) Grain Supply and Consumption Patterns in South Korea

The total grain demand in South Korea is estimated at around 19-20 million tons. The total grain consumption increased by approximately 110% in 2009 from 8.8 million tons in 1970. Consumption increased continuously, to 20 million tons by 1996, and has seen a moderate decrease for the last 10 years, standing at 18.5 million tons as of 2009.

According to yearly trends in the change of grain consumption by usage, direct food consumption continued to drop by about 25.9% to around 5.08 million tons today from 6.86 million tons in 1970. The grain consumption for processing largely increased 4.2 times, from about 850,000 tons to 3.60 million tons, and grain consumption for feed grew 15.3 times, to 8.92 million tons (Table 2-17).

The total grain supply in South Korea is estimated overall at 22 million tons despite yearly variation. The grain composition by supply format shows that domestic production stands at 5.3 million tons; imports at 14 million tons; and the carry-over from the previous year is 2 million tons. The average total grain supply for 2005-2007 was 22 million tons, doubling from 10 million tons in 1970, with an average annual increase of 2.8%. The yearly trends in change of grain supply show that the grain supply increased from 10 million tons in 1970 to 23 million tons in 1995, an increase of 117% for 25 years, with a 4.7% average annual increase rate. For the 10 years following, the grain supply remained on a moderate decline, at an annual average rate of 0.53%. In 2007, the total grain supply was estimated at 22 million tons, of which the total domestic production was 5 million tons, accounting for 24.5% of the total; imports stood at 14 million tons, or 65.4%; and carry-over from the previous year was 2 million tons, making up 10.1% of the total ("Statistics of Food, Agriculture, Forestry, and Fisheries," 2011).

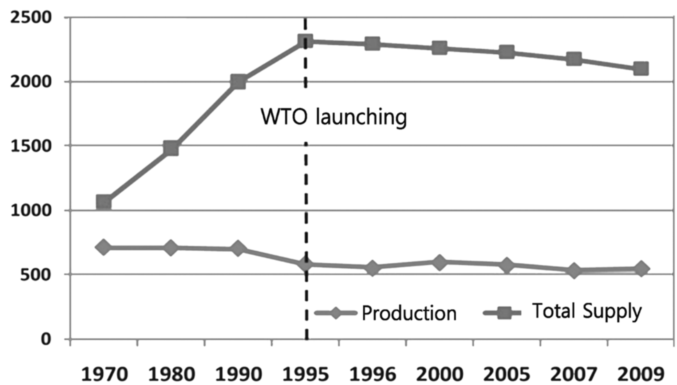
Table 2-17. Changes in Grain Consumption, Supply, and Stock by Usage in South Korea

		1970	1980	1990	1995	1996	2000	2005	2006	2007	2009
Consumption (000 ton)	Total	8,825	12,596	16,286	19,974	20,867	19,961	19,847	19,771	19,717	18,538
	Food	6,863	6,860	6,302	6,127	6,178	6,164	5,329	5,773	5,732	5,085
	Processing	853	2,072	3,291	3,776	3,906	3,850	4,300	3,731	3,670	3,596
	Feed	584	2,472	6,301	9,373	10,372	9,285	8,783	9.292	9,240	8,915
	Seed	168	117	86	66	69	72	68	64	64	64
	Misc.	357	1,075	302	632	342	590	1,058	743	836	876
Supply (000 ton)	Total	10,668	14,775	19,939	23,093	22,901	22,586	22,275	21,960	21,694	20,942
	Carry over	1,456	2,676	2,904	3,019	3,119	2,301	2,706	2,428	2,189	2,650
	Production	7,097	7,048	7,013	5,816	5,504	5,931	5,718	5,433	5,315	5,470
	Imports	2,115	5,051	10,022	14,258	14,278	14,624	13,851	14,099	14,190	12,822
Year-end stock (000 ton)		1,843	2,179	3,657	3,119	2,034	2,625	2,428	2,189	1,977	2,404
Rate of stock (%)		20.1	17.3	22.5	15.6	9.8	13.2	12.2	11.1	10.0	9.0
Consumption (kg/person)		219.4	195.1	167.0	160.5	160.2	153.3	135.5	134.4	132.5	125.4
Self-sufficiency (%)	Including feed	80.4	73.0	43.1	29.1	26.4	29.7	29.4	27.7	27.2	29.5
	Excluding feed	86.1	79.1	70.3	55.7	52.4	55.6	53.4	52.7	51.6	56.9

Source: "Statistics of Food, Agriculture, Forestry, and Fisheries," 2011.

In 1995 domestic grain production decreased to 5.8 million tons, or by 17%, from the level of 7 million tons that had remained constant from the 1970s to the early 1990s. Afterwards, it remained on the same level before dropping again in 2005. Since then, production decreased by about 7% in the 3 years following, for an annual average decrease rate of 3.5% (Figure 2-8).

Figure 2-8. Changes in Total Grain Production and Supply in South Korea



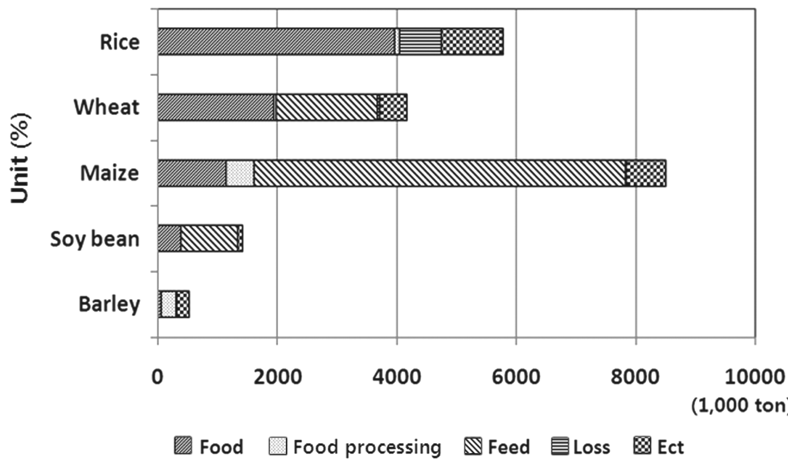
The total grain supply in 2009 was composed of 30.1% rice, 2.7% barley, 21.7% wheat, 44.3% maize, and 1.2% other. The domestic production of rice stood at 4.84 million tons, imports reached 250,000 tons, and the carry-over was 990,000 tons out of a total supply of 5.78 million tons. In the case of barley, the amounts of domestic production and imports were 150,000 tons and 160,000 tons, respectively, and the carry-over amounted to 190,000 tons out of a total supply of 520,000 tons. The total supply of wheat and maize was 4.18 tons and 8.51 tons, respectively, and imports in 2009 stood at

3.74 million tons and 7.2 million tons each, making them almost entirely dependent on imports.

3) Grain Consumption Patterns and Amounts by Type

The staple grains consumed in South Korea are rice, barely, wheat, maize, and soybeans. In terms of consumption patterns by type in 2009, 8.4% of the rice among the total demand of 5.06 million tons was used for processing and the rest was mostly consumed for food, whereas the rate of natural waste was as much as about 12.6%, amounting to 630,000 tons. In the case of barely, although the total consumption accounted to a mere 1.7% of total grain consumption, 15.8% was consumed for food, 6.6% for feed and miscellany, and 73% for processing. The demand for wheat, which was almost entirely dependent on imports, was 3.33 million tons; 48% was consumed in the form of flour for food, 15.3% for processing, and 35.8%, amounting to 1.17 million tons, was consumed for feed. In the case of maize, which accounted for 46% of total grain consumption, 77.9% of the total demand of 9.04 million tons was consumed for feed and 21% for processing, and most of the supply was imported. The demand for soybeans reached 1.4 million tons, 7% of which was consumed for food, 24.1% for processing, and 67.8% for feed, which refers to the soybean meal created after oil extraction as a core protein source for livestock ("Food Balance Sheet," 2010; Figure 2-9).

Figure 2-9. Comparison of Staple Grains Consumption by Usage in South Korea in 2009



This increase in demand for grain is attributable to a sharp rise in the demand for meat, and thus feed grain, which has occurred as consumption patterns shift towards more expensive and diversified foods in conjunction with economic development and higher national income.

Lower than the trend of change in total grain demand, the total annual grain consumption for food in South Korea decreased by about 52%, from 219 kg/person/year in 1970 to 104 kg/person/year as of 2010 (Table 2-14). On the other hand, the consumption per person of total grain was estimated at approximately 422 kg as of 2010, after decreasing from its peak of 458 kg, which was a 67% increase in 1996 from 274 kg in 1970. The reason behind the increase in total grain consumption lies in the rise in grain consumption for feed and processing. In particular, consumption for feed increased 13 times, from 18 kg/person/year in 1970 to 228 kg/person/year in 1996, while annual grain consumption per person for feed was estimated at around 190 kg. The grain consumption per person for processing reached 89 kg after a gradual increase until 2005 but declined again recently.

In addition, the grain supply structure has been shaped largely by trends in grain consumption. The total annual grain supply per capita in South Korea (production, imports, and carry-over from the previous year) reached 512 kg/person/year in 1995 after a gradual increase from around 331 kg in 1970, followed by a decrease estimated at 485 kg/person/year in 2010. Domestic production decreased by almost half, to 113 kg/person/year in 2010 after a continuous decline from 220 kg/person/year in 1970, but the net increase in grain demand for feed and processing greatly raised the importation of wheat, soybeans and maize, which in turn increased total grain imports per capita to 316 kg in the 1990s from 66 kg in 1970. Total imports were estimated at around 332 kg/person/year in 2010 after a slight decrease from the peak and a recent rise (Table 2-18).

Table 2-18. Changes in Grain Consumption, Production, and Imports per person in South Korea

(unit: kg)

	1970	1980	1990	1995	2000	2003	2005	2006	2007	2010
Total consumption per person	274	330	380	443	425	424	412	409	407	422
Food consumption per person	219	195	167	161	153	138	136	134	133	104
Feed consumption per person	18	65	147	208	198	199	183	192	191	217
Processed foods consumption per person	27	54	78	84	82	83	89	77	76	87
Total supply per person	331	388	465	512	481	483	463	455	448	485
Production per person	220	185	164	129	126	115	119	123	110	113
Imports per person	66	132	234	316	311	301	289	292	293	322

Source: "Statistics of Food, Agriculture, Forestry, and Fisheries," 2011.

As of 2010, the grain consumption per person for food use consisted of 74.0 kg of rice, 31.4 kg of wheat, 1.2 kg of barley, 4.0 kg of maize, 7.6 kg of soybeans, 3.4 kg of root and tuber crops, and about 3.8 kg of other grains. Rice and wheat composed 57.6% and 25.4%, respectively, which made up 83% of total consumption (Table 2-4). According to the yearly trends of change, rice consumption dropped to 74.0 kg in 2010 from 136.4 kg in 1970. Rice consumption declined moderately from the 1980s but decreased, on average, by about 3.5 kg from 2001 to 2003, with a recent slowdown in the decline of the average 1.6 kg or so. Wheat consumption increased to 33.9 kg in 1995 and remained at that level until 2010 without any distinct change.

The consumption of barley, which had been a staple food item along with rice until rice self-sufficiency was achieved in the 1970s, decreased by 63%, from 37.3 kg/person/year in 1970 to 13.9 kg/person/year in 1980, and further decreased to 1.6 kg/person/year in 1990, standing at an annual consumption of 1.2 kg/person/year in 2010. The per capita consumption of soybeans, the core vegetable protein source in Korea, increased to 8.0 kg in 1980 from 5.3 kg in 1970, standing at 7.6 kg/person/year in 2010. In other crop items, the annual consumption per person of root and tuber crops (potato and sweet potato) stands at the current level after being reduced from 10.2 kg in 1970 to 6.3 kg in 1980, and 3.3 kg in 1990. The consumption of maize and other cereals are at their current level after a gradual increase until the early 2000s. In conclusion, Korean food consumption patterns have changed over time from grain-focused to livestock products, vegetables, and fats and oil. Moreover, as indirect grain consumption has greatly increased, the country has depended heavily on imported feed grains such as maize, soybeans, and wheat.

4) Trends in the Supply and Demand of Other Food Items in South Korea

The food resources produced in South Korea are classified as grains, root and tuber crops, legumes, nuts, seeds, vegetables, fruit, meat, milk, fish and shellfish, seaweed, and fats and oil. The supply and demand of grain and soybeans, which account for most legumes, was discussed in the previous section. This section will review the supply and demand status of root and tuber crops, vegetables, fruit, meat, milk, and fish products that have quantitative importance.

The total annual domestic production of root and tuber crops in 2009 stood at a level of 930,000 tons, showing a decrease by half over the previous 3 decades, from 1.8 million tons in 1980 (Table 2-19). Potato and sweet potato are the main items of root and tuber crops, and the production of sweet potato fell to 320,000 tons from 1.38 million tons in the 1980s. Potato production increased slightly, to 610,000 tons in 2009 from 420,000 tons in the 1980s (Table 2-20).

Legumes for processing and food use mainly refers to the oil extraction of soybeans, which is required to be classified as feed since soybean meal after oil extraction is used as feed. Therefore, self-sufficiency in soybeans for food use should be calculated by a formula of domestic production/food use (%). The domestic soybean production was 330,000 tons until the 1990s and decreased by less than half in the 2000s.

Vegetable production increased to 10.1 million tons in 2009 from 7.3 million in 1980, while the production of the main items, radish and Korean cabbage, decreased. The annual production of radish was 1.7 million tons, and that of cabbage was 3.2 million tons until 2000, but these numbers recently fell to 1.2 million and 2.5 million tons, respectively. The decrease was mainly caused by problems in the distribution process, including frequent extreme weather patterns such as the continuation of the rainy season into August and price collapse.

The domestic production of fruit is on the rise. The total fruit production increased 3.5 times from 830,000 tons in the 1980s to 2.88 million in 2009. The production of watermelon and mandarin oranges significantly increased, whereas apple production dropped (Table 2-20). The production of eggs rose by more than double, from 260,000 tons to 570,000 tons during the same period, and that of milk increased as much as 4.8 times, from 450,000 tons to 2.15 million tons.

The total supply of meat increased 4.5 times, from 530,000 tons in the 1980s to 2.41 million tons in 2009. Domestic production increased from 510,000 tons to 1.8 million tons during the same period, with an increase of imports from under 1 ton to 470,000 tons. Most of the imported meat was beef, and 430,000 tons of the annual beef supply in 2003 was composed of 140,000 tons of domestic beef (32.5%) and 290,000 tons of imported beef (67.5%). The domestic meat production in 2009 was 200,000 tons of beef, 720,000 tons of pork, and 410,000 tons of chicken, with the level of meat self-sufficiency at 80%.

The total supply of fish and shellfish increased to more than double, from 2.13 million tons in the 1980s to 4.36 million tons in 2009. During the same period, imports surged from 40,000 tons to 1.69 million tons, dropping the level of self-sufficiency in fish and shellfish to 61% in 2009. Fish production has not changed much, while shellfish production increased from 590,000 tons in the 1980s to 940,000 in the 1990s, and has remained at this level without any noticeable change.

Table 2-19. Annual Balance Sheet of Other Food Items

(unit: 000 ton)

Food items	Statement	1980	1990	2000	2007	2009
Starchy roots	Production	1,809	983	883	882	939
	Imports	0.0	0.0	10	15	15
	Total supply	1,809	983	893	897	954
	Processing	552	290	9	0.0	-
	Consumption for food	898	512	590	667	713
	Self-sufficiency (%)**	100	100	98.9	98.3	98.4
Pulses	Production	326	337	148	176	155
	Imports	427	1,108	1665	1,293	1,281
	Total supply	858	1,552	1,898	1,539	1,512
	Consumption for food	370	450	507	526	482
	Self-sufficiency (%)**	88.1	74.9	29.2	33.5	32.2
Vegetables	Production	7,298	8,751	11,430	9,587	10,100
	Imports	0.0	97	356	1,108	959
	Total supply	7,298	8,874	11,792	10,716	11,068
	Processing	23	0.0	0.0	0.0	-
	Consumption for food	5,101	6,461	8,880	8,173	8,416
	Self-sufficiency (%)**	99.9	98.9	97.7	90.2	92.6
Fruit	Production	833	1,766	2,436	2,749	2,881
	Imports	15	0.0	330	575	388
	Total supply	848	1,766	2766	3324	3,269
	Processing	14	7	4	203	6.2
	Consumption for food	747	1,540	2,467	2,781	2,891
	Self-sufficiency (%)**	98.5	102.5	88.3	83.5	89.5

Food items	Statement	1980	1990	2000	2007	2009
Meat	Production	516	1,053	1,660	1,711	1,807
	Imports	1	86	386	511	478
	Total supply	536	1,142	2110	2,310	2,410
	Processing	0.0	0.0	0.0	0.0	-
	Consumption for food	530	1,040	1,905	2,111	2,251
	Self-sufficiency (%)**	97.4	92.9	83.9	78.2	77.5
Milk	Production	452	1,801	2,313	2,231	2,146
	Imports	0.0	0.0	645	976	972
	Total supply	452	1,968	3,006	3,213	3,127
	Processing	0.0	525	511	451	419
	Consumption for food	412	1,363	2315	2,674	2,598
	Self-sufficiency (%)**	109.7	92.8	81.2	70.8	70.5
Fish and shellfish	Production	2,090	2,832	2115	2460	2,314
	Imports	40	365	1404	1747	1,692
	Total supply	2,130	3,473	4103	4529	4,361
	Processing	0.0	0.0	0.0	0.0	-
	Consumption for food	1,496	2,211	2290	3233	2,939
	Self-sufficiency (%)**	132.7	121.7	87.7	65.3	74.8

Source: KREI, "Food Balance Sheet," each year.

* Pulses Self Sufficiency (%): (Domestic Production/Food Consumption) × 100.

** Self Sufficiency Rate (%): (Domestic Production/Domestic Consumption***) × 100.

*** Domestic Consumption: Food + Processing + Feed + Seed + Loss.

Table 2-20. Production of Staple Foods in South Korea (unit: 000 ton)

Domestic Production	1980	1990	2000	2007	2009
Starchy roots	1809	984	884	883	939
potato	422	391	539	597	610
sweet potato	1387	592	345	286	329
Pulses	326	332	148	176	154
soybean	257	252	116	156	132
red bean	33	31	13	5	6
Tree nuts	45	89	97	84	83
Oil crops	57	68	42	40	44
sesame seed	12	40	32	16	20
Vegetables	7298	8752	11430	9588	10100
radish	1568	1761	1759	1194	1256
Korean cabbage	2993	3373	3149	2217	2528
onion	542	407	878	1213	1372
scallions	397	467	671	489	446
Fruit	833	1766	2436	2750	2881
watermelon	303	593	923	742	847
apple	568	629	489	436	494
mandarin oranges	331	493	563	778	753
Meat	516	1054	1661	1712	1807
beef	93	95	214	171	200
pork	235	507	714	706	722
chicken	90	172	262	380	409
Eggs	260	393	479	544	573
Milk	452	1802	2313	2232	2146
milk	452	1752	2253	2188	2110

Domestic Production	1980	1990	2000	2007	2009
Fish and shellfish	2090	2832	2115	2461	2314
fish	1498	1888	1269	1330	1426
shellfish	592	944	846	1131	888
Seaweed	317	442	388	811	870
Oils and Fats	117	49	25	15	21
Alcoholic Beverages	2729	2953	3324	3955	4111

Source: KREI, "Food Balance Sheet," each year.

2.2.2. Structure and Status of Food Supply in North Korea

1) Food Supply and Demand in North Korea

The World Food Program (WFP), the Korean Rural Development Administration (KRDA), and the Food and Agriculture Organization of the UN (FAO) grasp the situation of North Korean food production. Although experts refer to the WFP survey data as the most reliable source, most of the statistics on North Korean agriculture and food have poor credibility.

Despite the diligent efforts made by North Korea to increase food production, production volume has not grown significantly. At one point in the mid-1990s, food production dropped to less than 2.7 million tons from 4 million tons, revealing the severe starvation North Korea suffered from 1996 to 2001 (Table 2-21). In 1996/97, food demand in North Korean stood at 5.34 million tons with a shortage of 2.36 million tons, as production was less than 3 million tons. Under the severe food shortage of 1.2 million tons, with imports of only

500,000 tons and food aid of 660,000 tons, hundreds of thousands of people are estimated to have died of starvation. Widespread starvation was prevalent until 2004, and the situation has improved very little. Since 2004, food production has recovered to the level of the mid-1990s, with total grain production standing at 4.15 million tons (Table 2-21).

Table 2-21. Trends in Food Supply and Demand in North Korea from 1995 to 2004

(unit: 000 ton)

	'95/96	'96/97	'97/98	'98/99	'99/00	'00/01	'01/02	'02/03	'03/04
Domestic Supply	4,077	2,995	2,663	3,481	3,420	2,920	3,656	3,840	4,156
Production	4,077	2,837	2,663	3,481	3,420	2,920	3,656	3,840	4,156
Carry-over	n.a.	158	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Consumption	5,988	5,359	4,614	4,835	4,751	4,785	4,957	4,921	5,100
Food	3,688	3,798	3,874	3,925	3,814	3,871	3,855	3,893	3,944
Feed	1,400	600	300	300	300	300	300	178	178
Misc.	900	961	440	610	637	614	802	851	748
Deficiency	1,911	2,364	1,951	1,354	1,331	1,865	1,301	1,084	944
Commercial imports	700	500	700	300	210	200	100	100	100
Food aid	630	660	760	840	586	1,100	819	300	440
Absolute deficiency	581	1,204	491	214	535	565	382	684	404

Note: 2003/04 crop output includes about 50,000 tons of grain produced in home gardens.

Source: FAO/WFP, Special Report: "FAO/WFP Crop and Food Supply Assessment Mission to the Democratic People's Republic of Korea," 1996-2003 (each year).

Table 2-22 is an estimate of the North Korean food supply and demand from 2000 to 2008, where demand is estimated based on North Korea's ordinary food ration (700 g per person per day), and supply is the amount of crop production of the previous year. In 2009, output stood at merely 4.11 million tons against 6.5 million tons of demand, setting virtual self-sufficiency at 63%.

Table 2-22. Trends in Food Supply and Demand in North Korea

(unit: 0,000 ton)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Consumption	613	626	632	639	645	651	650	650	650	650
Production	359	395	413	425	431	454	448	401	431	411

Note: Demand is an estimation based on normal food rations (700 g per person), and supply is the crop yield of the previous year.

Source: Rural Development Administration (RDA), Republic of Korea.

Statistics of imported grain in North Korea show that imports increased to 280,000 tons in 2009/10 from 130,000 tons in 2005/06. During this period, an average of 200,000 tons of grain was imported for 60 million dollars every year. However, due to the global food crisis in 2007/08, the cost of imports is estimated to have surged to 117.58 million dollars in 2009/10 (Table 2-23).

Table 2-23. Commercial Grain Imports in North Korea (October and November, 2005-2011)

Crop Year	Average price ($/ton)	Imports (tons)	Amount of Imports ($)
2005/06	207	130,000	26,904,418
2006/07	207	170,000	35,182,700
2007/08	303	203,508	61,581,280
2008/09	355	175,937	62,440,925
2009/10	417	281,963	117,589,640
2010/11*	455	40,357	18,348,110
Average		192,282	60,739,793

Note: Imports shown through January, 2011.

Source: Estimate of the North Korean regime and the assessment mission team, WFP/FAO/UNICEF, "Rapid Food Security Assessment Mission to the Democratic People's Republic of Korea" (Mar 24, 2011).

North Korea's food import items are primarily maize and flour. The annual maize import for the three years from 2008 to 2010 was estimated at 890,000 tons, and the annual flour import was calculated at 53,000 tons. The import on rice increased to 83,000 tons in 2010 from 20,000 tons in 2008. North Korea's total food import increased to 310,000 tons in 2010 from 150,000 tons in 2008 (Table 2-24).

Table 2-24. Record of Imported Grains in North Korea, 2010-2011

(unit: ton)

Item	Barley	Maize	Rice	Other grains	Flour	Beans	Total
2011. 1	-	600	10,815	240	1,951	480	14,086
2	-	470	312	0	295	145	1,222
3	-	9,050	1,117	0	13,692	265	24,124
4	-	9,819	3,937	123	14,069	130	28,078
5	1	27,491	5,410	60	17,348	18	50,328
2011.1-5	1	47,430	21,591	423	47,355	1,038	117,838
2010.1-12	1,021	87,630	83,947	1,019	114,311	25,766	313,694
2009.1-12	350	83,119	53,687	268	40,265	25,701	203,390
2008.1-12	390	97,606	20,079	1,017	6,642	29,002	154,736

Source: http://db.kita.net (Korea International Trade Association, KOTIS)

The record of bilateral food aid to North Korea indicates that the amount of food aid significantly decreased, to 30,000 tons in 2008/09 from 430,000 tons in 2005/06, 420,000 tons in 2006/07 and 130,000 tons in 2007/08 (Table 2-25).

Table 2-25. Bilateral Food Aid to North Korea (2006-2010)

Crop Year	Aid country	Item	Amount (tons)
2005/06	South Korea	Rice	403,500
	India	Rice	2,000
	China	Soybeans	33,695
Total			439,195
2006/07	South Korea	Rice	400,000
	China	Soybeans	23,610
Total			423,610
2007/08	South Korea	Rice	115,650
	China	Soybeans	17,450
Total			133,100
2008/09	Myanmar	Rice	8,500
	Canada	Soybeans	200
	China	Soybeans	22,336
Total			31,036
2009/10	China	Rice	690
	Myanmar	Rice	1,500
	Vietnam	Rice	3,000
	Canada	Soybeans	260
	China	Soybeans	21,082
	China	Flour	100
	Russia	Flour	9,982

Source: WFP/FAO/UNICEF, "Rapid Food Security Assessment Mission to the Democratic People's Republic of Korea" (Mar 24, 2011).

2) Present Status of Food Production by Item in North Korea

The data released by WFP, the Rural Development Administration (RDA) of ROK, and FAO on North Korean grain production from 2000 to 2010 reveal little difference, showing 4.1 million tons of grain production in North Korea (Table 2-26).

Table 2-26. Trends in Grain Production in North Korea (2000-2010)

(unit: 0,000 ton)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
WFP	292	366	384	416	424	-	-	-	334	432	425
RDA	359	395	413	425	431	454	448	401	431	411	402
FAO	306	394	416	431	433	441	442	383	422	414	-

*Data from the years 2005, 2006, and 2007 are missing from the WFP source.

The staple food sources in North Korea are rice and maize. According to the FAO data, the production of rice recovered to 1.54 million tons in 2004 from 1.09 million tons in 2000, remaining at the same level in 2009 (Table 2-27). Maize production increased to 1.72 million tons in 2003 from 1.04 million in 2000. Meanwhile, the production of soybeans and potatoes decreased, standing at 210,000 and 390,000 tons each in 2009. Wheat production rose from 36,000 tons in 2000 to 126,000 tons in 2004, remaining at the latter level until 2009.

Table 2-27. Crop production in North Korea (unit: 000 ton)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Barely	19.7	47.4	46.9	46.9	43.5	50.3	52.4	51.0	44.2	42.8
Maize	1,041.0	1,483.0	1,651.0	1,725.0	1,727.0	1,630.0	1,750.0	1,587.0	1,411.4	1,705.0
Millet	39.1	46.5	60.5	83.7	50.2	55.8	59.5	56.7	56.7	56.7
Oats	10.6	5.8	8.0	8.0	8.0	8.0	8.0	8.0	9.6	9.1
Rice	1,098.5	1,339.1	1,420.9	1,458.6	1,540.5	1,679.2	1,611.0	1,215.2	1,860.3	1,518.4
Rye	48.6	55.1	48.6	48.6	48.6	48.6	48.6	48.6	58.9	55.7
Sorghum	6.9	9.7	13.8	20.0	13.8	20.7	22.1	20.7	25.1	23.7
Wheat	36.0	89.2	104.4	115.9	126.0	139.0	143.3	140.4	126.0	121.7
Beans	290.0	300.0	339.8	300.0	260.7	265.3	227.9	225.0	250.2	216.3
Potato	467.5	567.0	471.0	505.8	513.0	517.5	500.0	475.0	380.1	390.0
Total	3,057.9	3,942.7	4,164.8	4,312.5	4,331.3	4,414.3	4,422.7	3,827.5	4,222.4	4,139.5

Notes:

① The grain conversion rate of each food item references the Ministry of Food, Agriculture, Forestry, and Fisheries' "Food Policy Database." The grain conversion rate is 68% for barely, 93% for foxtail millet, 53% for oats, 81% for rye, 69% for sorghum, and 72% for wheat.

② The grain conversion rate for rice is 65%, the same as specified in the WFP source.

③ The grain conversion rate for potatoes is calculated as 25% of the production.

Source: FAOSTAT.

The North Korean grain production estimate by the Rural Development Administration of ROK shows a slight difference from the FAO statistics (Table 2-28). The production of rice in 2009 is slightly high at 1.91 million tons, and the production of maize stands at 1.3 million, with a difference of 400,000 tons. However, the production of legumes and root and tuber crops is calculated each at 530,000 tons, with other food items included aside from soybeans and potatoes.

Table 2-28. Estimated Grain Production in North Korea

(unit: 0,000 ton)

Year	Total	Rice	Maize	Pulses	Starchy roots	Barley and other grains
2003	425	172	171	10	47	25
2004	431	180	167	13	45	26
2005	454	202	163	17	47	25
2006	448	189	175	16	45	23
2007	401	153	159	15	47	27
2008	431	186	154	16	51	24
2009	411	191	130	53	53	22

Source: Rural Development Administration (RDA), Republic of Korea.

Since 1996 North Korea has promoted a policy of animal husbandry to expand the raising of plant-eating animals, particularly rabbits and goats, with an effort to revive animal husbandry, which rapidly collapsed during the food crisis in the 1990s. The number of large livestock such as cows increased slightly, while the number of pigs, which are dependent on feed grain, decreased. The number of grass-eating animals increased at a fast pace; in particular, the number of rabbits and goats rose 6.4 times and 3.8 times, respectively, in 2003 compared to 1996 (Table 2-29).

Table 2-29. Changes in the Number of Livestock in North Korea

(unit: 000 head)

	1996 (A)	1997	1998	1999	2000	2001	2002	2003 (B)	B/A
Cattle	615	545	565	577	579	570	575	576	0.94
Milk cows	-	-	-	-	-	9	9	-	-
Pigs	2,674	1,859	2,475	2,970	3,120	3,137	3,152	3,178	1.19
Sheep	248	160	165	185	185	189	170	171	0.69
Goats	712	1,077	1,508	1,900	2,276	2,566	2,693	2,717	3.82
Rabbits	3,056	2,740	2,795	5,202	11,475	19,455	19,482	19,576	6.41
Chickens	8,871	7,547	8,965	10,371	14,844	15,804	17,259	18,711	2.11
Ducks	1,098	822	1,372	1,624	2,078	3,158	4,189	4,613	4.20
Geese	554	357	462	829	889	1,090	1,247	1,247	2.25

Source: http://www.reliefweb.int (FAO, Special Report: "FAO/WFP Crop and Food Supply Assessment Mission to the DPR Korea," Oct 30, 2003).

2.3. Optimal Food and Nutrition Models for Koreans

The Koreans, who lived as a united people for thousands of years, are now living in two separate environments, divided into North and South, without any exchange at all for 65 years, since the liberation from Japanese occupation in 1945. South Korea developed into an advanced nation with more than 20,000 dollars of per capita income in 2011, following rapid economic growth that began in the 1970s. In contrast, North Korea has suffered severe economic difficulties and has relied on food rationing that runs short of the basal metabolic requirement and international emergency relief food since the 1980s.

As mentioned above, the daily food intake of South Koreans averages 1.3 kg, and 20% of that amount, 270 g, consists of animal foods: meat, milk, fish, and eggs. Food energy intake is at the level of 2,000 kcal, and fat intake is increased by animal food consumption. Food energy intake is composed of 65% carbohydrates, 15% protein, and 20% fat. An increase in obesity due to overeating and over-nutrition, particularly child obesity, has emerged as a social issue, and metabolic syndromes and degenerative diseases, including cancer, diabetes, hypertension, and heart disease are widely prevalent. With the unlimited importation of shortage foods, self-sufficiency in total food energy has dipped below 50%, with self-sufficiency in grain a mere 26%. Nevertheless, society is falling into a structure of wanton waste in which 30% of food is thrown away.

On the other hand, the North Koreans are dependent on 500 g of daily food rations (primarily maize) and consume almost no animal foods such as meat or milk. Per capita daily calorie intake is estimated at 1,600 kcal per day, and people are assessed to be chronically undernourished. Under such circumstances, diseases linked to under-nutrition, such as tuberculosis, are prevalent, and the physique of North Koreans is much smaller than that of their southern neighbors, with an obvious trend towards stunting (Table 2-30).

We propose a food and nutrition optimization model for Koreans to simultaneously solve the problems of surplus and deficiency in North and South Korea. The data suggested in this study indicate a rapid increase in South Korea's foreign dependency on food since 1980. Grain self-sufficiency plunged from 73% in 1980 to 43% in

1990 and 29% in 2000. The annual per capita rice consumption decreased from 132 kg in 1980 to 120 kg in 1990, 94 kg in 2000, and 74 kg in 2010. The daily per capita animal food intake doubled over 5 years, from 98 g in 1980 to 183 g in 1985. During this period, the number of patients with metabolic syndromes such as cancer, diabetes, hypertension, and heart disease rose alarmingly. Along with malnutrition issues in North Korea, the South Korean issue of overeating must be addressed. Korean unification can serve as an opportunity to solve the problems of nutritional deficiency and surplus in North and South Korea, respectively.

Table 2-30. Nutritional Anthropological Assessment of 60 Years of Korean Division

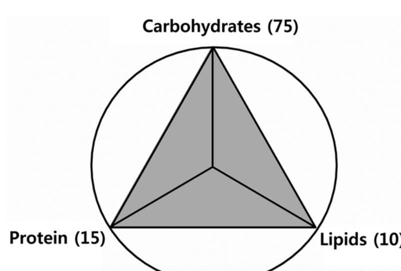
	South Korea	North Korea
Daily food intake (g/person)	1,300	500(+)
Daily energy intake (kcal/person)	2,000	1,600
Energy composition (Carbohydrates : protein : lipids)	65:15:20	80:12:8
Self-sufficiency in grains (%)	26	63
Average height (cm, male/female)	173/159	166/155
Obesity ratio (%)	33	-
Tuberculosis/death ratio (000 person)	90/8	344/25
GDP (US$/person)	20,000	1,000
Political system	Open democracy	Closed communitarianism

Koreans have traditionally eaten rice as a staple and consumed soybeans to fill the shortage of protein. The nutritional goal of Koreans according to the foods found in chopbansang, the traditional Korean menu plan, is to supply 2,000 to 2,500 kcal per day for an adult man, including 80-90 g of protein (animal protein 20-30%), with a calorie composition of 75% carbohydrates, 15% protein, and 10% fat (Lee, C.H. et al., Ryu, Si-sang, 1988; Table 2-31).

The nutrient intake of Koreans shown in the 1981 National Food Consumption Survey Report was 2,040 kcal of energy, 69.9 g of protein, 20.3 g of fat, and 394.2 g of carbohydrates, and the calorie composition of protein, fat, and carbohydrate was 13.7%, 8.9%, and 77.3%, respectively, which was close to the nutritional goal pursued by the Korean traditional diet.

Table 2-31. Nutritional Goal for Koreans Suggested by the Traditional Standard Diet in Korea

Recommended dietary allowance (adult/male)
- Energy 2,000-2,500 kcal
- Protein 80-90 g
Calorie composition
- Carbohydrates 73-77%
- Protein 15-18%
- Lipids 10-12%
Protein composition
- Animal protein 20-30%



Source: Lee, and Ryu, 1988.

In 1986, energy intake stood at 1,983 kcal, composed of 15.4% protein, 13.2% fat, and 71.4% carbohydrates. It has been assessed that fat energy composition rapidly increased, from 8.9% in 1981 to 13.2% in 1986.

The nutritional status of the people in South Korea improved remarkably in 1981 compared to the 1970s. In 1981, the nutrient intake of South Koreans reached the recommended level except for calcium. Therefore, it is deemed desirable to set the optimum food intake of Koreans to the level recorded in 1980. To reach to this optimum level, South Koreans would now be required to double their rice consumption, reduce by half their animal food consumption, and reduce the per capita daily food intake to 1 kg. On this basis, the food demand of North Koreans at a future time of unification in chapter 5 was calculated based on the food intake of South Koreans in 1980.

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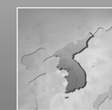
03 Assessment of Food Production Potential on the Korean Peninsula



3.1. Status and Circumstances of Food Production in North Korea

3.1.1. State and Causes of Food Shortage in North Korea

1) Chronic Food Shortage in North Korea

North Korea's total food production was estimated at 5.49 million tons in the 2005/06 crop year, showing a trend towards recovery from 4.56 million tons in the 1995/96 crop year. The annual supply over the past 15 years has averaged 5.17 million tons. From the viewpoint of supply sources, domestic production accounts for 78% of the total, at an annual average of around 4.01 million tons, and the remaining 22% of the total supply has been provided by commercial imports and food aid or assistance from abroad. Total food supply has fallen to the level of 167 kg annually per capita, which is equivalent to 1,640 kcal in energy. This number falls far short of the World Food Program (WFP) recommendation, 222 kg, which is equivalent to 2,130 kcal in energy. North Korea clearly suffers from chronic food shortage. Under the circumstances, the North has no other option but to depend on commercial imports from other countries or foreign food aid/assistance to secure a considerably large amount of food. However, North Korea's foreign relations and trade have been extremely limited since the nation has so few allies. The North's economy worsened significantly with the collapse of the Soviet Union and later, China's economic liberalization and new transitional economy. North Korea's need for commercial imports only expanded.

Recent North Korean food imports from foreign countries reached its peak at 930,000 tons in 2005/06 but dropped sharply, to 290,000 tons in 2008/09. Although North Korea had annually received more than 400,000 tons of rice under the multinational support of South Korea, the WFP, and others before 2008/09, the amount of food aid decreased by 30,000 tons in 2008/09 and continued to be limited in 2009/10. It will not be easy for North Korea to break out of the cycle of chronic food shortage because of economic difficulties involved in purchasing commercial imports and producing food domestically, and due to the political and financial straits of aid-giving nations. Fortunately, however, China has continued to offer assistance at an annual average of 20,000 tons of soybeans and key non-food items such as fuel and agricultural materials. Russia, Myanmar, Vietnam, and India are also providing grains and flour, but the amount is insufficient to fill the food shortage. North Korea must supplement the food assistance it receives with commercial imports in order to overcome national undernourishment. At this time, however, North Korea's opportunity to import food is greatly limited due to changes in domestic economic policies such as currency reform and an imbalance in global grain prices spurred by the surge of grain raised and sold for fuel.

2) Food Production Outlook for North Korea

North Korea has about 9% and 41% more space in total arable land and food crops cultivation, respectively, compared to South Korea. It also distributes preferentially available resources to farming through the collective farm system. In spite of such preferential circumstances the amount of crop production stands at 78% of that of South Korea. The immediate causes include lagging technology and an absolute shortage of production materials such as fertilizer, agricultural chemicals, agricultural equipment, and energy. Indirectly, a socio-political system that fails to properly operate such factors is the fundamental cause, and there has been a continuous food shortage since the 1990s. In particular, the supply of chemical fertilizers amounts to less than 30% of the amount needed, and most farming equipment has not been updated since the 1960s. The absolute lack of energy impedes the smooth operation of farming equipment; energy is supplied only in late April for farming.

In 1990, the collapse of Soviet Union and the economic liberalization of China seriously deteriorated North Korea's foreign relations, putting the North Korean economy in a worse situation. These changes resulted in a sharp drop in productivity in every sector, including agriculture. The absolute lack of materials for agricultural production such as fertilizer, agricultural chemicals, fuel, and agricultural machine parts, and the series of natural disasters since 1995 have seriously impacted agriculture and farm lands. In particular, the continual weather disasters severely damaged crop production and crashed vital elements of the agricultural infrastructure such as irrigation and drainage systems. As result, the major cereal crop production plunged, causing an extreme food shortage.

The policy for developing terraced farms to make mountainous areas arable as a means of farmland expansion devastated about 32% of North Korea's total forest area. This deforestation created an environment vulnerable to natural disasters and climate change, and damage to food production has accumulated year after year with increasingly frequent natural disasters. Moreover, the agricultural structure remains at the level of the 1960s, thus failing to break out of perpetual underdevelopment.

The staple food crops of North Korea are rice and maize, which account for about 80% of the total food. Until the 1990s, maize production in North Korea took up half of the total. However, as rice production increased to about 45% in the 2000s, maize production declined sharply, to 35% (Table 3-1). On the other hand, in South Korea rice production grew remarkably, from 60-70% in the 1970s to 85% in the 1990s and 88% in the 2000s.

Table 3-1. Staple Crops Production (unit: 000 ton)

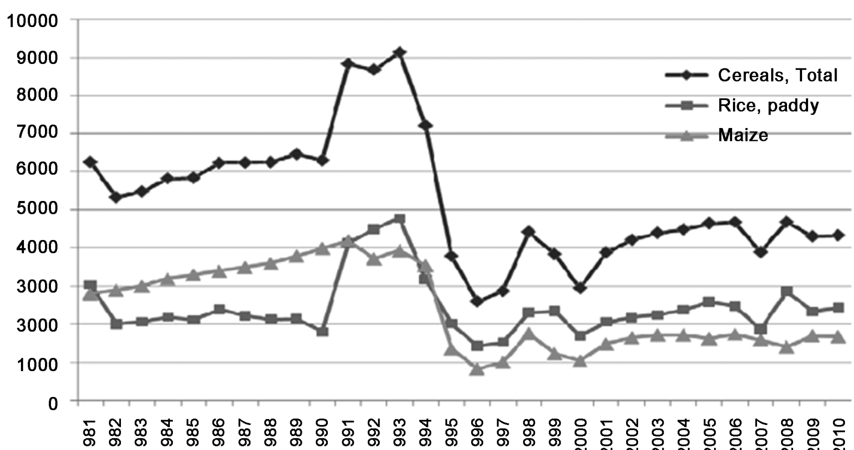
year	South Korea				North Korea				South/North (ratio)	
	rice	%	corn	%	rice	%	corn	%	rice	corn
70	3,939	56.8	68	1.0	1,480	37.2	1,855	46.6	2.7	0.04
80	3,550	66.7	154	2.9	1,245	33.5	2,035	54.8	2.9	0.08
90	5,606	84.5	120	1.8	1,457	36.3	1,949	48.6	3.8	0.06
95	4,695	85.7	74	1.4	1,211	35.1	1,851	53.6	3.9	0.04
00	5,291	89.5	64	1.1	1,424	39.7	1,440	40.1	3.7	0.04
05	4,768	86.4	73	1.3	2,024	44.6	1,630	35.9	2.4	0.04
08	4,843	88.1	93	1.7	1,858	43.1	1,544	35.9	2.6	0.06

Note: Rice production is based on polished rice.

Source: Statistics Korea (KOSTAT), "Main Statistics Index on North Korea," 2009.

Figure 3-1. Staple Food Crops Yield in North Korea (FAO, 2010)

(unit: 000 ton)



3) Causes of Food Shortages in North Korea

The basic element of agricultural production may be summarized as production infrastructure, which includes factors such as arable land and irrigation facilities, production and cultivation techniques, production supplies such as fertilizer, agricultural chemicals, and fuel, and motivation of the powers of production, such as the human labor force. The details pertaining to North Korea follow below.

First, the main agent of production, the peasant, has low morale and lacks motivation to produce. North Korea is a socialist country where an individual receives no ownership of property or incentives to produce; any production belongs to the regime or the community as a unit of a collective farm. There is thus no guarantee of accumulation of wealth from production but there is a growing skepticism about the chances of overcoming chronic poverty, which has the effect of lowering producers' motivation to increase production volume.

Second, the leadership system is centralized and monolithic under the Juche, or self-determination, farming method. It excludes experts' creative technical developments and leadership on production techniques. Monolithic work directions given under the continuous quota system without considering climate, land, or regional characteristics are strongly resisted, and there are no regular, proper updates to move in the direction of high-quality varieties of seeds, for example, or technical development and distribution.

Third, materials are lacking for the production, procurement, and storage of agricultural machine parts and oils. A long downturn in the domestic economy sharply reduced the production and procurement of agricultural production materials. With poor procurement of parts needed for current agricultural machines, outdated machines supplied in the 1960s and 70s continue to be used, thus severely restricting production activity.

Fourth, the aging and devastated production infrastructure has been inadequately restored. Mountainous areas were excessively developed to create terraced farms, sideline farms, and marginal fields in order to expand arable land. The soil loss from frequent rain damage and landslides created higher river beds and poor drainage, which made the restoration of buried arable area difficult and disturbed production for a long time.

Fifth, the consecutive, repeated production of a monocrop, maize, is responsible for a high rate of soil erosion that largely degraded soil fertility, the resulting acidification of which sharply decreased productivity.

Sixth, the collapse of the Soviet Union and the transition economy of China further isolated North Korea from the international community.

Seventh, continual weather disasters such as drought, typhoons, and floods in the 1990s caused overlapping damage, thus sharply reducing production volume.

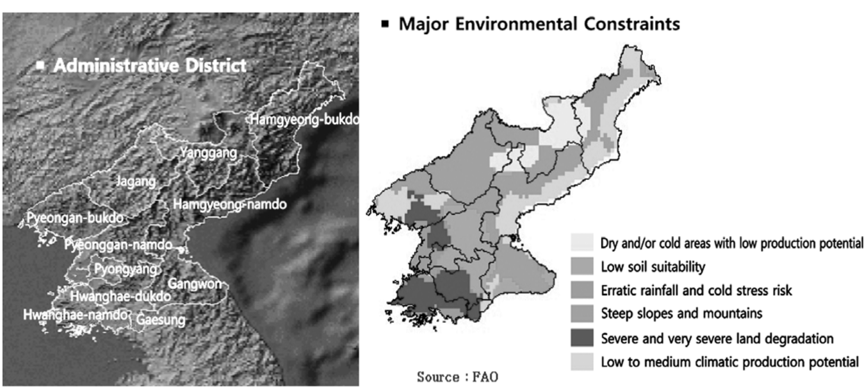
These challenges must be addressed in order to overcome the food security problem in North Korea. Perhaps more importantly, granting ownership and incentives to small-holder farmers to focus on increasing production may be essential to providing the socioeconomic freedom individuals need to feel a sense of fulfillment from their efforts. Neighboring China provides a lesson in that it advanced to become one of the G2 economies by transitioning in 1979 to an open-door policy and implementing other reforms necessary to support the world's largest population, 1.3 billion. North Korea has sufficient potential not only to secure larger arable lands and resources than South Korea but also to support its population of 24 million people, which is half the population of South Korea.

3.1.2. Agricultural Production Infrastructure of North Korea

1) Geographical Conditions of North Korea

The administrative districts of North Korea are composed of 1 metropolitan city (Pyongyang), 2 special metropolitan cities (Nasun, Nampo), 24 cities in 9 provinces, and 147 districts. The total land area of North Korea is 122,762 km^2, about 55% of the 221,336 km^2 that compose the total area of the Korean peninsula, thus edging out South Korea in size. The topography of North Korea comprises 80% mountains and 20% plains, with a high mountain range in the north-east and plains in the southwest. High mountain ranges and their steep slopes have often caused soil erosion from rainfall. Seasonal precipitation fluctuates greatly, and there is a wide annual range of temperatures affected by the continent. Therefore, North Korea has limited arable land, a short crop cultivation period, and meteorological disadvantages. The geographical distribution of most arable land in North Korea falls on the inland plains of the western region, which has low adaptability for crop production and low soil fertility. The west coastal plains are characterized as a low productive zone with habitual flooding and rainfall and cold damage. The southwest plains and the coastal areas in Hwanghae Province are categorized as areas suffering from severe soil erosion and collapse. The east coastal plains are classified as a below-average productive zone with adverse climate conditions, and Yanggang Province across the Baekdu Mountains is generally referred to as a dry and habitually cold-damaged area with low productive potential. The inland areas from Gangwon Province to North Pyeongan Province and Hamgyeong Province comprise steep mountainous areas that are difficult to cultivate for crops (Figure 3-2).

Figure 3-2. Administrative Districts and Major Environmental Constraints for Agricultural Production in North Korea (FAO, 2010)

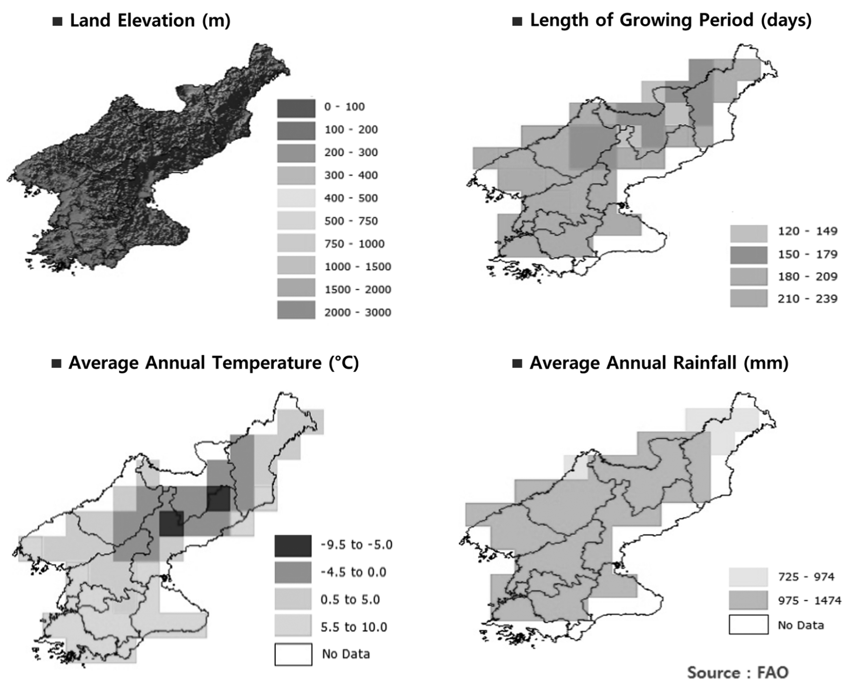


2) Weather Conditions in North Korea

The annual average temperature of North Korea is 3-6℃, much lower than the average 14-15℃ in the southern parts of South Korea and 10℃ in the central provinces. The temperature in the upper regions of the Yalu river is low, averaging around 3°C; Chungjin in North Hamgyeong Province in the northeast region averages 7.7°C; and the western coastal plains, including Pyongyang and Gaeseong, average 9-10°C, which is similar to the central provinces of South Korea. Winter in North Korea averages -5.5°C with a short frost-free period of 6-8 months. Summer is the rainy season and temperatures on the low end average 24°C. Therefore, the biggest restrictive weather factor in crop production is temperature, which is not sustained at high enough levels for the critical growing period of summer crops such as rice and maize, mainly due to the short cultivation period and the injury of early frost. It is also important to manage the sowing time of crops in the regions that are available for double-cropping winter crops.

The annual average precipitation of North Korea is 600-1,400 mm, lower than that of South Korea, which averages 1,200-1,400 mm. Although North Korea's absolute amount of annual precipitation is enough to grow crops, the distribution of rainfall ranges from May to August, thus requiring proper irrigation facilities during other periods for stable crop production. The spring drought often causes difficulties in the cultivation of unirrigated crops, and the heavy rain from July to August also results in serious damage, this time from flooding and soil erosion. North Korea's rainfall also varies by region. The rainfall in northern regions such as Ganggye and Hyesan is 600-700 mm, which means the area is rather dry. On the other hand, east-coastal Hamheung and Sariwon in the western plains average about 900 mm, while coastal plains areas, mainly in Hwanghae Province, receive up to 1,000-1,300 mm (Figure 3-3).

Figure 3-3. Length of Growing Periods and Major Weather Distribution in North Korea (FAO, 2010)



3) Farming Population Composition and Arable Land by Household

A. Farming Population

North Korea's farming population stood at 6.03 million in 1970, which accounted for about 40.5% of the total population. The absolute population engaged in farming continued to grow, reaching 8.57 million as of 2008. It has remained at that level, but the proportion now makes up only 36.8% of the total, and has not changed much since the 1990s (Table 3-2). South Korea's farming population gradually declined from 14.42 million, about 45% of the total, in the 1970s to about 3.18 million, or 6.6% of the total population in 2008. In contrast with South Korea, the farming population of North Korea has not diminished much. The total farming population on the Korean peninsula is 11.76 million, accounting for 16.4% of the total population at this time.

Table 3-2. Farming Population on the Korean Peninsula

(unit: 000 person)

Year	South Korea		North Korea		South & North		South/North (ratio)
	Farming population	%	Farming population	%	Farming population	%	
1970	14,422	44.7	6,036	40.5	20,458	43.4	2.4
1980	10,827	28.4	6,731	38.2	17,558	31.5	1.6
1990	6,661	15.5	7,644	37.8	14,305	22.7	0.9
1995	4,851	10.8	7,863	36.5	12,714	19.1	0.6
2000	4,031	8.6	8,160	36.8	12,191	17.6	0.5
2005	3,434	7.1	8,460	36.8	11,984	16.7	0.4
2006	3,304	6.8	8,493	36.8	11,797	16.5	0.4
2007	3,274	6.8	8,538	36.8	11,812	16.5	0.4
2008	3,187	6.6	8,573	36.8	11,760	16.4	0.4

Source: Statistics Korea (KOSTAT), "Main Statistics Index on North Korea," 2009.

B. Farming Households and Arable Land per Household

The number of farming households in North Korea stood at about 1.99 million as of 2008, an increase of around 38.7%, or approximately 550,000 households, from the 1970s, with an annual average increase rate of about 1%. As a result, the arable land per household decreased by an average 0.46 ha per year to 0.96 ha as of 2008. On the other hand, farming households in South Korea declined by about half, from 2.48 million to 1.21 million during the same period. As opposed to North Korea, South Korea's arable land per household increased from 0.93 ha to 1.45 ha with a reduction in the number of farming households (Table 3-3). Since the combined number of farming households in North and South Korea hovers around 3.2 million, the average arable land per household is 1.14 ha. South Korea's number of farming households is about half the size of North Korea's farming households, while its arable land per household is 1.5 times bigger than that in the North.

Table 3-3. Farming Households and Arable Land per Household

(unit: 000 household; ha)

	South Korea		North Korea		South and North		South/North (ratio)	
	Farming households	Arable land	Farming households	Arable land	Farming households	Arable land	Farming households	Arable land
1970	2,483	0.93	1,437	1.42	3,920	1.11	1.7	0.65
1980	2,155	1.02	1,603	1.31	3,758	1.14	1.3	0.78
1990	1,767	1.19	1,820	1.18	3,587	1.18	1.0	1.01
1995	1,501	1.32	1,872	1.06	3,373	1.18	0.8	1.25
2000	1,383	1.37	1,943	1.03	3,326	1.17	0.7	1.33
2005	1,273	1.43	1,991	0.96	3,264	1.14	0.6	1.49
2006	1,245	1.45	1,991	0.96	3,235	1.15	0.6	1.51
2007	1,231	1.45	1,992	0.96	3,223	1.15	0.6	1.51
2008	1,212	1.45	1,993	0.96	3,205	1.14	0.6	1.51

Source: Statistics Korea (KOSTAT), "Main Statistics Index on North Korea," 2009.

4) The Agricultural Zone and Its Characteristics in North Korea

The rice cultivation zone that North Korea submitted to the UNDP/FAO in 1992 is divided into 17 zones as measured by the given topography of each territory, weather conditions and cropping system (Table 3-4). The Korean Rural Development Administration has integrated and reclassified the areas into 8 zones after consideration of weather characteristics. The areas and primary cultivated crops in each of the 8 agricultural zones are shown in Table 3-5. Rice paddy fields are distributed across about 62.4% of Zone I, which belongs to the west coastal plains, and span about 79% of Zone I and Zone II, which include the central and mountainous areas of the west. The cumulative temperature in these regions is 3,200-3,800℃, and the primary crops cultivated are rice, maize, legumes, barley, vegetables and apples. The cumulative temperature in Zones III, IV, V, and VI is 2,800-3,800℃, and the primary products in these zones are maize, legumes, barley, herbs, rice, livestock, and apples. Zone VII belongs to the southern area of the east coast, including Hamheung, Wonsan, and Gosung, comprising the east coast rice production area as well as cultivated maize and vegetables. Zone VIII belongs to the northern inland high areas, including Hyesan, Musan, and Gapsan, and produces primarily potatoes and barley, mainly cultivated with animal husbandry and beekeeping, and partly used for extremely early varieties of rice.

Table 3-4. Classification of Agricultural Ecological Zones and Weather Characteristics in North Korea

Zone No.	Regions	Average Annual Temperature (°C)	Precipitation (mm)	Cumulative Temperature (>10°C)	Frost Free Period (days)
1	Northeast area of Yanggang Province (Baekmu Highlands)	0-4	600-900	1500-1200	100-200
2	Southeast area of Yanggang Province, Northern area of South Hamgyeong Province	0-4	500-800	1900-2000	125-130
3	East coast of North Hamgyeong Province	4-7	600-900	2200-2600	140-160
4	Inland area of North Hamgyeong Province	2-5	700-800	2500-2900	120-155
5	Inland mountain area of Jagang Province	4-6	800-1000	2600-2900	125-155
6	East coastal area (Wonsan)	4-10	1200-1350	2600-3000	140-155
7	Northeast coast of South Hamgyeong Province	7-8	600-700	2800-3200	150-160
8	Southwest Jagang Province, North area of North Pyeongan Province	6-7	900-1000	3000-3200	150-170
9	East inland area of North Pyeongan Province (Heechun)	6-8	1100-1400	3000-3100	140-165
10	Inland area of South Pyeongan Province	6-8	1100-1300	2800-3000	140-160
11	Southern inland area of East coast (Hamju)	5-9	1100-1200	2900-3000	160-180
12	East coastal area (Bukchung)	8-9	700-1100	3000-3400	180-200

Zone No.	Regions	Average Annual Temperature (°C)	Precipitation (mm)	Cumulative Temperature (>10°C)	Frost Free Period (days)
13	West coast of North Pyeongan Province	8-9	900-1400	3000-3600	165-200
14	Inland area of North Hwanghae Province, Gangwon Province	7-10	1000-1200	3250-3600	160-170
15	Coastal plain field area of South Pyeongan Province	8-14	1000-1100	3500-3700	175-190
16	Plain field area of West coast (Haeju)	10-11	1000-1100	3600-3850	175-200
17	South costal area of Gangwon Province (Gosung)	9-11	1200-1400	3600-3800	180-190

Source: UNDP/FAO, "Business Report," 1992.

Table 3-5. Classification of Agricultural Zones and Crop Placement

Agricultural Zones	Paddy Fields		Cumulative Temperature (>10°C)	Regions	Primary Crops Cultivated
	(000 ha)	(%)			
I. Plains in the west coast	405.9	62.4	3400-3800	Pyongyang, Gaeseong, Nampo, Hwanghae Province, plains of South Pyeongan Province	rice, maize, pulses, barley, vegetables, apples
II. Central and mountainous areas of the west	105.9	16.3	3200-3400	Central and mountainous areas of the west, part of Jagang Province	maize, rice, barley, sericulture

Agricultural Zones	Paddy Fields (000 ha)	(%)	Cumulative Temperature (>10°C)	Regions	Primary Crops Cultivated
III. Northern mountainous area	11.5	1.8	2800-3200	Manpo, Junggang, Dongchang, Jagang Province, partial mountainous area of North Pyeongan Province	maize, rice, herbs, sericulture
IV. Central inland mountainous area	9.1	1.4	3400-3800	Yeongwon, Sinpyeong, Sepodong, mountainous area of South Pyeongan Province and North Hwanghae Province	maize, pulses, potatoes, rice, livestock, sericulture
V. Northeast costal area	22.1	3.4	3250-3400	Northeast costal area including Hoeryeong, Onsung, Najin, Sunbong, Uhrang and Gilju	maize, barley, rice, livestock
VI. Central east coast	26.6	4.1	3000-3000	Central east coastal area including Hwadae, Gimchaek, Bukchung, Hucheon and Sinheung	maize, rice, pulses, barley, apples
VII. Southern east coast	67.6	10.4	2800-3000	Southern area of east coast including Hamheung, Hamju, Geumya, Wonsan and Gosung	rice, maize, vegetables, sericulture
VIII. Northern inland high mountainous area	1.3	0.2	less than 2700°C	Northern inland mountainous area including Musan, Daeheungdan, Hyesan, Gapsan, Pungsan	potatoes, barley, sericulture, livestock, apiculture

Source: UNDP/FAO, "Project Report," 1992.

3.1.3. Size and Usage of Arable Land in North Korea

1) Total Land Area and Its Utilization in North Korea

According to FAO statistics, the total land area of North Korea stands at around 12 million ha, which is larger than South Korea's 9.9 million ha. In terms of land composition, mountain and forest land comprises approximately 5.8 million ha, accounting for 48% of the total, and agricultural areas comprise around 2.9 million ha (about 24%), showing an increase by about 4 percentage points from approximately 2.52 million ha in 1980. Arable land makes up 2.65 million ha (22%), with an increase rate of about 3 percentage points (Table 3-6). In terms of the usage pattern of arable land, there are 585,000 ha of paddy fields (29%) and about 983,000 ha of upland fields (49%), in which upland areas account for almost half the total arable land, implying that North Korea has about 68% more upland areas than paddy fields, in contrast to South Korea (Figure 3-4). Arable land also includes 8% orchards, 3% mulberry fields, and around 10% non-arable land.

The accuracy of the data on arable land in North Korea varies by publishing organization. In terms of the trends in changes since 1990, FAO statistics indicate that arable land in North Korea increased continuously from 2005 and remained at the level of around 2.7 million ha until recently, whereas Statistics Korea (KOSAT) shows that it has been on a continuous decline since the middle of the 1980s. While the FAO estimates arable land area at around 2.65 million ha as of 2009, South Korea's Statistics Korea (KOSTAT) estimates it at 1.91 million ha, or a gap of as much as approximately

740,000 ha. In this case FAO statistics run high. This research, therefore, aims to use the data released by Statistics Korea (KOSTAT) of South Korea as its basis in the discussion of arable land that follows.

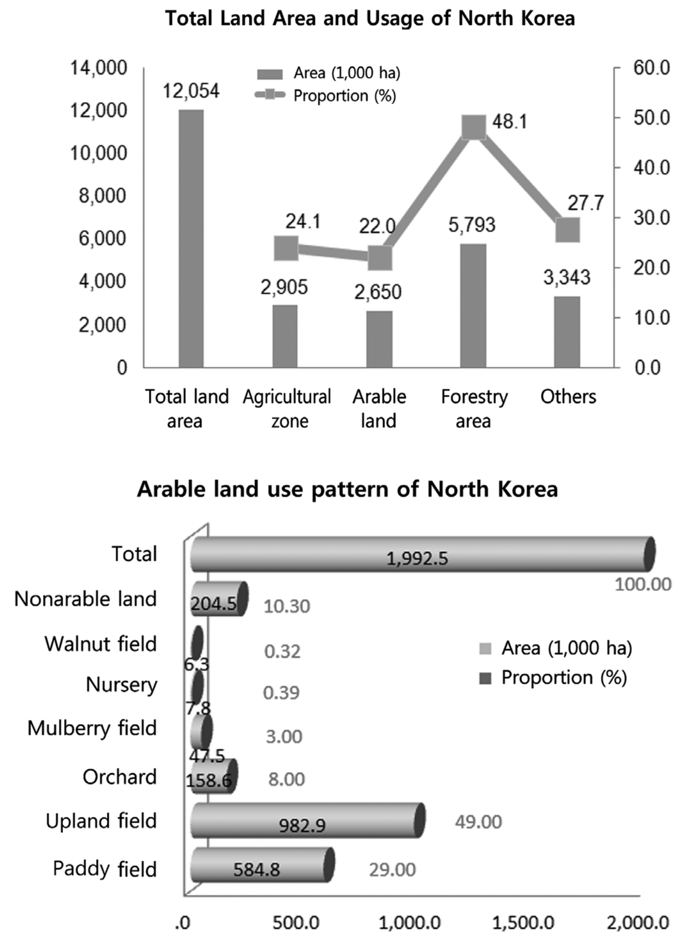
Table 3-6. Total Land Area and Usage Patterns in North Korea

(unit: 000 ha)

Year	Total Land Area	Agricultural Zone	Arable Land	Forestry Area	Other
1980	12,054	2,515	2,285	-	2,156
(%)	100.0	20.9	19.0		17.9
1985	12,054	2,515	2,285	-	2,156
1990	12,054	2,518	2,288	8,201	1,322
1995	12,054	2,650	2,400	7,567	1,824
2000	12,054	2,850	2,600	6,933	2,258
2001	12,054	2,850	2,600	6,806	2,385
2002	12,054	2,950	2,700	6,679	2,412
2003	12,054	2,950	2,700	6,553	2,538
2004	12,054	2,950	2,700	6,426	2,665
2005	12,054	3,000	2,750	6,299	2,742
2006	12,054	2,950	2,700	6,172	2,919
2007	12,054	2,950	2,700	6,046	3,045
2008	12,054	2,950	2,700	5,919	3,172
2009	12,054	2,905	2,650	5,793	3,343
(%)	100.0	24.1	22.0	48.1	27.7

Source: Korea Rural Economy Research Institute (KREI), "North Korean Statistics," 2012.

Figure 3-4. Total Land Area, Arable Land, and Land Usage in North Korea (2009)



Source: Korea Rural Economy Research Institute (KREI), "North Korean Statistics," 2012.

According to KOSTAT's data, the amount of arable land in North Korea increased from 2.037 million ha in 1970 to 2.141 million ha in 1990 and decreased to 1.91 million ha by 2008, where it remains today. Among the arable lands, upland fields account for approximately 68%, at 1.301 million ha, and paddy fields make up around 32%, at 609,000 ha (Table 3-7).

In South Korea, the amount of arable land has decreased from 2.298 million ha to 1.759 million ha as of today, and is composed of 40.5% upland fields and 59% paddy fields. Total arable land of North and South Korea stands at 3.669 million ha as of 2008, consisting of 55% upland fields and 45% paddy fields (Figure 3-5).

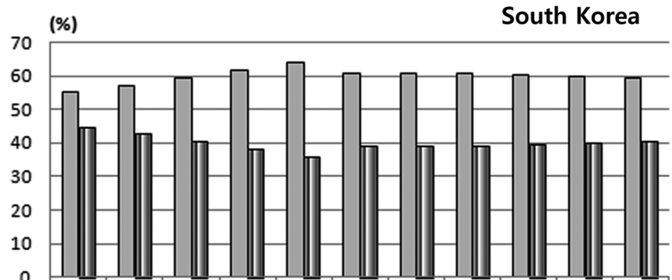
Table 3-7. Trends in Arable Land in North and South Korea

(unit: 000 ha)

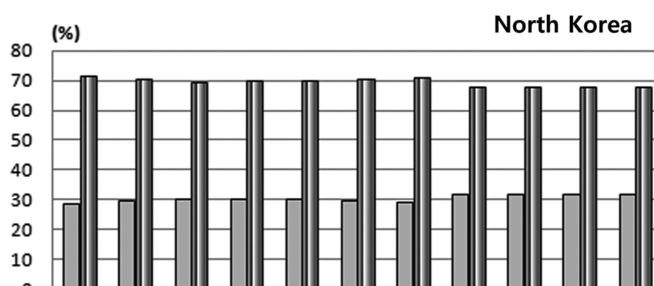
Year	South Korea		North Korea		North & South		South/North (ratio)	
	Paddy fields	Upland fields	Paddy fields	Upland fields	Paddy fields	Upland fields	Paddy fields	Upland fields
1970	1,273	1,025	580	1,457	1,853	2,482	2.2	0.7
1975	1,277	963	610	1,468	1,887	2,427	2.1	0.7
1980	1,307	889	635	1,469	1,942	2,358	2.1	0.6
1985	1,325	819	640	1,500	1,965	2,319	2.1	0.5
1990	1,345	764	645	1,496	1,990	2,260	2.1	0.5
1995	1,206	779	585	1,407	1,791	2,186	2.1	0.6
2000	1,149	740	576	1,416	1,725	2,156	2.0	0.5
2005	1,105	719	609	1,298	1,714	2,017	1.8	0.6
2006	1,084	716	609	1,301	1,693	2,017	1.8	0.6
2007	1,070	712	609	1,301	1,679	2,013	1.8	0.5
2008	1,046	713	609	1,301	1,655	2,014	1.7	0.5

Source: Statistics Korea (KOSTAT), "Main Statistics Index on North Korea," 2009.

Figure 3-5. Proportion of Paddy Fields to Upland Fields in North and South Korea



	1970	1975	1980	1985	1990	1995	2000	2005	2006	2007	2008
Paddy area	55.4	57	59.5	61.8	63.8	60.8	60.8	60.6	60.2	60	59.5
Upland area	44.6	43	40.5	38.2	36.2	39.2	39.2	39.4	39.8	40	40.5



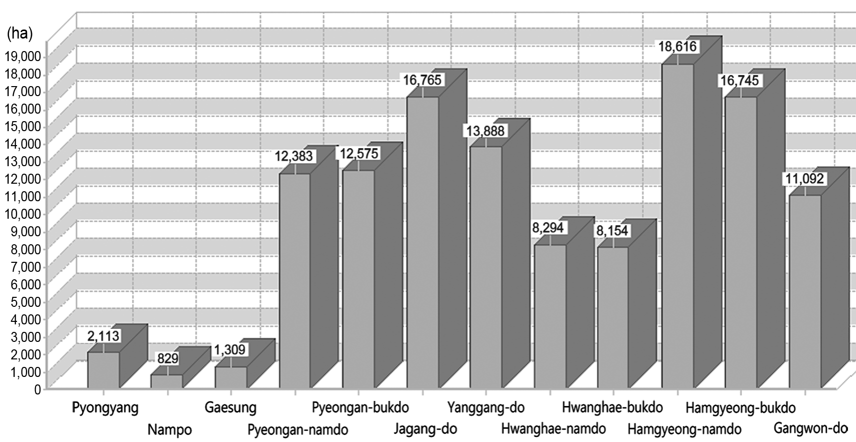
	1970	1975	1980	1985	1990	1995	2000	2005	2006	2007	2008
Paddy area	28.5	29.4	30.2	29.9	30.1	29.4	28.9	31.9	31.9	31.9	31.9
Upland area	71.5	70.6	69.8	70.1	69.9	70.6	71.1	68.1	68.1	68.1	68.1

2) Arable Land and Usage

North Korean farming is highly intensive due to relatively small-scale farming and a policy of self-sufficiency in staple grains. However, the soil in North Korea has become acidified, with a pH in the 5-7 range, and has been poorly fertilized, with low organic content of 0.5%; moreover, there is high risk of soil erosion, particularly in upland cropping. Arable land in North Korea consists of i) annual crop cultivation areas, ii) perennial crop cultivation areas, iii) permanent pasture land and pasturage, and iv) forestry and timber production areas. Land for cultivation is estimated at about 1.85 million ha, which includes 600,000 ha for rice, 650,000 ha for maize, 300,000 ha for fruit, 200,000 ha for vegetables, 50,000 ha for barley and other cereals, and 40,000 ha for potatoes. Land use for cultivation of the top two staple crops, rice and maize, accounts for 80% of the total, which is much higher than the 60-65% of land used for staple crops in neighboring countries. The North Korean regime consistently promotes programs for arable land expansion, currently with a sea reclamation project and a project to use irrigation to transform upland fields into rice paddies. When the peninsula was divided, the proportion of North Korean paddy fields to upland fields was 2 to 8, with some inclined paddies. However, reckless and excessive projects to expand arable land, particularly those involving terraced farms, resulted in severe damage from frequent torrential rain. The random development of hillsides under the reinforced terraced farm project led to severe soil erosion and landslides, which in turn led to soil sedimentation in irrigation canals. This problem required excessive amounts of national maintenance funds to fix the canals. Moreover, the monoculture of maize followed by the cropping of vegetables has perpetuated a vicious cycle of seriously deteriorating the fertility of the soil, accelerating acidification, causing landslides and compounding the damage from drought.

As shown in Figure 3-6, the regional distribution of arable land in North Korea consists of 18,616 ha in South Hamgyeong Province, 16,765 ha in Jagang Province, 16,745 ha in North Hamgyeong Province, 13,888 ha in Yanggang Province, 12,575 ha in North Pyeongan Province, 12,383 ha in South Pyeongan Province, 11,092 ha in Gangwon Province, 8,294 ha in South Hwanghae Province, 8,154 ha in North Hwanghae Province, 2,113 ha in Pyongyang, 1,309 ha in Gaeseong, and 829,000 ha in Nampo.

Figure 3-6. Arable Land by Province in North Korea



Source: Major Statistics Index on North Korea, KREI.

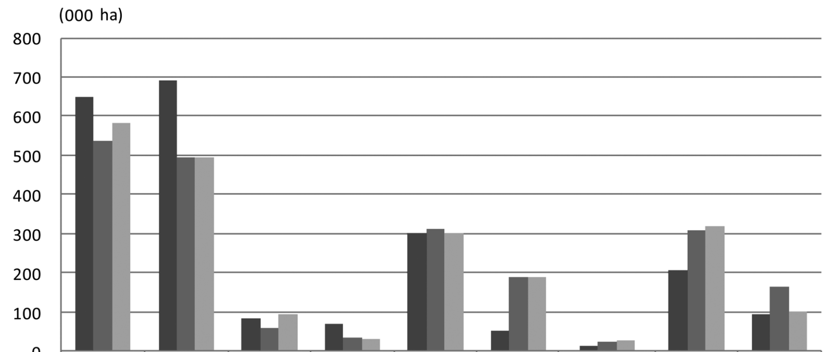
3) Food Crop Cultivation Area and Its Utilization

Arable land for food crops in North Korea is estimated at 1.224 million ha by the FAO, of which two staple crops, rice and maize, occupied about 88% of the total in 2007, or 583,000 ha and 496,000 ha, respectively.

Total land use for all crops in North Korea reaches 2.139 million ha, which includes all the different food crops (Figure 3-7). Land usage for all food crop production is estimated at about 80% of the total, or 1.72 million ha, and vegetable and fruit production comprises about 20%, or 420,000 ha. For food crops, rice production accounts for about 34%, maize 29%, soybeans 17%, root and tuber crops 13%, and barley 7%, of which the three major crops, rice, maize, and soybeans, comprise about 80% of the total.

Trends in land usage for the cultivation of different crops show that production of the staple crops rice and maize is on the decline, while production of roots and tubers, vegetables, and fruits is rising. The area for rice cultivation stood at about 583,000 ha as of 2007, which was a reduction by about 67,000 ha from 650,000 ha in 1980, an annual average decrease rate of around 0.4%. In the same period, the cultivation area for maize decreased by about 194,000 ha, from 690,000 ha to 496,000 ha, at an annual average decrease rate of around 1.04%. Land for barley cultivation diminished by around 44%, from approximately 70,000 ha to 31,000 ha, with an annual average decrease rate of 2.1%. On the other hand, land cultivated for wheat, potatoes, and sweet potatoes now accounts for approximately 310,000 ha, almost double that of 1980. The amount of land cultivated for soybeans has not changed significantly, having remained steady at about 300,000 ha. Areas cultivated for vegetables and fruit has increased from 207,000 ha to 319,000 ha and from 95,000 ha to 100,000 ha, respectively.

Figure 3-7. Changes in Cultivated Land by Food Crop in North Korea



	rice	maize	wheat	barley	pulses	potato	sweet potato	vegetable	fruit
1980	650	690	85	70	300	50	14	207	95
2000	535	496	59	34	310	188	23	309	164
2007	583	496	93	31	300	190	27	319	100

Source: Statistics Korea (KOSTAT), "Main Statistics Index on North Korea," 2009.

The regional distribution and land acreage of cultivated food crops are shown in Table 3-8. More than 60% of cultivated land is concentrated in the west plains and west coastal regions, while about 25% is found on the east coast. The largest area of cultivated land is found in South Hwanghae Province, with 253,000 ha, followed in order by North Pyeongan Province with 205,000 ha, North Hwanghae Province with 168,000 ha, South Pyeongan Province with 158,000 ha, South Hamgyeong Province with 24,000 ha, North Hamgyeong Province with 91,000 ha, and Gangwon Province with 79,000 ha. Regional distribution of cultivated land for staple food crops shows that about 80% of rice is grown in the west coastal plains, with about 43% of total rice produced in South Hwanghae Province and North Pyeongan Province, with 146,000 ha and 101,000 ha, respectively. About 20% of rice is grown in North and South Hamgyeong Provinces and east Gangwon Province. Thus the west coastal plains are the main rice producing regions. Maize, one of the staple crops cultivated in the upland fields, is more or less evenly distributed across the country with less regional deviation in the size of cultivation area compared to rice. About 64% of maize is cultivated in Hwanghae Province and Pyeongan Province, and approximately 27% of maize is grown in the eastern regions of Hamgyeong Province and Gangwon Province.

Table 3-8. Cultivated Land Area and Production of Food Crops by Region in North Korea

Regions	Area (000 ha)			Production (000 ton)		
	Total	Rice	Maize	Total	Rice	Maize
North Korea	1,224	570	503	4,441	2,426	1,683
Pyongyang	27	16	7.3	112	78	27
South Pyeongan	156	83	61	623	399	204
North Pyeongan	205	101	87	795	453	308
Jagang	50	7	35	147	26	106
South Hwanghae	253	146	87	1,020	682	301
North Hwanghae	168	70	80	616	300	285
Gangwon Province	79	34	36	229	100	115
South Hamgyeong	124	60	47	382	185	150
North Hamgyeong	91	25	50	262	72	151
Yanggang	38	2	7.6	159	128	25
Nampo	38	27	7.6	159	128	25

Source: Statistics Korea (KOSTAT), "Main Statistics Index on North Korea," 2009.

4) Comparison of Arable Land and Crop Acreage between North and South Korea

The cultivation area for food crops in North Korea was 2.499 million ha in the 1970s, with about 123% arable land usage, but this usage declined continuously thereafter and has remained at the level of approximately 85% (Table 3-9). In South Korea, land cultivated for food crops in the 1970s stood at 2.947 million ha, about a 128% arable land usage rate, but after a continuous decrease, land usage for crops has dropped sharply, to the level of around 65% as of today. Land for food crop cultivation in North and South Korea has been reduced by half, from 5.446 million ha in 1970 to 2.759 million ha today.

Table 3-9. Arable Land and Cultivated Acreage for Food Crops in North and South Korea

(unit: 000 ha)

	South Korea		North Korea		North & South		South/North (ratio)	
	Arable land	Cultivated area	Arable land	Cultivated area	Arable land	Cultivated area	Arable land	Cultivated area
1970	2,298	2,947	2,037	2,499	4,335	5,446	1.13	1.18
1975	2,240	2,531	2,078	1,889	4,318	4,420	1.08	1.34
1980	2,196	1,982	2,104	1,822	4,300	3,804	1.04	1.09
1985	2,144	1,780	2,140	1,728	4,284	3,508	1.00	1.03
1990	2,109	1,669	2,141	1,734	4,250	3,403	0.99	0.96
1995	1985	1,346	1,992	1,486	3,977	2,832	1.00	0.91
2000	1,889	1,318	1,853	1,572	3,742	2,890	1.02	0.84
2005	1,824	1,234	1,907	1,608	3,731	2,842	0.96	0.77
2006	1,800	1,180	1,910	1,609	3,710	2,789	0.94	0.73
2007	1,782	1,163	1,910	1,610	3,692	2,777	0.93	0.72
2008	1,759	1,145	1,910	1,614	3,669	2,759	0.92	0.71

Source: Statistics Korea (KOSTAT), "Main Statistics Index on North Korea," 2009.

3.1.4. Food Crop Production Per Unit

1) Yield Productivity of Food Crops in North Korea

The food crop productivity per unit area in North Korea is estimated at an average 3.63 tons/ha (Table 3-10). Looking at staple food crops, the productivity of rice is estimated at 4.26 tons/ha in paddy, maize at 3.35 tons/ha, soybeans at 1.71 tons/ha, potatoes at 3.3 tons/ha, and barley and other cereals at around 2.0 tons/ha, indicating that the potential yield of total crops, except soybeans, stands at half the level of South Korea's capacity (Table 3-11).

Table 3-10. Food Crop Cultivation Area, Yield, and Total Production in North Korea

	Total	Rice	Maize	Pulses	Other cereals	Potatoes
Cultivation Area (000 ha)	1,224	570	503	90	13	48
Productivity (ton/ha)	3.63	4.26	3.35	1.71	2	3.3
Production (000 ton)	4,441	2,426	1,683	154	19	158

Source: FAO, 2010.

Table 3-11. Staple Food Crop Productivity in South Korea

(unit: ton/ha)

	Rice	Wheat	Barley	Maize	Pulses	Potatoes
2004	6.79	3.33	4.46	4.26	1.63	5.11
2005	6.61	3.21	4.87	4.84	1.74	5.46
2008	6.94	4.06	4.64	5.05	1.76	5.89
2009	7.06	3.71	4.68	5.02	1.98	5.52

Regional differences in food crop productivity range from the highest, at 4.18 tons/ha in Yanggang Province and Nampo City, to the lowest of around 2.90 tons/ha in Jagang Province, Gangwon Province and North Hamgyeong Province (Table 3-12). Yanggang Province, Nampo City, Pyongyang City and South Hwanghae Province produce 4 tons and above, South Pyeongan Province and North Pyeongan Province yield 3.99 tons/ha and 3.88 tons/ha respectively (higher than the national average), and North Hwanghae Province produces about the national average. However, Gangwon Province, Yanggang Province, South Hamgyeong Province, and North Hamgyeong Province yield 2-3 tons/ha, falling short of the national average (Table 3-12). By crop, maize productivity does not deviate largely, standing at 3.02-3.70 tons/ha with a national average yield ability of 3.35 tons/ha, and rice productivity averages about 4.26 tons/ha nationwide, with a more or less greater regional deviation than maize. In the primary rice cultivation areas, the west coastal and southwest regions, capacity ranges from 4.27 tons/ha in Yanggang Province to 4.86 tons/ha in Pyongyang City, revealing little difference, while the low temperature zone in the east coastal regions and North Pyeongan Province produce 2.21-3.08 tons/ha, indicating a large regional deviation.

Table 3-12. Food Crop Cultivation Area, Productivity and Production by Region of North Korea

(unit: ton/ha)

	Total			Rice			Maize		
	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production
Total	1,224	3.63	4,441	570	4.26	2,426	503	3.35	1,683
Pyongyang	27	4.14	112	16	4.87	78	7.3	3.70	27
South Pyeongan	156	3.99	623	83	4.81	399	61	3,34	204
North Pyeongan	205	3.88	795	101	2.21	453	87	3.54	308
Jagang	50	2.94	147	7	3.71	26	35	3.03	106
South Hwanghae	253	4.03	1,020	146	4.67	682	87	3.46	301
North Hwanghae	168	3.67	616	70	4.29	300	80	3.56	285
Gangwon	79	2.90	229	34	2.94	100	36	3.19	115
South Hamgyeong	124	3.08	382	60	3.08	185	47	3.19	150
North Hamgyeong	91	2.88	262	25	2.88	72	50	3.02	151
Yanggang	38	4.18	159	30	4.27	128	7.6	3.29	25
Nampo	38	4.18	159	27	4,74	128	7.6	3.29	25

Source: FAO, 2010.

Table 3-13 compares the productivity per unit area of food crops and rice between North and South Korea. Food crop productivity per unit area in North Korea is about 2.67 tons/ha, or 56% that of South Korea's 4.8 tons/ha. Its rate has remained the same for the past 20 years without major variation in any given year. The annual average rate increase of rice productivity reached about 0.8%, but increased by about 16% from 2.81 tons/ha in 1991. Still, it is a relatively low yield, only 61% of the South Korean yield of 5.34 tons/ha. Moreover, the food crop productivity per person among the farming population in the North is 0.52 tons/ha, about 37% that of the South Korean productivity of 1.42 tons/ha, which is indicative of the considerably low labor productivity of food crops in North Korea.

Table 3-13. Comparison of Food Crop and Rice Productivity between North and South Korea

(unit: ton/ha)

	Food Crop Yield		Rice Yield		Per Capita Yield of Farm	
	South	North	South	North	South	North
1991	3.96	2.78	4.42	2.81	1.03	0.57
1992	4.17	2.69	4.57	2.69	1.09	0.55
1993	3.77	2.45	4.15	2.32	1.03	0.49
1994	4.06	2.78	4.55	2.64	1.11	0.53
1995	4.04	2.32	4.41	2.10	1.13	0.44
1996	4.54	2.52	5.03	2.33	1.31	0.47
1997	4.63	2.33	5.14	2.61	1.27	0.43
1998	4.29	2.55	4.77	2.54	1.31	0.49
1999	4.49	2.72	4.90	2.81	1.43	0.52
2000	4.45	2.28	4.89	2.64	1.47	0.44
2001	4.61	2.50	5.05	2.94	1.58	0.48
2002	4.27	2.63	4.64	3.00	1.56	0.50
2003	4.02	2.70	4.35	2.96	1.41	0.51
2004	4.56	2.70	4.95	3.09	1.42	0.52
2005	4.47	2.82	4.90	3.46	1.61	0.54
2006	4.49	2.80	4.93	3.23	1.60	0.53
2007	4.32	2.49	4.66	2.60	1.53	0.47
2008	4.80	2.67	5.20	3.17	1.73	0.50
2009	4.93	2.55	5.34	3.26	1.78	-

Source: Statistics Korea (KOSTAT), “Main Statistics Index on North Korea,” 2011.

3.1.5. Trends in the Supply and Demand of Agricultural Production Materials in North Korea

1) Fertilizer Recommendations and Requirements per Crop in North Korea

The proper fertilization recommendation and total fertilizer requirement per food crop in North Korea are shown in Table 3-14. The total cultivated area for food crops is estimated at 1.763 million ha with 1.232 million ha of mono-cropping and 206,000 ha of double-cropping and/or winter crops. In addition, land cultivated for fruits and vegetables is estimated at 474,000 ha. Among monoculture items, the cultivated area of rice is about 570,000 ha, maize 503,000 ha, potatoes 44,000 ha, soybeans 96,000 ha, and other crops 18,000 ha. The recommended amount and ratio of nitrogen, phosphoric acid, and potassium needed to properly fertilize each crop is figured as 110.2-62-76.8 kg/ha for rice, 94-79-68 kg/ha for maize, 103-111-143 kg/ha for potatoes, 96-30-30 kg/ha for soybeans, and 130-59-49 kg/ha for barley. The proper fertilization of fruits and vegetables is known to average 180.0-87.3-129.3 kg/ha. If the proper fertilization recommendation per crop is applied to currently cultivated areas, the total fertilizer requirement is estimated as follows:

Total Fertilizer Requirement

- Total requirement in component: 561,900 tons (367,000 tons for food crops, 194,900 tons for other crops)
- Total requirement in net weight: 1.4963 million tons (990,400 tons for food crops, 505,900 tons for other crops)

Nitrogen Fertilizer

- Total requirement in component: 265,700 tons (174,900 tons for food crops, 90,800 tons for other crops)
- Total requirement in net weight: 577,600 tons (380,200 tons for food crops, 197,400 tons for other crops)

Phosphorus Fertilizer

- Total requirement in component: 127,500 tons (87,000 tons for food crops, 40,500 tons for other crops)
- Total requirement in net weight: 637,500 tons (435,000 tons for food crops, 202,500 tons for other crops)

Potassium Fertilizer

- Total requirement in component: 168,700 tons (105,100 tons for food crops, 63,600 tons for other crops)
- Total requirement in net weight: 281,200 tons (175,200 tons for food crops, 106,000 tons for other crops)

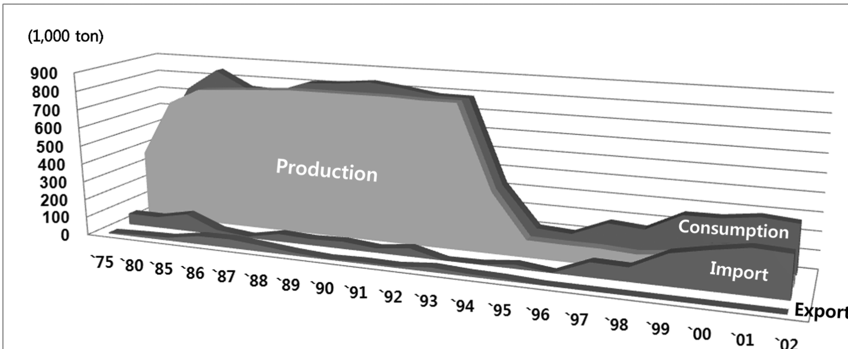
Table 3-14. Fertilization Recommendations and Estimates of Fertilizer Requirements per Food Crop in North Korea

Category	Cultivation area (000 ha)	Recommended amount of fertilization (kg/ha)			Estimated total fertilizer requirement (000 ton)			Total amount (000 ton)
		N	P_2O_5	K_2O	N	P_2O_5	K_2O	
Mono-cropping (Avg.)	1,232	110.2	62.0	76.8	151.20	69.00	84.40	304.60
Winter crop/ Double-cropping (Avg.)	206	116.5	85.0	96.0	23.73	18.03	20.72	62.48
Average of Food crop	1,763	112.0	68.6	82.3	174.90	87.00	105.10	367.00
Total (Weight basis)	-	-	-	-	380.2	435.0	175.2	990.4
Non-food crop	474	180.0	87.3	129.7	90.80	40.50	63.60	194.90
Total (Component basis)	2,237	-	-	-	265.70	127.50	168.70	561.90
Total (Weight basis)	2,237	-	-	-	577.6	637.5	281.2	1,496.3

2) Supply and Demand of Fertilizer

As indicated in Figure 3-8, the total fertilizer consumption increased from about 400,000 tons in the early 1970s to about 700,000 tons in the late 1970s. It has been assessed that North Korea fertilized sufficiently when the country produced about 780,000 tons of fertilizer in 1993, after declining from its peak of 830,000 tons in 1990. However, domestic production fell by 320,000 tons, or about half, in 1994; in 1995 production dropped to less than 100,000 tons and fell yet again, to less than 50,000 tons, in the 2000s, resulting in an absolute shortage. Import volume then increased greatly, and fertilizer consumption now remains in the range of 270,000-280,000 tons, which is near 30% of the total requirement. The current lack of fertilizer is considered to be one of obstacles to sufficient food production.

Figure 3-8. Supply and Demand of Chemical Fertilizer in North Korea



	`75	`80	`85	`86	`87	`88	`89	`90	`91	`92	`93	`94	`95	`96	`97	`98	`99	`00	`01	`02
Export	5	12	16	45	48	33	16	5	10	8	24	14	10	0	0	0	0	0	0	0
Import	62	61	96	25	7	42	34	40	24	45	0	3	22	1	79	75	168	206	238	229
Production	375	680	765	777	787	797	797	797	797	790	790	334	95	92	92	82	104	50	43	37
Consumption	434	729	844	755	746	806	815	832	811	783	781	323	104	93	171	157	253	256	281	266

Source: Korea Agricultural and Rural Research Institute, "Main Statistics Index on North Korea."

Nitrogen fertilizer consumption in North Korea is about 75 kg/ha, half the level of an adequate amount (150 kg/ha), and phosphate and potassium fertilizers are hardly used. According to a report by the UNDP in 1988, two major staple food crops (rice and maize) in North Korea were estimated to be fertilized only by 30 kg/ha of nitrogen fertilizer, accounting for only 18.8% of the total demand (Table 3-15). According to a KREI (Korea Rural Economic Institute) report, North Korea's, fertilizer requirement is estimated at 580,000 tons. Even though the total inputs increased to 120,000 tons in 1998, 240,000 tons in 2003, and 230,000 tons in 2004, yet the supply still meets less than 40% of demand. These increases in input included 30% in domestic production and commercial imports and more than 70% in food aid/assistance by the international community, starting with South Korea (Table 3-16). However, the recent suspension of South Korean assistance in fertilizer and the surge in global crude oil prices made commercial imports to North Korea difficult as well.

Table 3-15. Input of Production Factors for Cultivation of Rice and Maize in North Korea (1998)

Materials	Unit	Actual Input (%)		Requirement	
		Rice	Maize	Rice	Maize
N	kg/ha	30 (18.8)	30 (18.8)	150-170	157-179
P_2O_2	kg/ha	n.a.	n.a.	75-875	75-85
KCl	kg/ha	n.a.	n.a.	75-85	75-85
Pesticides	kg/ha	n.a.	n.a.	1.7	1.7
Seeds	kg/ha	60 (100)	40 (100)	60	40
Vinyl	kg/ha	n.a.	n.a.	600	230
Agricultural machinery	hour/ha	18 (37.5)	18 (81.8)	48	22
Fuel	liter/ha	26 (19.7)	22 (20.4)	132	108
Water	m^3/ha	10,000 (100)	n.a.	10,000	n.a.

Note: Based on first-class land.
Source: UNDP, 1998.

Table 3-16. Supply and Demand of Chemical Fertilizer in North Korea

(unit: 000 ton on a component basis)

Division	1997	1998	2003	2004
Requirement	580	580	580	580
Total Supply (%)	193	124 (100)	244 (100)	230 (100)
- International aid	n.a	77 (62.1)	175 (71.7)	166 (72.2)
- Domestic production	n.a	47 (37.9)	32 (13.1)	56 (24.3)
- Commercial imports	n.a	n.a	37 (15.2)	8 (3.5)
Shortage	387	(456)	(336)	(350)

Source: KREI, North Korean Agriculture Trends, vol. 9, 2007.

2) Food Crop Fertilization and Regional Comparisons

Fertilizer consumption for the top two staple food crops, rice and maize, according to a report by the FAO, is shown in Table 3-17. Rice is estimated to require fertilizer averaging 81 kg/ha of nitrogen, 13 kg/ha of phosphoric acid (P_2O_5), and 2 kg/ha of potassium (K_2O). The estimates for maize are 58 kg/ha of nitrogen, 12 kg/ha of phosphoric acid (P_2O_5), and 11 kg/ha of potassium (K_2O). These numbers indicate that the production of food crops in North Korea mainly requires nitrogen fertilizer, although there is a severe shortage vis-à-vis demand.

Rice has a higher use-efficiency of fertilizer than upland crops, since it is generally cultivated with irrigation systems. Considering that the recommendation for an adequate amount of fertilizer for cultivating rice in North Korea is N-P-K=120-130-80 kg/ha on a component basis, it is assessed that the nitrogen fertilizer only accounts for an average of 60-70%, and phosphoric acid and potassium make up almost none of the fertilizer.

Table 3-17. Fertilizer Consumption for Food Production by Region in North Korea (Component basis, 1998-2000)

Province	Rice (kg/ha)				Maize (kg/ha)			
	N	P_2O_5	K_2O	Total	N	P_2O_5	K_2O	Total
Pyongyang	100	16	2	118	66	15	16	97
South Pyeongan	87	14	3	104	61	14	14	89
North Pyeongan	96	16	4	116	64	14	17	95
Jagang	76	11	1	88	67	13	10	90
South Hwanghae	90	21	5	116	65	18	19	101
North Hwanghae	72	15	3	90	50	13	14	76
Gangwon	82	11	1	94	56	9	5	70
South Hamgyeong	80	8	2	90	54	11	11	76
North Hamgyeong	83	7	1	91	51	9	6	67
Yanggang	50	0	0.5	51	68	5	5	78
Gaeseong	78	20	0.5	98	66	16	15	97
Nampo	80	19	1	100	71	17	16	104
Average	81	13	2	96	58	12	11	81

Source: FAO, "Fertilizer Use by Crop," *FAO Fertilizer and Plant Nutrition Bulletin*, 2006.

As a C_4 plant, maize commonly has a nutrient absorption rate 30-50% higher than other crops, and the efficiency of its fertilizer drops if farms in dry conditions fail to be properly irrigated. The amount of fertilizer for maize, then, ought to be increased. It is known that maize absorbs 25-30 kg of nitrogen, 10 kg of phosphoric acid, 20-35 kg of potassium, and 8-10 kg of calcium and magnesium, respectively, and a considerable amount of silicon to produce one ton of grain. The requirement for nitrogen is normally 150-180 kg/ha, and fertilization should be adjusted further depending on soil conditions, fertility, and the response of fertilizer to different weather conditions. Yet the amount of nitrogen fertilizer currently used for maize is merely 30-40%, or in absolute shortage, and the micro-elements phosphoric acid and potassium are also in absolute deficiency.

According to an FAO report (2006), the fertilizer usage per unit area consumed to produce staple food crops by region is shown in Table 3-17. In the case of rice, nitrogen fertilizer ranges from 50-100 kg/ha, with huge regional differences. The west plains region, the primary cultivation area of rice, including Pyongyang, South Pyeongan Province, and South Hwanghae Province, uses 87 kg/ha of nitrogen fertilizer, while North Hwanghae Province, Nampo, and Gaeseong use 72-80 kg/ha. The rice cultivation area in the northeast region consumes a slightly lower level of nitrogen fertilizer, 80-83 kg/ha, comprising South Hamgyeong Province, North Hamgyeong Province, and Gangwon Province. The northwest mountain plains in Yanggang Province consume the lowest amount of nitrogen fertilizer: only 50 kg/ha. Phosphorus fertilizer consumption stands at 19-21 kg/ha in South Hwanghae Province, Gaeseong, and Nampo, 14-16 kg/ha in Pyongyang, North Hwanghae Province, North Pyeongan Province and South Pyeongan Province, and 7-11 kg/ha in North and South Hamgyeong Provinces and Gangwon Province in the northeast region. Potassium fertilizer is consumed across the country at merely 0.5-5 kg/ha, an overall low level.

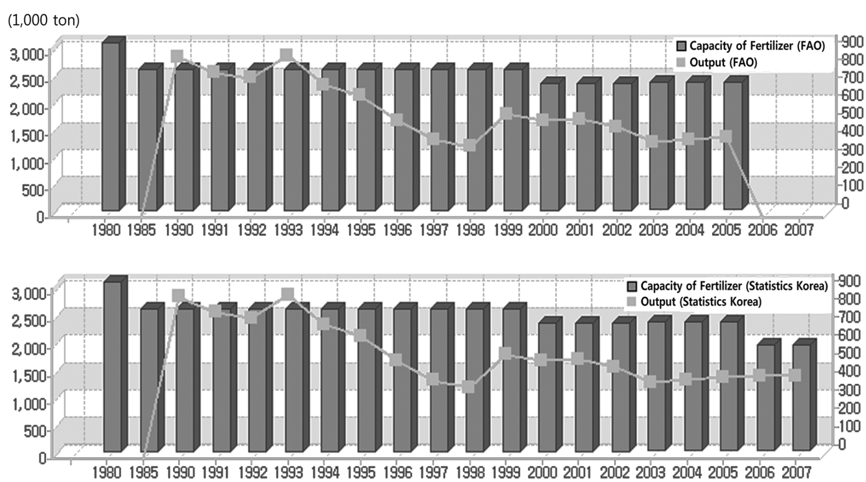
Thus, in terms of the amount of fertilizer for maize cultivation, North Hwanghae Province, Hamgyeong Province, and Gangwon Province consume 50-56 kg/ha of nitrogen fertilizer, and other areas use 61-71 kg/ha of the fertilizer, confirming a slightly higher usage in the southwest plains. Phosphate and potassium fertilizer consumption is low in the northeast area of Gangwon Province and the Hamgyeong Provinces, and slightly higher in other areas. In general, the application of fertilizers in food crop production is assessed to be at an absolute low, particularly in the northeast area of the Hamgyeong Provinces, Gangwon Province, and the northern mountainous area of Yanggang Province.

3) Fertilizer Production of North Korea

North Korea's production of fertilizer had met the domestic requirement by the early 1990s with the amount of fertilizer produced in three fertilizer factories in Namheung, Heungnam, and Aoji. Data from Statistics Korea (KOSTAT) shows the capacity of fertilizer production of North Korea as of 2009 at approximately 1.94 million weight tons, with production volume at around 460,000 component tons (Figure 3-9).

Despite the capacity of such facilities for fertilizer production, North Korea is not able to meet the domestic demand for fertilizer. It is likely those facilities may not be operating properly, based on the nationwide shortage of raw materials that began in the early 1990s due to the collapse of the Soviet Union, an allied socialist nation, North Korea's economic isolation from the international community after China's switch to a transition economy, and a long-term global economic deterioration that has made it difficult to import raw materials and procure crude oil for the production of sufficient fertilizer. An additional reason North Korea may lag behind is that its fertilizer production facilities are outdated and aging, having been built before the 1970s and having failed to make the transition to efficient modern facilities. Modernization of said facilities is now urgently required.

Figure 3-9. Production Capacity and Output of Fertilizer (data comparison between the FAO and Statistics Korea (KOSTAT))



4) Fertilizer Production and Production Capacity in North and South Korea

Currently, South Korea's fertilizer production far outpaces that of its northern neighbor in terms of production facility and capacity. The production capacity of fertilizer in South Korea is about 4.25

million tons on a weight basis, and output is about 2.55 million tons on a component basis, which exceeds the domestic requirement. South Korea produces enough to achieve self-sufficiency in fertilizer and exports half the amount of its output.

As the fertilizer production of North and South Korea is as much as 6.2 million tons on a weight basis and a total of 3.02 million tons on a component basis, it is feasible that North and South Korea will be self-sufficient in fertilizer production at the time of unification. Recently the total fertilizer production in South Korea has exceeded 1 million component tons, indicating that twice the domestic consumption of about 500,000 tons is being produced (Table 3-18).

Table 3-18. Production Capacity and Output of Chemical Fertilizer in North and South Korea

	Production capacity (000 ton)			Output (000 ton)		
	South Korea	North Korea	North & South Korea	South Korea	North Korea	North & South Korea
2000	4,588	2,352	6,940	3,730	539	4,269
2005	5,034	2,372	7,406	3,950	450	4,400
2008	4,249	1,949	6,198	3,188	479	3,667
2009	4,249	1,949	6,198	2,558	466	3,024

Notes:
① Yield in weight basis tons, output in component basis tons.
② Based on nitrogen 46%, phosphoric acid 20% contained.

Source: Korea Fertilizer Industry Association, Statistics Korea (KOSTAT), "Main Statistics Index on North Korea," 2011.

5) Supply and Demand of Pesticides

The main trade partners of North Korea had been the allied countries of socialist states, including the Soviet Union, China, and some countries in Eastern Europe. With the collapse of the socialist allies in the early 1990s, many states cut back on investments in North Korea and reduced exports, including crude oil and raw materials, which caused a sharp decrease in the operation rate of production facilities, hitting hard the production of essential materials such as fertilizer and agricultural chemicals. Before long, agricultural materials production facilities could barely operate, and as the domestic economic condition contracted, it became more difficult to import necessary commodities. The operation rate of production facilities for agricultural materials is now less than 20%, with no prospect of improvement.

In North Korea, except for the Shinheung Chemistry Alliance Enterprise, which was completed in 1992, agricultural chemical manufacturing factories were mostly constructed in the early 1960s, suggesting severely aged facilities. North Korea had been producing necessary agricultural chemicals on its own until the 1980s, and in the early 1990s the net weight of agricultural chemical production was around 30,000 tons, comprised of about 20 types of chemicals. However, aging technology and facilities, as well as an absolute shortage of commodities and energy, are largely to blame for the decrease in production. The agricultural chemicals primarily manufactured today are presumed to be mostly limited to BHC and DDT, harmful chemicals of high residual toxicity.

While the agricultural chemical requirement of North Korea largely depends on the incidence of pests, diseases, and weeds, common commercial levels dictate that about 15,000 tons of modernized, highly potent agricultural chemicals are required annually, more than 8,000 tons of which are needed for minimum pest control. To meet its demand for agricultural chemicals North Korea imported them from China and Japan in the early 1990s, but has been almost entirely dependent on China since 1993. The amount of imports reached about 8,000 tons in the mid-1990s, but has since fallen to 3,000 tons, a severe shortage that fails to secure adequate prevention of pests and disease. Table 3-19 shows the consumption and production of fertilizer and agrochemicals in South Korea.

Table 3-19. Consumption and Production of Fertilizer and Pesticides in South Korea

Fertilizer production/ consumption	2008	2009	Pesticide production/ consumption	2008	2009
Total consumption (000 ton)	570.1	499.6	**Total consumption (tons)**	25,368	22,790
- Nitrogen	301.7	262.3	- Fungicide	6,865	6,146
- Phosphorous	115.5	101.9	- Insecticide	9,960	8,810
- Potassium	152.9	135.4	- Herbicide	6,073	5,909
Total production (000 ton)	1,151	865	- Growth regulator/Other	2,470	1,929
- Nitrogen	594.3	496.6	**Consumption (kg/ha)**	13.8	12.2
- Phosphorous	350.7	224.1	**Total production (tons)**	22,168	24,621
- Potassium	206.5	144.1	- Fungicide	6,351	7,124
By use (000 ton)			- Insecticide	7,592	9,178
- Agriculture	581.5	456.1	- Herbicide	5,813	6,168
- Export, Industry, Other	569.9	408.7	- Growth regulator/Other	2,412	2,151

3.1.6. Agricultural Mechanization in North Korea

1) Farm Mechanization Status of North Korea

North Korea follows an “agriculture first” policy, in which strenuous efforts are made to improve agricultural production with innovations in farm mechanization, chemicals, and agricultural scientific technology to adapt to the needs of the nation’s Juche (self-determination) farming method by stabilizing farming production with consistently good harvests (Han Chung-sung et al., 1994). For decades, North Korea has strongly pushed the "four principle movement" of "irrigation installation," "electrification," "mechanization," and "chemicalization," and in the 1960s declared the successful completion of irrigation installation and electrification. Mechanization and chemicalization followed: mechanization began in the early 1960s under the newly mandated "enforcement regulations" and prioritized collectivized farmland.

With farmland collectivization and agricultural cooperation achieved in 1958, North Korea started to promote the mechanization of farming, mainly focusing on large farming machines, tractors, and various kinds of tractor attachments. It seemed that farm mechanization aimed to mobilize labor in the mining and defense industries or on various construction sites and for the military under the slogan "Liberation of the people from farm work." However, since North Korea continues to mobilizes students, soldiers, and workers on a large scale for rice and upland crop (maize) planting, it is assumed that North Korea's farming may not be sufficiently mechanized except for plowing. The severe energy crisis in North Korea has caused it to lag dramatically in the production and supply of farming machines, and broken farming machines remain unfixed due to the failure to acquire the necessary machine parts or farming fuel in a timely manner.

According to North Korea's farm mechanization plan, 12 tractors per 100 ha were to be supplied in the plains (the equivalent of 28 horsepower tractors) and 10 in the mountainous areas until 1993, but in reality only 5 tractors per 100 ha were supplied. Moreover, the degree of North Korea's mechanization appears to have decreased further under the ensuing economic downturn. The number of tractors, key players among North Korean farming machines, declined from 70,000 in 1990 to 64,000 in 2003 (Table 3-20). In 2004 the number of tractors in operation stood at about 20,000, half the amount required, which means that half of the agricultural groundwork depended on animal or man power (FAO/WFP, 2004; Table 3-21). As of yet there is no supply or ability to procure parts or tires for the aging agricultural machines, and further, the operation of the machines is severely limited by fuel shortage.

Table 3-20. Comparison of Number of Tractors between North and South Korea

(unit: 1 tractor)

	2000	2002	2003	2005	2006	2007	2008	2009
South	191,631	206,371	211,576	27,873	236,707	243,662	253,531	258,662
North	64,699	64,250	64,200	64,200	64,200	64,200	…	…

Source: KOSTAT, "Main Statistics Index on North Korea" (2009); FAO (2007-2010).

Table 3-21. Available Power Status of North Korean Agriculture

Types	Potential Power		Operation Power		
	Number (A)	Power (1,000 kWh)	Number (B)	Power (1,000 kWh)	B/A (%)
By Man	3,490,000	254	4,400,000	328	129
By Animal	800,000	418	800,000	418	100
Agriculture Machinery	70,000	2,231	20,000	463	20
Total	-	2,902	-	1,199	41

Source: UNDP; Korea Agricultural and Rural Research Institute (KARRI) (2006).

A rice planting machine called Daedongganho was developed in 1973 and has been remodeled and used until now (Park Woo-poong et al., 1996). Rice seedlings are being raised on cold seedling nursery beds to produce 40-50 day-old seedlings, unlike South Korea's rice seedlings, which are raised with seedling boxes for 20-25 days. Instead of employing one worker on a planting machine as in South Korea, in the North three workers ride on a machine to plant rice seedlings: one for driving the machine and two in the rear for inserting rice seedlings into planting holes in the paddy. Thus the North requires three times the manpower to transplant rice seedlings compared to South Korea, but also requires much greater manpower as a machine-working team that consists of 14 persons, including 5 for pulling and binding rice seedlings, 3 for delivering rice seedlings to the paddy, and 3 to fill holes missed after transplanting, all of which results in very low work-efficiency. To be efficient, the North must shift to South Korea's single-driver rice planting machine. Pest control is also carried out manually in the North, so a supply source is needed to power a mechanical control system or to develop an automatic control system.

Although there is a tractor-attached blade mower system for crop harvest, most of the crops are harvested by manpower due to poor procurement of energy and mower parts. Harvesting in North Korea currently requires a large labor force and has a high rate of product loss and low-quality produce due to the failure to harvest on time. Rather than using their semi-automatic thresher, North Korea must advance its system toward the full automatic combine, as is used in the South. It is also necessary that the North establish a comprehensive system for dry storage of the harvest.

In conclusion, North Korea must modernize their farming system and mechanization and acquire sufficient supplies of machine parts and fuel in order to use their labor force efficiently and replace harvest loss with quality farm produce.

2) Status of Production and Supply of Agricultural Machines in North Korea

According to early agricultural mechanization plans released by North Korea, facilities for manufacturing agricultural machines would be expanded, particularly focusing on the production and supply of large farming machines, under the goal of producing 21,000 machines (including the Chunrima 10,000 and Poongnyeon 5,000) from 1971-1976; 45,000 (10 per 100 ha of arable land) in the second, 7-year plan period (1978-1984); and 1.5 times higher than that in the third 7-year plan period (1987-1993).

Considering the output operation rate of each agrimachine production factory, it has been assessed that the actual production volume of tractors in North Korea reached about 3,200 in 1957-1960, 17,100 in 1961-1970 and 21,210 in 1971-1976, with an annual average volume of 1,700 in the 1960s and 2,500 in the 1970s. The production volume of tractors in the 1970s was estimated at 30,000 until 1973, 45,000 1978-1986, and 67,000 1987-1996.

The North's repair service for agricultural machines is systematized, just like production. Major repairs are conducted in provincial repair shops, medium-scale repairs in district farming machine repair workspaces, and small-scale repair in mechanization work-groups of collective farms. The number of such working groups across the country is estimated at 1,107 ("Nongmin Shinmun," July 3, 1996).

Although North Korea has introduced the self-manufactured cultivator-like tractor Chungsung and tractors Chunrima and Poongnyeon, these are slightly changed versions of old models, of which it is estimated that there were 8 types. The cultivator-like tractor Chungsung, with 6 horsepower, is designed to work on any fuel, whether petroleum, diesel oil, or heavy oil, and there are research results on alternative fuels for tractors such as methane gas, indicating a certain level of improvement in commercialization of alternative energy.

Despite North Korea's report to the FAO on the number of projected tractors as 139,000 in 1998, the FAO doubted the credibility of the data, given the land available for mechanization and the operating performance of tractors, and readjusted the number to 71,000. The number of North Korean tractors released after a back-and-forth with the FAO was 75,000 units, an average 3.8 units per 100 ha. Based on these results, farm mechanization in North Korea is estimated to have been in suspension since its peak in the early or middle 1980s.

3.1.7. Agricultural Infrastructure Organization of North Korea

1) Readjustment of Arable Land

Since the 1950s North Korea has continued to promote a nationwide infrastructure adjustment project to enhance agricultural production under the rubric "Mother Nature Re-creation Project." The project aimed to expand arable lands by developing terraced farms and land reclamation, improve soil fertility and land readjustment, and increase irrigation systems through the development of water resources and river construction. However, the reckless development of terraced farmland increased landslides and soil erosion when heavy rains came, which also caused irrigation canals and river beds to flood. Crop production was damaged exceedingly by frequent weather disasters such as floods and drought.

North Korea has since undertaken the adjustment of its leftover pieces of arable land that had been so randomly and inconsistently formed. Starting in 1998 in Gangwon Province, and based on the 5 principles of the renamed "Mother Nature Re-creation Plan" (October 1976), North Korea has pursued upland irrigation of 400,000 ha, the development of terraced farmland of 120,000-200,000 ha, land readjustment, and land reclamation. As shown in Table 3-22, around 51.6% of the total area of paddy fields, or 580,000 ha, has been standardized in field plot sizes from 2,644 square meters to 4,958 square meters, resulting in 531,340 ha of patchy land readjusted to 149,384 standardized plots of land. With that change, paddy fields have increased by about 6,090 ha since the levee size for the rice paddies decreased from 629,000 km to 16,000 km.

In regional arable land adjustments, approximately 84% of the total 35,800 ha of paddy fields was readjusted in Gangwon Province, 50% of 100,000 ha in North Pyeongan Province, 6.5% of 150,000 ha in South Hwanghae Province, 92% of 98,000 ha in South Pyeongan Province, and 69% of the total was adjusted in Pyongyang and Nampo, each. The construction standards for land units of paddy fields and the floor plan for the arable land adjustment project are demonstrated in Table 3-23 and Figure 3-10 below.

Table 3-22. Overview of Arable Land Adjustment Project

Province	Paddy field (000 ha)	Adjustment land (000 ha)	Expanded land (ha)
Gangwon	35.8	30.0	1,760
North Pyeongan	103.1	51.5	2,000
South Hwanghae	150.3	100.0	2,310
South Pyeongan	98.0	90.0	-
Pyongyang, Nampo	41.9	29.0	-
Total	429.1	300.5	6,070

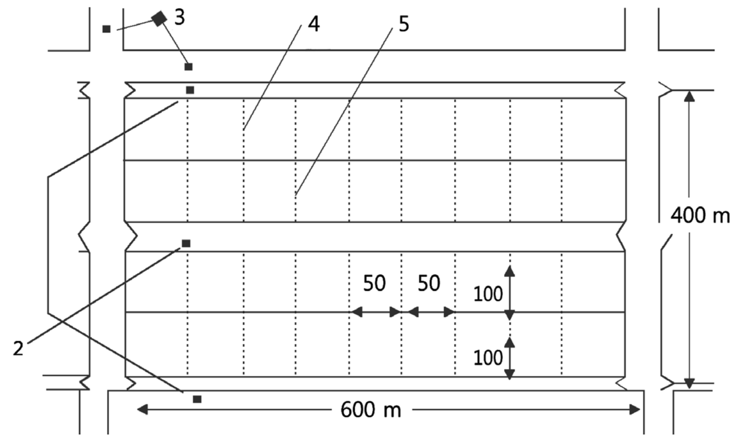
Note: Land in arable land adjustment: 2644 m^2 to 3305 m^2 in Gangwon Province, 3,305 m^2 to 4,958 m^2 in other regions.
Source: Ministry of Unification, “Weekly Trends” (Oct 28, 2012); FAO/WFP, “Special Report on Paddy Field Areas” (2002).

Table 3-23. Construction Standard of Paddy Fields for Arable Land Adjustment

Slope	Land area (pyeong*)	Land width (m)	Land length (m)	Ratio
under 30 degrees	1,500	40, 50	125, 100	1:2
1-30 degrees	1,200	30, 40, 50	132, 99, 80	1:4.4, 2.5, 1.6
1 degree	1,000	30, 40, 50	110, 83, 66	1:4, 2, 1.3
2 degrees	800	20, 30, 40	132, 88, 66	1:6.6, 3, 1.7
3 degrees	800	20, 25	132, 106	1:1.6, 4

Source: Park Seok-hong, “Research on North Korean Agriculture” 10-11 (2004), 1-15; Ko Byeong-sub, Gangwon Province Agricultural Construction Office (2001).
*3.3 m^2

Figure 3-10. Floor Plan for Arable Land Adjustment of Paddy Fields in North Korea



Source: Park, "North Korean Agriculture;" Park Yong-Sang, North Pyeongan Agricultural Construction Office, 2003.

2) Irrigation Facilities

Only about 45% of the land producing North Korea's top two staple food crops is able to be irrigated; about 31% is unable to be irrigated at all (Table 3-24). For rice paddies, areas of complete irrigation account for 56% of the total, partially irrigated land 26%, and non-irrigated areas about 18%. For maize, 31% of the land is completely irrigated, 23% partially irrigated, and about 46% non-irrigated.

Table 3-24. Irrigated Farmland in North Korea

Types	Paddy fields (rice)		Fields (maize)	
	Area (000 ha)	Proportion (%)	Area (000 ha)	Proportion (%)
Complete irrigation	320	56	155	31
Partial irrigation	150	26	115	23
No irrigation	102	18	226	46
Total	572	100	496	100

Most of the irrigation facilities in North Korea are large-scale irrigation networks composed of a multi-phase flow system that is characterized as high-energy and low-efficiency. Most facilities are also old or obsolete, having been launched in the 1950s and 1960s, and struggle to operate properly due to the lack of available energy. Improvements or readjustments to these facilities are not feasible under current economic conditions.

Irrigation projects pursued as items of national importance in the 1950s included water resource development, river construction, and forest and water conservation projects; the mid-1960s saw an increased emphasis on agricultural water projects. North Korea's existing agricultural irrigation is basically composed of a river water system, the operation of which has often required vast amounts of energy. Until the 1980s, pumping river water was the main method for irrigating crops, but this was readjusted to a natural flow irrigation system in the late 1990s. This project produced some important results, including completion of the 154 km Gaecheon-Taesungho Canal, which begins with a sluice in Gaecheon city's Daedong River and follows a natural-flow waterway to Taesungho. Underneath this irrigation canal, the water of Daedong River was stored in dozens of reservoirs in western areas so that 15 cities and districts of South Pyeongan Province, Nampo, and Pyongyang have been able to use the water for agricultural purposes for about 100,000 ha of arable land and as a source of industrial water. North Korea also constructed a 260 km Baekma-Cheolsan waterway in 2004 with reservoirs and water canals, apparently in another effort to switch to a natural flow irrigation system for agriculture (Table 3-25).

Table 3-25. Regional Irrigation Areas and Facility Status in North Korea

Irrigation locations	Province	Area (ha)	Canal (km)	No. of Constructions	No. of Pumping stations
South Pyeongan Province	South Pyeongan	57,360	2,100	3,600	1,399
Yeonbaek	Gaeseong	55,750	3,040	606	88
Seoheong	South Hwanghae	38,161	1,163	5,148	929
Yeomju	North Pyeongan	36,712	54	619	4
Amnok	North Pyeongan	25,243	1,996	7,106	828
Hamheong	South Hamgyeong	20,629	998	4,327	244
Singok	North Hwanghae	6,328	225	576	13

Previous irrigation facilities in North Korea had some critical constraints. First, they consisted of a multi-phase flow system, which consumed too much energy. The representative case in point is the Namgang-Birubul waterway, which is burdened by a 12-step flow irrigation system in the Singok area of North Hwanghae Province. Second, the systems were less efficient due to the excessively large size of irrigation zones. Irrigation zones covered 100,000 ha in South Pyeongan Province, 66,000 ha in Giyang, and 89,000 ha in Amnok. Such a large scale makes the adoption of a multi-phase flow system inevitable because the waterway is long and complex, and this decreases efficiency. Third, the small and medium-sized agricultural water zones experienced an absolute shortage, which led to unused irrigation facilities. The number of reservoirs in North Korea is 1,890, one-tenth that of South Korea, which has 17,820. Large reservoirs have been used for multiple purposes, such as water for power generation, residential water, or industrial water. Fourth, the agricultural irrigation facilities have severely aged. Most of the North Korean agricultural irrigation facilities were built in the 1950s and 1960s and are greatly outdated due to low performance capabilities and lack of energy, which largely limits the operation of the facilities. Therefore, North Korea must diagnose the existing performance of agricultural irrigation facilities, double-check the efficiency of such plants, build more small and medium-scale reservoirs for agricultural water only, and change the high energy, large-scale flow irrigation systems to natural flow irrigation systems focused on small and large-scale reservoirs to the extent possible (Lee Jung-chul, 2001).

3.1.8. Lopsided Trade Opportunities in North Korea

North Korea is highly dependent on trade with China, which accounts for 78.5% of the total trade volume of the country, a number that has been growing sharply since 2000 (Table 3-26; Figure 3-11). The main reasons for North Korea's growing dependence on China for trade include the fact that China is North Korea's biggest ally, geographical proximity, the need for Chinese imports of crude oil and raw materials, global sanctions on North Korea for various military provocations, and the difficulty of contracting inter-Korean trade due to strained North-South relations. Finally, the Chinese central government's policy for the development of Northeast Asia and North Korea seems likely to shift from trade-oriented to investment-oriented, as pointed out in the recently published report "2010 Overall Evaluation of the North Korean Economy and 2011 Outlook" by the Korea Institute for National Unification.

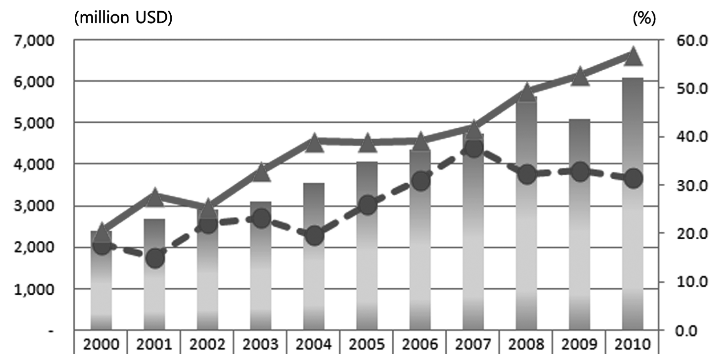
Table 3-26. Trends in North Korean Trade with South Korea and China

(unit: million USD)

Division	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total trade volume	2,394	2,673	2,902	3,115	3,554	4,058	4,346	4,739	5,636	5,093	6,086
South Korea-North Korea	425	403	642	724	697	1,056	1,350	1,798	1,820	1,679	1,912
China-North Korea	488	740	738	1,023	1,385	1,580	1,700	1,974	2,787	2,681	3,466

Source: KOSTAT, "Major Statistical Data of North Korea" (2011).

Figure 3-11. Trends in North Korean Trade with South Korea and China



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total trade volume	2,394	2,673	2,902	3,115	3,554	4,058	4,346	4,739	5,636	5,093	6,086
South-North Korea Trade	17.8	15.1	22.1	23.2	19.6	26.0	31.1	37.9	32.3	33.0	31.4
North Korea-China Trade	20.4	27.7	25.4	32.8	39.0	38.9	39.1	41.7	49.4	52.6	56.9

3.2. Status of Food Production and Measurements of Production Increase in North Korea

3.2.1. Food Situation and Consumption Patterns in North Korea

1) Food Situation in North Korea

North Korea's food crisis has been in progress since the mid-1980s with a downturn in agricultural production under the socialist, collective farming system. This may have been the result of the failure of the North Korean agricultural policy, or Juche (self-determination) farming method, which was adopted in the mid-1970s. In the 1980s North Korea was already suffering from a shortage of about 2 million tons against the standard food rations, producing annually only 4.15 million tons of food on average. At this time, North Korea had already reduced food rations 22% per person from the average amount of 700 g in 1985. Famine had not set in yet thanks to the assistance of the Soviet Union and other socialist countries, as well as North Korea's ability to maintain a partial self-earning capacity.

Under a series of natural disasters like flood and drought in the 1990s, North Korea's food production decreased by a devastating 3.5-4.0 million tons, bringing the nation into an annual food shortage of 2.5-3.0 million tons against normal food rations. The former socialist allies of the North had reduced assistance and trade with North Korea, which left the country facing economic difficulties, and the availability of agricultural production materials plunged. The series of natural disasters reduced food production to less than 4 million tons, leaving the country to face widespread starvation.

However, the food supply was able to remain at 4-4.5 million tons during the mid-2000s, the same level as in the mid-1980s. This was due to the continuous fertilizer assistance from South Korea and food aid from abroad, good weather conditions, and North Korea's own efforts to improve its agricultural systems. Under these circumstances, Pyongyang and some other areas attempted to normalize their food rationing system on October 1, 2005, but not because the food shortage had stabilized at around 2 million tons against the total demand based on proper food rations. The food shortage in North Korea is considered to be a structural problem that North Korea is now addressing by promoting new agricultural policies such as decentralized measures that transfer considerable rights to collective farms regarding agricultural management activities, including the right to choose one's crops, discretionary disposal of surplus produce, choice of seasonal farming activities, discretionary organization of small group units, manager selection, and farm workforce assignments. In some areas the North Korean regime has conducted pilot programs for a household-based farming system called the "individual farm management system" and has expanded the arable land size per person to 1,322 m^2. North Korea has also undertaken a large-scale land adjustment project and changed its agricultural system from monoculture of food crops based on Juche (self-determination) farming methods and high-density planting to double-cropping, the Ghamsa (gratitude) Agricultural Revolution, soybean planting, wide planting cultivation, and high yield farming. North Korea has made relatively large investments in agriculture compared to its other industries, as seen in its "January 2006 Three-Year Plan for Key Industries and Agriculture" (2006-2008).

2) Food Consumption Patterns in North Korea

In the traditional diet of North Koreans, vegetable and fruit consumption accounts for one-third of the daily calorie intake. Kimchi, potatoes, sweet potatoes, rice, and maize make up about 50% of the daily intake. The rest of the diet consists of legumes like soybeans, fish, meat, other livestock products, and milk. Milk is primarily consumed by young children. Under the public distribution system (PDS), rice and maize are distributed at a high price to the non-farming population, which accounts for about 63% of the total population. The public distribution of cereals is primarily based on a person's energy needs and therefore is distributed in differing quantities depending on age, gender, labor intensity and privilege. With the grain shortages, the PDS has been simplified and decentralized, moving from the central government to the military. The daily per capita food ration has contracted from its maximum of 600 g to 150-350 g. In bad years there may be no food rations at all in some areas. Potatoes have recently been included among the food items given in rations. They are often sold through the PDS along with cereal-based food products such as supplementary food for infants produced in food processing factories. Parents buy such products at a reduced price with vouchers issued by health centers. In winter, kimchi is distributed not under the rationing system via PDS, but through neighborhood general stores that provide required amounts of products regardless of the number of family members. Fresh foods including vegetables, tubers, and fruit, and salt and soybean paste can be purchased at the stores in a town, but only for residents of the town. With the voucher issued by the health center, pregnant women take priority when buying fresh vegetables and fruits in the neighborhood stores during the period between 2 months before the birth and three months after delivery.

3.2.2. Measures to Increase Food Production in North Korea

The basic needs of agricultural production in the North entail the expansion and reorganization of the production infrastructure, including that of arable land and irrigation facilities, improving production technology in terms of the yield capacity of crops and cultivation techniques, and securing sufficient supplies of production materials like fertilizer, agricultural chemicals, and fuel. The details of each of these elements are outlined below.

Production Infrastructure

- Conserving and Expanding Arable Land: Food production will be enhanced through partial land adjustments that are based on existing usage patterns. It is necessary to conserve current arable land and to explore developing new areas of arable land.
- Infrastructure: Decrepit facilities must be reorganized and water resources and irrigation facilities expanded (e.g., for upland crops and vulnerable areas).

Production Technology

- Improvement of Capacity in Crop Varieties: This requires a comparison analysis of the yield ability of crop varieties in North and South Korea, the development of crop varieties adaptable to the different growing zones in North Korea, the establishment of a seed production and distribution system, and continuous support for research and development to improve the capacity of different crop varieties.
- Cultivation Techniques: Cultivation technology should be raised to the technology level of South Korea.

Production Materials

- Fertilizer supply must sufficiently meet demand, the latter of which can be discovered through the review and analysis of fertilization methods and volume by crop and region. Through the expansion and remodeling of pesticide and fertilizer production facilities, such as was done in South Korea, the North could also secure ample production of pesticides and other production materials, such as PE film. Production mechanization is needed in the North and will require a greater supply of farming equipment and tools, as well as the establishment of local production systems.

1) Establishing a Reliable Supply and Demand System of Agricultural Production Materials

It is inevitable that expanding land for cultivation and improving agricultural productivity will enhance the capacity to produce food. However, expansion of arable land in the North is limited, and with improper development of land for cultivation, natural disasters can cause substantial side effects, as seen with the torrential rains that caused landslides in the ad hoc terraced farms on mountainsides. So in fact it is very difficult in North Korea to increase productivity by expanding arable land now that the terraced farms developed in mountainous areas are required to revert to forest land. Instead, it is necessary to increase the input of agricultural materials, to develop agricultural technology, and to reform the agricultural management system to enhance North Korea's agricultural productivity. The short-term available means is to increase the use of agricultural materials, most importantly the production of fertilizers. The estimated fertilizer requirement for agricultural production in North Korea is 561,900 tons on a component basis and 1.496 million tons on a weight basis, and that for food crops is 367,000 tons on a component basis and 990,400 tons on a weight basis (Table 3-28).

2) Enhancing the Yield Potential of Food Crops

In the middle and long run, development of agricultural technology is paramount. Although the Juche, or self-determination, farming method has been more flexibly applied since the death of Kim Il-sung, the framework has remained. The Juche farming method should be altered to improve agricultural productivity. It is important to convert farm management from the existing collective farming system to a household-based farming system. Taking China and Vietnam as examples, it is possible to improve productivity by 30% without the additional input of farming materials if system change is achieved. However, it might be difficult to immediately realize a change since the system continues to be linked to the ideological structure of North Korea.

It is hard to expect that North Korea will expand food production through commercial imports. Adding to its already large trade deficit, the UN Security Council placed sanctions on North Korea, and as the situation has worsened, North Korea has filled its trade deficit with exports of weaponry. Every year the regime imports around 200,000 tons of food from China and other countries. Given its track record of imports, it seems that North Korea has limited capacity to import foods because of the lack of foreign exchange.

3.2.3. Improvement of Production Structure and Management System

North Korea's state-run farms and industrial lands are owned by the regime, and the land for collective farms, accounting most of the farmland, is under the joint ownership of the farm members. This type of land ownership will become the initial condition for structural reform and privatization of North Korean agriculture in the post-unification era. The issue to approach for the long term after unification is reformation of the agricultural management structure in North Korea. It will be essential to clearly suggest the privatization of farmlands and the direction and political goal for reforming the structure of agricultural management, since these are closely linked to agricultural production activities. Therefore, basic principles should be set out for the conversion of state-owned and collective farms to farmland privatization. In particular, granting ownership or management power of land and buildings is needful to gain a competitive edge in the market through privatization and decollectivization. To that end, an agriculture amendment act is needed in the North that will correspond to the South Korean system.

The agricultural production structure of North Korea is characterized by socialist ownership and management and socialist communities under the state-owned collective farming management system. Currently, collective farmland accounts for more than 90% of the total arable land in North Korea, which is estimated to have decreased by around 3,000 ha in the 2000s due to increased urbanization, mergers of farms, and conversions of state-run farms and comprehensive farms. The planned production and distribution management structure in North Korea lowers competitiveness in production, decreases efficiency and quality, limits input factors, depends on regional self-sufficiency, and significantly decreases incentives and motivation. This is why it is necessary to reorganize the management structure to suit the privatization of agricultural production and household-based small production. To that end, securing rights of ownership in agriculture will establish a financial foundation and a system for the reorganization of collective farms. The following are also needed in order to make restructuring work: a compensation act, assistance in readjustment, investment subsidies, and political measures to provide grants for full and part-time family farming, business partnerships, and scale-ups focused on cooperation/collective farming for commercial farming systems.

- Direction to reform agricultural structure in North Korea after unification

① Adoption of North-South Integrated Model: lessons from East Germany on structural reform in agriculture in the post-unification era.

- Restructuring should vary by speed and by form of economic and political consolidation

② Goal and principle of structural reforms in North Korean agriculture

- Goal: to establish an agricultural management system with quick market adaptability and competitiveness
- Principle: to provide sufficient and complete information to

those engaged in agriculture in order to guarantee the discretionary options of the individuals involved in the reform process

③ Ownership reestablishment and establishment of the direction of structural reform in agricultural management

- Examination of relevant systems to prepare for the emergence of various agricultural management styles
- Consideration of assistance measures for adaptation of farms and farm workers in North Korea

For reference, it is helpful to refer to the privatization of agricultural property and the reform of agricultural structures in East Germany

- Agriculture in East and West Germany before Unification
  - Characteristics of the agricultural management structure of East Germany: mostly collective farms, partially state-owned farms, collectivization (separation of farms for agricultural produce and livestock products)
  - Agricultural structure in West Germany: small-scale family farms

  ⇛ Tasks to be resolved: privatization of agricultural property and reform of agricultural management structure

- German unification progressed rapidly with the opening of the border between East and West Germany by the East German authority in 1989

The German unification process is summarized step by step as follows:

- Dec. 9, 1989: East German authority leaves the national border (collapse of the Berlin Wall)
- March 18, 1990: Non-communist government elected in East Germany
- May 18, 1990: East-West German agreement established on currency, economy, and social integration (national treaty)
- June 29, 1990: Agricultural Adjustment Act adopted by East German parliament
- July 1, 1990: West German currency, Deutsche Mark (DM), used in East Germany with currency consolidation
- August 1, 1990: EU regulations adopted
- August 31, 1990: Treaty on completion of German unification reached (unification treaty)
- Oct 3, 1990: Consolidation of East and West Germany completed

(1) Privatization of agricultural property

(2) Disbanding and conversion of collective farms

(3) Assistance on restructuring agricultural management and helping farmers adapt to the market economy system

3.3. Measures to Increase Food Production in South Korea

3.3.1. Food Production Status and Measures to Increase Food Production in South Korea

The total food production of South Korea was 5.507 million tons as of 2010. South Korea is dependent on imports for more than 70% of the total grain demand for food and feed and for about 45% of the grain demand for food and processed food except for feed.

The staple edible cereals in South Korea are rice, barley, wheat, beans, maize, and other cereals. The production of rice and potatoes, in which South Korea is self-sufficient, accounts for about 94% of total food production. The production of other cereals, wheat, maize, and soybeans makes up only 5-6%. Since rice production accounts for about 89% of total grains, the food production of South Korea is primarily composed of the production of one staple food item, rice. The total self-sufficiency rate in soybeans, which is an important protein source in an ordinary diet in South Korea, stands merely at 8-9%, and the self-sufficiency rate of edible soybeans is only 32%. Maize is the primary grain for feed, followed by wheat bran and soybean cake, which are important protein sources for livestock. Almost all of the feed grains are dependent on foreign imports, becoming the fundamental cause of South Korea's low level of self-sufficiency.

South Korea, which has excellent conditions for the domestic production of rice as a staple grain, should maintain and improve its yield of rice, while at the same time significantly increasing self-sufficiency in edible soybeans, a traditional upland field crop. These measures would help reduce the South's dependency on foreign food grains. To reduce foreign dependency on feed grains as well, the South can increase self-sufficiency in hay grass production by increasing the use of restricted arable land.

The key factors for improving self-sufficiency in food crops are as follows:

① To expand and preserve arable land, the basics of production, and improve land use;

② To develop reliable, high-yield varieties to enhance potential yield;

③ To increase soil fertility and advance cultivation techniques to raise the unit yield;

④ To modernize decrepit production infrastructures and expand and organize irrigation facilities; and

⑤ To establish a reliable supply system of production materials.

In addition, the government should invest aggressively in improving public interest factors such as land use and environmental conservation.

- Proposal to Secure the Maximum from Farmland and Increase Land Usage
  - Apply strict standards of farmland conversion, including conversion to public use to maintain high quality farmlands

- Promote creation of a map of nationwide farmland information to address the issue of fallow areas and abandoned arable land
- Continue to promote organizing the infrastructure of farmland and agricultural water for agricultural scale-up
- Assist production of the high-income crops barley and soybeans for land production adjustment
- Efficiently use farmland by promoting the scale-up of farming by professional farmers and the production of animal feed crops in concert with the cultivation and animal husbandry industries

Technical Developments to Improve Yield Productivity

- Expand the development of high-quality varieties to improve yield ability and safety against disasters
- Expand processing quality and the yield ability of functional varieties and increase resistance to disaster
- Use technological methods for discovering and addressing the causes of productivity gaps

Establishment of Efficient Agricultural Management Bodies

- Encourage efficient agricultural management bodies by facilitating leases
- Strengthen assistance with administrative advances to approved farmers via management checks
- Offer assistance to small and aging farms to participate in cooperatives/collective farming on a village level

- Expand corporate management in order to maintain efficiency and sustainability in farming

- Vitalization of Local Economies with Strengthened Connection between Agriculture and the Food Industry
  - Create a "meeting place" for the agricultural and fishing industries and food companies and retailers to provide management consultation and to send experts
  - Develop prototypes, participate in exhibitions through alliances, and help to find a market and brand a given area by promoting exports
  - Offer low-interest loans under a partnership among agriculture, commerce, and the public, increase the credit security limit, and reduce the tax for equipment investments
  - Provide assistance such as expansion of loan rates for small-size company equipment

3.3.2. Measures to Increase Rice Production

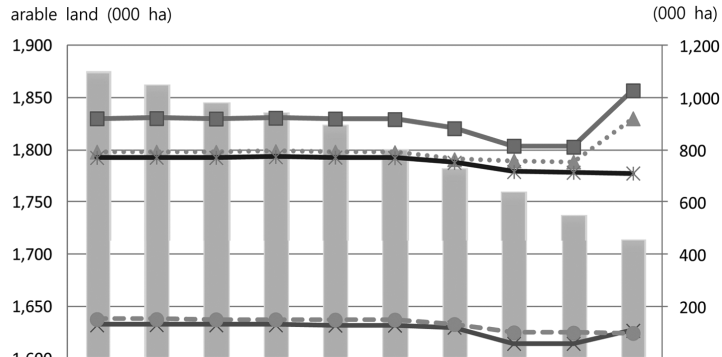
Rice is an important economic resource in agriculture and rural areas; historically it has been the most essential staple crop in Korea, where the geographical and meteorological conditions are perfect for rice. Since the rice-producing fields have an important function in the public interest, the maintenance and preservation of rice paddies is deemed integral to protecting the nation's land and managing the environment.

To achieve food security for 75 million people in a post-unification era, agricultural policies will need to address production increases of the staple food, rice. South Korean rice production increased from 3.939 million tons in 1970 to 6.006 million tons in 1977 and remained at around 5.5 million tons in the 1980s and 1990s, then began to decrease, from 5.515 million tons in 2001 to less than 5 million tons after 2004, and finally 4.259 million tons in 2010, in a continuous decline. The decreasing trend in rice production occurred in tandem with a sharp decrease in rice production areas, which occurred under the global liberalization policy of the WTO system and led to relative inferiority of income in the rice industry. In addition, as economic development increases the national income, and the increase rate of rice yield ability slows, it is estimated that the decline in rice production is due to the reduction in rice and grain consumption that coincides with upper-class, diversified food consumption trends and types. Nevertheless, the country has maintained self-sufficiency in rice thanks to the technological achievement of substantially enhancing the unit yield capacity of rice. To increase rice production, efforts to expand and preserve production areas must be strengthened and unit productivity must be improved.

1) Preservation of Arable Land

South Korea's rice production area increased from 1.203 million ha in 1971 to 1.262 million ha in 1987, but decreased to 1.001 million ha in 2004, to less than 1 million ha (980,000 ha) in 2005, and further to 892,000 ha in 2010. With the growing demand for industrial development of small arable lands, arable land is disappearing, and the paddy fields have been greatly reduced. Under the circumstances, it is difficult in reality to expand rice production areas. The data released by Statistics Korea (KOSTAT) demonstrates that the arable land in Korea converted to non-farming areas since 1970 is as much as over 600,000 ha. In the decade since 1997 the total arable land reduction stood at around 142,000 ha, a reduction averaging 14,200 ha, or 0.8%, annually. In 2007, total arable land was 1.782 million ha, with an increase by 4,300 ha with cultivation, reclamation, and restoration of farmland, while the total reduction was 23,200 ha, with a net reduction of 18,900 ha, or about 1.1% of total arable land. Half of the reduction comes from the permanent extinction of arable land, including 10,000 ha used for building construction, 4,200 ha for public facilities, 6,200 ha for abandoned land, and 2,800 ha for other. In terms of arable land reduction per land use pattern, paddy fields have been reduced by more than 14,000 ha compared to upland fields, which declined by 5,000 ha. Presumably this is because land has been converted from rice in order to cultivate higher-income crops. Although land for food production was well preserved under a strong government policy, the arable land reduction rate has soared since 2007 as the conversion of land to other purposes has expanded, creating a serious threat to the policy preserving farmland for food production. It takes too much money and time to revert arable land once it has been converted to non-arable land, so it is critical to thoroughly preserve and protect farmland, particularly on the level of national land management and environmental conservation, so that the people's quality of life may be improved beyond the simple level of food.

Figure 3-12. The Status of Land Designated for Agricultural Development in South Korea

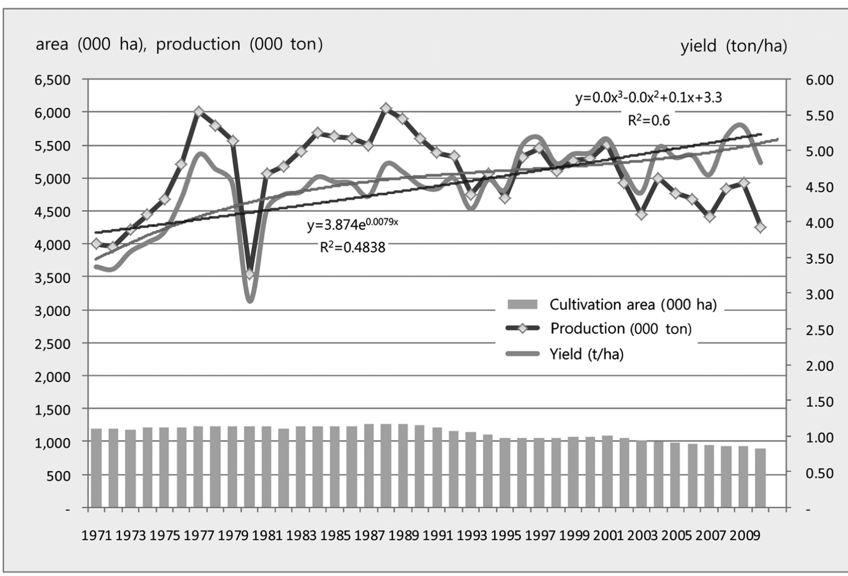


	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Arable land area (000 ha)	1,876	1,863	1,846	1,836	1,824	1,801	1,782	1,759	1,737	1,715
Agricultural develop ment area (000 ha)	920	921	919	922	919	917	882	815	811	1,027
Agricultural develop ment region	792	792	791	794	792	790	763	758	754	920
Reserved region	128	129	128	128	127	127	119	57	57	107
Paddy field	770	771	770	773	771	769	751	716	713	710
Upland field	150	150	149	149	148	148	131	99	98	97

2) Technological Developments to Improve Crop Yield

Until 1970, South Korea suffered from chronic food shortages due to its inability to increase its rice yield above 3.5-4.0 tons/ha, with an average yield per farm of 2.7-3.3 tons/ha. However, based on the green revolution technology of the 1970s, the yield potential of rice variety increased to more than 5.5 tons/ha, at an average yield per farm of more than 5 tons/ha. Since the 1980s, the demand for premium-quality rice increased as the food consumption patterns of consumers shifted towards high-class and diversified foods: national self-sufficiency in rice and an increase in national income gave rise to a demand for higher-quality rice. The yield of such premium rice increased to 5.8 tons in the 1990s, the average yield per farm nationwide reaching about 5 tons/ha. This contributed to maintaining the total rice production at 5.5 million tons, despite a concurrent reduction in cultivated land.

Figure 3-13. Change of Rice Area, Production and Yield in South Korea



Although the quality of rice increased and diversified further in the 2000s, the yield of different varieties of rice remained static, indicating that more effort is required to improve the yield ability of high-quality rice and to increase resistance to pests, disease, and cold damage. It is also important to enhance farm adaptability to a direct seeding cultivation ecology in order to reduce production costs. To increase rice production, it will be necessary to develop varieties that meet customer expectations in quality and to reduce production costs so as to guarantee the income of farmers and gain competitiveness at the same time. These methods of increased yield and premium quality will be indispensable as the processing industry expands and global warming spurs further ecological change in rice production.

3) Nurturing Rice Production Companies and Continuous Promotion of Institutional Policies for Income Stabilization of Rice Production Farms

For reliable production of competitive rice, it is necessary to first establish the institutional and political foundation for rice production. The average income of farmers is two-thirds the income of urban workers, and the average income of peasant farmers, defined as farming less than 3 ha, is only 50% of the income of their urban counterparts. The number of rice production farms is on the decline, and the population of farmers is significantly aging. There are no government measures to assist small farmers with farms under 1 ha, who account for 60-70% of the total farming population. Under the circumstances, it is necessary to come up with measures to gauge whether to maintain the rice industry in 10-20 years. It is necessary to support small farmers and rice-producing companies in order to secure their income. Agricultural policies should focus on supporting production management resources such as productive assets and management technology for scaled-up, professional agricultural companies.

It is crucial to relieve the anxiety of production farms due to the expansion of open markets, and this can be attained by establishing and promoting goals to achieve national self-sufficiency in rice and by proposing detailed plans for strengthening institutional policies for reliable management through creation of a rice production management body. It will also be necessary to establish various policies for regional development, including advancing crisis management systems such as farm insurance for agricultural produce; bolstering farm income stabilization by expanding the sources of income; and reforming the system of assistance for assuring basic living conditions of the vulnerable classes, including workers on small-scale rice farms.

4) Reduction of Production Cost for Higher Rice Competitiveness

Korean rice is less competitive in terms of price since it is cultivated on small farms at a higher production cost. To reduce the production cost of Korean rice, labor costs must be managed with labor-saving mechanization of the total rice production process, from sowing to harvesting to refining by expanding production volume and early completion of large-scale arable land adjustment. For a complete labor-saving farm mechanization, it is necessary to distribute the labor-saving, direct-sowing cultivation technique to more areas; to reduce the number of fertilizer applications through the development of slow-acting fertilizer; to reduce the number of pest control applications by developing biological control agents and comprehensively managing pests and disease; and to establish a foundation for semi-automated water resource management so that human labor in rice production will be significantly decreased. In addition, it is essential to foster large-scale rice production bodies and key professional agricultural organizations such as professional farms, trusted farming companies, and farming corporations.

3.3.3. Measures to Increase Production of Edible Soybeans

The domestically produced and consumed legume family is composed mainly of soybeans, adzuki beans, mung beans, and others, comprises an important source of vegetable protein for the nation, and is widely used as a key crop in processed foods such as soybean paste, soybean sprouts, and tofu.

The total consumption of soybeans as of 2010 was 1.599 million tons, with about 73% consumed as animal feed, which mostly consists of soybean cake after oil extraction as a main source of protein for livestock. The soybean consumption for food and processed food is 81,000 tons and 345,000 tons, respectively, accounting for about 27% of total consumption, at an annual per capita consumption of about 9 kg. On the other hand, the total production of soybeans is 139,000 tons, with self-sufficiency in overall soybeans at 9% and edible soybeans at around 32%. With total imports of 1.469 million tons, the demand for most soybeans consumed in Korea depends largely on foreign imports.

South Korea's total soybean production area is estimated to have declined from about 295,500 ha in 1970 to 75,200 ha as of this writing, at an annual average decrease rate of around 2% (Table 3-27). In particular, although the land area used for soybeans dropped to less than 100,000 ha in the 2000s, the total production of around 230,000 tons had not changed much for about 2 decades (until 1990), despite a continuous decrease in soybean cultivation area; instead, the unit yield ability increased approximately twice, from about 0.79 tons to 1.53 tons. However, with a large drop in cultivation area in the decade since 1996, to an average of about 90,000 ha, the yield of soybeans also substantially declined.

Table 3-27. Cultivation Area, Yield, and Production of Legumes in South Korea

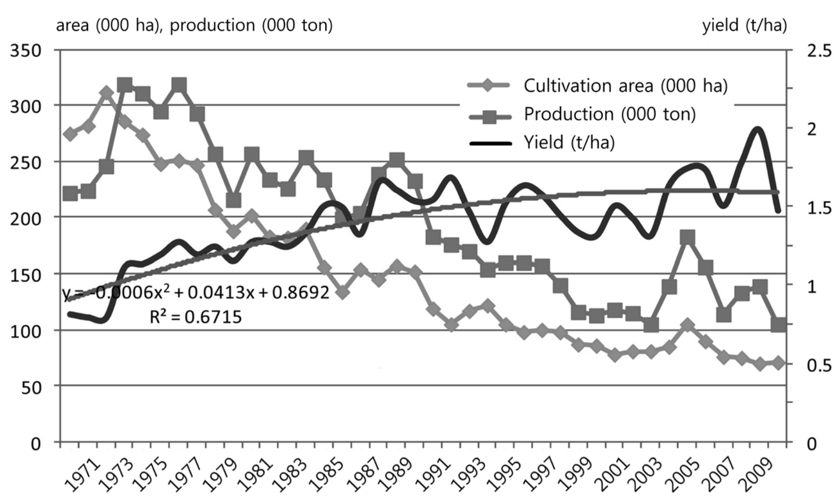
(unit: 000 ha, 000 ton)

Year	Total Legumes		Soybeans			Other Legumes	
	Cultivation Area (000 ha)	Production (000 ton)	Cultivation Area (000 ha)	Production (000 ton)	Yield (t/ha)	Cultivation Area (000 ha)	Production (000 ton)
1970	358.2	295.5	295.5	232.0	0.79	62.7	63.5
1980	243.5	266.2	188.4	216.3	1.15	55.1	49.9
1985	196.0	274.8	156.0	233.9	1.50	40.0	40.9
1990	187.7	271.3	152.3	232.8	1.53	35.4	38.5
1995	132.5	189.3	105.0	159.6	1.52	27.5	29.7
2000	107.2	134.2	86.2	113.2	1.31	21.0	21.0
2005	117.6	198.8	105.4	183.3	1.74	12.2	15.5
2006	101.1	169.9	90.3	156.4	1.73	10.8	13.5
2007	88.1	128.3	76.3	114.2	1.50	11.8	14.1
2008	86.8	146.9	75.2	132.7	1.76	11.6	14.2
2009	82.5	155.1	70.0	139.3	1.98	12.5	15.8
2010	83.1	119.3	71.0	105.4	1.47	12.1	13.9

Source: Food, Agriculture, Forestry, and Fisheries, "Statistics" (2011).

However, although total soybean production increased in 2002, thanks to a larger cultivation area and yield with the "purchase by grade" of paddy field soybeans, the cultivation area contracted again in 2006 when the purchase by grade system was abolished. Thus soybean production is currently decreasing (Figure 3-14). Globally, total soybean production is expected to increase, with GMO soybeans accounting for about 75% of the global soybean market, while land cultivated for soybean production is projected to decrease, especially with the demand for biofuel driving increased maize production in the US. Under the circumstances, it is absolutely necessary to come up with proactive measures to increase self-sufficiency in edible soybeans and to procure soybean imports for animal feed in order to meet the total domestic demand for soybeans.

Figure 3-14. Cultivation Area, Yield, and Production of Soybeans



Source: KOSTAT, *Statistics Yearbook of Food, Agriculture, Forestry, and Fisheries* (2011).

To increase self-sufficiency in soybeans, it is necessary first to set a goal for self-sufficiency in edible soybeans at more than 50%; to expand the cultivation area to meet the goal; to develop technology to increase unit yield; and to provide institutional assistance to guarantee the income of the production farms. For unit yield increase particularly, it is critical to develop high-yield varieties and reorganize the irrigation infrastructure in the upland fields as a cultivation technique. Soybean production will also increase by implementing a policy that marginal and fallow rice paddies be used to cultivate soybeans, an idea that has been promoted since 2002. It is crucial to develop mechanization for soybean harvest, to scale up cultivation, and to aggressively develop high yield varieties and cultivation techniques to meet production goals.

3.4. Measures to Increase Food Production in Post-Unification Era

3.4.1. Top 20 Agricultural Products in North and South Korea

The top 20 major agricultural products in North and South Korea are shown in Table 3-28 (FAO, 2012). In South Korea, the food crops in the top 20 agricultural products include rice and potatoes, but other crops, including soybeans and barley, are excluded from the top 20 due to extremely small production. Rice is the most dominant food crop among the 20 farm products in South Korea, which produces around 6 million tons in paddies, with a production value of around 1.6 billion dollars. Rice is not only a staple food crop, but also the most important player in agriculture and the rural economy.

The decline in the amount and value of production, however, threatens food security in South Korea.

While rice is produced more than any other food crop in South Korea, upland crops comprise a higher portion among total food crops in North Korea. The reasons for this are as follows:

i) North Korea has more upland fields than paddy fields because geographical conditions warrant high usage of mountainous areas;

ii) with its low temperatures and precipitation, North Korea's meteorological environment is suited to the cultivation of various upland crops, with limited adaptable areas for rice;

iii) upland crops play an important role as food crops, with the double-cropping of barley (wheat, barley) in the wintertime, of potatoes between summer crop cultivations in rice production areas in the southwest plains, and the mono-cropping of wheat and potato in spring in low-temperature zones in the north and unirrigated regions.

In North Korea, the top 10 products include rice, potatoes, maize, sweet potatoes, and soybeans (Table 3-28). In terms of the production amount and value of those food crops, rice is superior, with around 2.4 million tons of paddy rice, which is equivalent to 1.56 million tons of milled rice, valued at around 0.6 billion dollars. However, both production amount and value are declining, as in South Korea. The second most lucrative crop in the North is fresh vegetables, with a production amount of about two million tons and a value of 3.84 million dollars. In third and fourth place are potatoes and maize, with a production volume of around 1.71 million tons and 1.68 million tons, respectively, followed by apples, chinese cabbage and cabbage, fruit, sweet potatoes, soybeans, other legumes, and wheat, in that order. It appears that North Korea focuses its farm land policies not only on production of its main staple food, rice, but also on upland field crops in areas where rice cultivation is restricted. As a result, maize is positioned in the second-most important place after rice, since it has advantages in production in the summertime as an upland field crop. From the perspective of production volume, maize and potatoes are absolute winners, while legumes and barley, though staple grains, are produced at merely one million tons.

Table 3-28. Top 20 Agricultural Products of North and South Korea

Rank-ing	South Korea					
	2005			2010		
	Food items	Output (000 ton)	Production (Million USD)	Food items	Output (000 ton)	Production (Million USD)
1	Rice	6,435	1,780	Rice	5,804	1,605
2	Fresh vegetables	3,255	613	Fresh vegetables	2,698	508
3	Chinese cabbage	2,603	389	Fresh milk	2,103	656
4	Fresh milk	2,229	696	Chinese cabbage	2,036	305
5	Dry onions	1,023	215	Dry onions	1,412	296
6	Watermelon	905	103	Pork	1,098	1,687
7	Pork	899	1,383	Watermelon	679	77
8	Potatoes	894	132	Potatoes	617	86
9	Tangerines	638	158	Tangerines	615	152
10	Eggs	515	427	Eggs	570	473
11	Allium species	513	105	Chicken	514	731
12	Chicken	484	689	Apples	460	195
13	Chinese cabbage	443	181	Allium species	417	85
14	Tomatoes	439	162	Persimmons	391	126
15	Cucumbers	403	80	Tomatoes	325	120
16	Hot peppers	395	186	Hot peppers	310	146
17	Grapes	381	218	Chinese cabbage	308	126
18	Garlic	375	197	Beef	307	831
19	Apples	368	155	Cucumbers	306	61
20	Persimmons	364	117	Grapes	306	175

Rank-ing	North Korea					
	2005			2010		
	Food items	Output (000 ton)	Production (Million USD)	Food items	Output (000 ton)	Production (Million USD)
1	Rice	2,583	637	Rice	2,426	597
2	Fresh vegetables	2,450	462	Fresh vegetables	2,039	384
3	Potatoes	2,070	272	Potatoes	1,708	225
4	Maize	1,630	185	Maize	1,683	166
5	Chinese cabbage	690	98	Apples	752	318
6	Apples	668	283	Chinese cabbage	616	88
7	Fresh fruit	490	171	Fresh fruit	548	191
8	Sweet potatoes	350	23	Sweet potatoes	427	28
9	Soybeans	340	87	Soybeans	350	89
10	Other legumes	265	147	Other legumes	224	123
11	Wheat	193	26	Wheat	160	22
12	Pork	168	258	Eggs	160	132
13	Eggs	140	116	Pears	143	58
14	Chinese cabbage	135	55	Hare meat	134	249
15	Fresh milk	126	39	Peaches	116	63
16	Peaches	124	68	Pork	110	169
17	Oriental melons	121	22	Fresh milk	95	30
18	Watermelon	110	13	Oriental melons	88	16
19	Allium species	97	20	Onions/Green onion	88	18
20	Garlic	95	50	Watermelon	86	10

Source: http://faostat.fao.org/site/339/default.aspx.

3.4.2. Approach to Food Production in a Post-Unification Era

Considering the integration of the differences in geography and meteorology in North and South Korea, the food production policy of post-unification Korea should contain a plan to sustain self-sufficiency in rice first and foremost as the main staple food crop and to reduce foreign dependency on grains, particularly feed grain imports. Goals that are set to achieve self-sufficiency should keep in mind the given arable land and the current land use patterns of the North and South: priority must be given to rice production in the South due to its larger area of rice paddies, while the North has the advantage of larger upland areas for the cultivation of soybeans and feed crops. The next goal should focus on a continuous development of technology to improve unit productivity. To secure the land and achieve the goal of food production with technological advances, it is necessary to continue to expand and improve production infrastructure, including irrigation facilities, and to achieve a reliable supply and demand of production materials.

1) Goals for Staple Food Production in a Post-Unification Era

According to a long-term projection on the population of North and South Korea by Statistics Korea (KOSTAT), total population in a post-unification period, assumed to begin in 2015, is estimated at 74,056 million: 49,227 million in the South and 24,779 million in the North. By 2025, the projection becomes 75,025 million in 2025, 49,108 million in the South and 25,917 in the North. Based on the estimates above, the goals for staple food production in the post-unification era are as follows: i) to maintain complete self-sufficiency in rice so as to meet the demand of an annual per capita consumption in South Korea of 72 kg in 2015 and 70 kg in 2025; ii) to replace the current North Korean basic food crops of rice, maize, and potatoes entirely with rice in order to maintain complete self-sufficiency in rice at an annual consumption per person in North Korea of 132.4 kg in 2015 (the amount consumed by South Korea in 1980) and 120 kg in 2025 (the amount consumed by South Korea in 1990); iii) to have complete self-sufficiency in edible soybeans in North and South Korea based on the South Korean average per capita consumption (9 kg), despite the increase in distribution volume of GMO soybeans in the global market; and iv) to maintain the production of barley and other cereals to meet the demand in South Korea (7 kg including seeds). The estimated demand for each crop, based on these goals, is shown in Table 3-29. It will be necessary to continue imports of feed grains, mainly maize, while expanding the production of crops for feed, including maize, to reduce import volume. At the same time, it is regarded as necessary to seek long-term measures while maintaining current import levels of flour. Based on that, the goals for staple food production in a post-unification era are set as follows:

- Goal of Rice Production in Post-Unification Korea: 7.344 million tons (6.927 million-7.571 million tons)
  - Expansion of Rice Production in South Korea
    - Production Goal: 4.870 million tons (4.550 million-5.099 million tons)

※ Total Rice Demand (2010): 4.707 million tons (Food 3,638↓, Processed Food 554↑, Seeds and Other 515); consumption for food decreasing at an annual average rate of 1.5-2% and rising for processing

- Grounds: 955,000 ha × 5.10 tons/ha = 4.870 million tons

* Enhancing Yield Ability of Rice
5.10 tons/ha (4.90 tons/ha in 2005~5.34 tons/ha in 2009)

* Preservation of Rice Cultivation Areas
land maintained and expanded for rice production
(892,000 ha in 2010 → 55,000 ha)

- Rice Production Increase in North Korea
  - Production Goal: 2.474 million tons (2.377 million-2.571 million tons)
  - Yield Goal: 2.5-3.5 tons/ha (2010) → 4.34 tons/ha (4.17-4.51 tons/ha; 85% of South Korea)
  - Grounds: 570,000 ha × 4.34 tons/ha = 2.474 million tons

* Area of Rice Production: 57,000 ha (2010), Area of Paddy Fields (2010): 609,000 ha

- Self-sufficiency in Edible Soybeans Production Goals and Measures in Post-Unification Korea

• Production Goal: 759,000 tons (46,000 ha × 1.65 tons/ha)

※ Supply and Demand of Edible Soybeans (2010)

- Total Demand for Edible soybeans: 625,000 tons (438,000 in South Korea, 187,000 in North Korea)
- Total Production of Edible Soybeans: 293,000 tons (139,000 in South Korea, 154,000 in North Korea)
- Cultivation Area: 161,000 ha (71,000 in South Korea, 90,000 in North Korea)
- Yield Ability of Soybeans: 141 tons/ha (165 tons in South Korea, 116 tons in North Korea)
- Deficiency: 332,000 tons (299,000 in South Korea, 33,000 in North Korea)

Production Increase Measures for Soybeans

- Expand Soybean Cultivation Area: 161,000 ha → 460,000 ha

※ Convert part of the maize cultivation area in the north to soybean production: 300,000 ha out of 503,000 ha

- Convert maize cultivation land to soybeans in the western plains in North Korea (87,000 ha in South Hwanghae Province, 80,000 ha in North Hwanghae Province, 61,000 ha in South Pyeongan Province, 87,000 ha in North Pyeongan Province)

- Increase the yield ability of soybeans of North Korea to the level of South Korea: 1.16 tons → 1.65 tons/ha
- Strengthen the development of high-yield varieties by usage (soybean paste, tofu, and soybean sprouts)
- Develop production technology for labor-saving mechanization and scale-up

- Establish infrastructure of irrigation facilities for safe soybean production

2) Preservation of Rice Production Land

In post-unification Korea it is imperative that self-sufficiency be maintained in the production of rice, the primary staple food on the peninsula. Rice culture on the Korean peninsula is thought to have been predominant since the dawn of Korean history 5,000 years ago. Rice is a natural staple food crop in the given geographical and meteorological conditions, the monsoon temperate zone. The environmental situation and technical infrastructure for growing rice have allowed Korea to become a world-class producer, and production must be carefully maintained into the future. In this regard, it is necessary to preserve at least 1 million ha of rice paddies as of the present time in South Korea as well as to further improve production technology and infrastructure for enhancing rice production. When it comes to current arable land composition of both Koreas, the total arable land in the North and South makes up around 3.625 million ha, composed of 1.593 million ha of rice paddies and about 2.032 million ha of upland fields. South Korea's total arable land was 1.715 million ha as of 2010 and was composed of about 984,000 ha of rice paddies and 731,000 ha of upland fields, while the total size of arable land in North Korea stood at 1.910 million ha as of 2009, consisting of 609,000 ha of rice paddies and 1.301 million ha of upland fields. Currently the total amount of rice paddies on both sides of the Korean peninsula comes to about 1.472 million ha, 892,000 ha in South Korea and 580,000 ha in North Korea. It is a priority to maintain self-sufficiency in rice, the number one staple food, by maintaining a total rice cultivation area in North and South Korea of 1.580 million ha, with South Korea maintaining its rice cultivation area at 1 million ha, since it has relatively favorable conditions for rice production.

3) Improving Technology for Rice Productivity

Rice yield productivity per unit area needs to be maintained at the current level of 5 tons/ha in milled rice in South Korea and must increase from 2.5-3 tons to over 3.5 tons/ha in North Korea. If North Korea maintains rice paddies of about 600,000 ha and increases unit productivity to the level of South Korea, or by at least 85% from the current 60% level of yield productivity, it will produce enough rice to be self-sufficient in that staple food and will increase overall self-sufficiency in North Korea. It has been proven experimentally at Chulwon Substation, a branch station of the National Institute of Crop Science of the Rural Development Administration, that some collections of rice varieties from North Korea performed to the productivity level of South Korea, with an average of 85% of the South Korean varieties, under the standard cultural practices of South Korea. With adequate cultivation techniques and fertilization, the productivity of North Korean rice varieties was able to be increased to more than 4 tons/ha.

With the strategy above, the total rice production will reach 7.03 million tons. This will enable the self-sufficient production of rice to maintain food self-sufficiency for the total Korean population of 73 million in 2015.

4) Self-Sufficient Production of Edible Soybeans

It is necessary to revisit the efficiency of the usage of upland fields in North Korea, which has larger upland field areas than South Korea. With self-sufficiency in producing the Korean staple food, rice, it is necessary to convert acreage used for edible maize in North Korea to acreage for edible soybean production; this will establish a self-sufficient production system of non-GMO (genetically modified organism), edible soybeans amid the tide of the global prevalence of GMO crops. For self-sufficient production of edible soybeans, maize cultivation areas must be converted to soybeans in the region where soybeans are mainly produced in the west plains in North Korea, and to expand soybean production areas by switching marginal rice paddies to soybean cultivation in South Korea. Further, stable and reliable technology must be developed, such as improving high-yield soybean varieties, advancing cultivation technology, developing labor-saving mechanizations, and expanding irrigation infrastructure in upland fields.

5) Establishment of Feed Crop Production System and Pasture Land

Meat consumption commonly increases with the growth in per capita income that attends a developing national economy. Likewise, it is assumed that meat consumption will see a rapid increase in North Korea as diets improve significantly in the post-unification era. Therefore, dependency on foreign imports of feed grains and fodder for livestock production in the post-unification South is expected to increase. To avoid this situation, a production system for feed and forage crops must be established. First, maize production should be switched from food crops to forage crops in upland crop areas of North Korea. This strategy will relieve dependency on imported feed grains and improve the degree of self-sufficiency in fodder and hay feed. Currently, South Korea's self-sufficiency rate in cereals, including food and feed grains, tends to hover at 26%, with heavy dependency on foreign imports for almost all feed grains and hay feed for livestock production.

In conclusion, the upland areas of North Korea must be reestablished for both edible soybean production and a reliable system of livestock production. Current cultivation areas for maize can be partially converted to edible soybean production, and the remaining areas can switch to feed grains and forage crops in order to produce quality feed crops, including maize, and expand the grazing system for livestock by creating pasture land in mountainous areas in the North.

6) Production of Other Cereals including Barley

The current level of the total cultivation area of barley and other grains in both North and South Korea must be maintained and expanded with improvements in crop varieties and cultivation technology (Table 3-29). The production goal of other cereals averages a daily consumption of around 7 kg, including seeds, at the level currently consumed in South Korea.

Table 3-29. Production Goal and Estimation Standards of Rice, Edible Soybeans, and Other Crops in Post-Unification Korea

Crop types	South Korea			North Korea		North and South Korea	
	2010	2015	2025	2015	2025	2015	2025
Population (000 persons)	49,410	49,227	49,108	24,779	25,917	74,056	75,025
Rice demand (000 ton)[1),2)]	4,707	3,548	3,438	3,280	3,112	6,828	6,548
Edible soybean demand (000 ton)[3)]	438.0	443.4	442.0	223.0	233.3	664.4	675.3
Other crops demand (000 ton)[4)]	347.0	344.9	345.9	173.5	181.4	518.4	525.2

Notes:

1) Rice demand in South Korea is based on the projected per capita annual consumption of 72 kg in 2015 and 70 kg in 2025.
2) Rice demand in North Korea is based on the projected per capita annual consumption of 132.4 kg in 2015, the level consumed in South Korea in 1980, and 120 kg in 2025, the South Korean level in 1990.
3) Edible soybean demand is based on the annual average per capita consumption in South Korea of 9 kg in 2010 (including processed products).
4) Demand for other crops is based on the annual average per capita consumption in South Korea of 7 kg in 2010 (including seeds).

Source: KOSTAT, *Statistics Yearbook of Food, Agriculture, Forestry, and Fisheries* (2011).

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04 Assessment of the Production Potential of Fisheries in North and South Korea

4.1. Supply and Demand of Fishery Products in North and South Korea

After unification fishery products are expected to play an important role in the North Korean diet to help alleviate the many diseases due to deficiencies in nutrients like protein suffered by residents there. Dynamic research by the Japan Cancer Prevention Research Center on the causes of death of 265,000 Japanese people over the course of 17 years showed that people live longer if they consume fish and shellfish more frequently. Further, it has been discovered that the increase in the infection rate of all kinds of degenerative diseases and the death rate can be controlled by the consumption of fish and shellfish (IPC, 1992). For example, those who seldom eat fish or fishery products may die from hypertension or cancer (lung and uterine) with 1.8 times and 2.6 times higher occurrence rates, respectively. In other words, fish and shellfish contain a bioactive substance that prevents degenerative diseases such as hypertension or cancer.

Therefore, in the post-unification period fishery products would not only be a source of needed protein for North Koreans, but would also help prevent diseases with the bioactive substances they contain.

4.1.1. Supply and Demand of Fishery Products in South Korea

The South Korean fisheries industry was an export-led industry until the early 1970s but has suffered from deteriorating domestic production conditions and changes in the environment since the mid-1980s. Marine resources have been drained due to coastal pollution and reclamation, and operational fisheries have largely contracted since the UN Maritime Convention took effect (1994), the Korea-Japan Fisheries Agreement was reached (1999), and the Korea-China Fisheries Agreement was concluded (2001). However, there is growing demand for fishery products, which comprise one of the top 2 food resources along with agricultural products. Also, securing the food supply and establishing a response system are emerging as important fishery policies in preparation for uncertainty in global supply and demand for fishery products and fluctuations in the global fisheries market.

With improved living standards and a higher preference for healthy food, South Korea's consumption of fishery products increased every year, from 3.215 million tons in 1995 to 4.07 million tons in 2009, yet domestic production stands at 3.182 million tons, far below consumption (Table 4-1). South Korea has imported more than a million tons of fishery products every year from China, Japan, Russia, Vietnam, the US, and North Korea.

Table 4-1. Supply and Demand of Fishery Products in South Korea (net weight)

(unit: 000 ton)

Division		1995	2000	2005	2006	2007	2008	2009
Supply	Production	3,348	2,545	2,714	3,302	3,275	3,360	3,182
	Imports	948	1,420	2,557	2,646	2,604	2,135	2,186
	Last year of stock	460	582	531	512	575	618	567
Total		4,756	4,547	5,802	6,190	6,454	6,113	5,935
Demand	Domestic consumption	3,215	2,699	4,169	4,568	4,625	4,280	4,071
	Exports	1,170	1,338	1,047	1,047	1,211	1,266	1,336
	This year of carry over	371	510	575	575	618	567	528

Source: Ministry of Agriculture, Forestry and Fisheries, Fisheries Policy Division.

South Korea's daily per capita consumption of fishery products is on a slight rise, having increased from 16.4 g in 1995 to 16.5 g in 2009 (Table 4-2).

Table 4-2. Animal Protein Supply for South Koreans

(unit: g/day/person)

Division	1995	2000	2005	2006	2007	2008	2009
Total	39.6	41.19	45.43	46.7	48.46	46.71	46.45
Livestock products	22.87	26.27	26.29	27.12	28.59	28.30	29.93
Fish and shellfish	16.4	14.92	19.14	19.58	19.86	18.41	16.52
Proportion (%)	41.7	36.2	42.1	41.9	40.9	39.4	35.6

Source: Korea Rural Economic Institute, 2010.

4.1.2. Supply and Demand of Fishery Products in North Korea

Since the food shortage in the middle of the 1990s, North Korea's agricultural and fisheries industry has been in a recession, and the nation cannot escape its food shortage under the current situation. It is estimated that the amount of fish caught in North Korea plunged because of its primary dependence on offshore fisheries, reduced resources for fisheries, and decreased frequency of fishing due to the shortage of oil (Table 4-3). In South Korea, the need for exchange and cooperation has been emphasized in order to help the North overcome the long-term depression of its agricultural and fisheries industry and to jointly develop an inter-Korean agricultural and fisheries industry.

Table 4-3. Fishery Production in North Korea (unit: 000 ton)

Division	1995	2000	2005	2006	2007
Total	1,065	681	714	714	714
Aquaculture	739	468	508	508	508
Fishing	326	213	206	206	206

Source: FAO, Fishstat Plus: Commodities Production and Trade.

Meanwhile, the FAO data show that North Korea is increasing its export volume every year, regardless of domestic fishery production and consumption, in order to earn the foreign capital necessary for economic development. According to the data, North Korea exported 59,481 tons of fishery products out of 347,229 tons produced between 1995 and 1997, and 123,368 tons out of 268,700 tons produced between 2003 and 2005, with a production decrease of one third but an export increase by more than twofold. As a result, the annual per capita consumption of fishery products has dropped from 16.9 kg to 7.2 kg (Table 4-4).

Table 4-4. Per Capita Annual Fishery Product Consumption in North Korea

(unit: ton, 000 person, kg/year)

Division		1995	2000	2005	2006	2007
Imports	Total imports	1,243	1,863	2,540	2,842	2,894
	Fishery products	6	26	27	38	59
	Proportion (%)	0.5	1.4	1.1	1.3	2.1
Exports	Total Exports	1,143	1,174	1,925	2,523	2,308
	Fishery products	72	138	216	192	150
	Proportion (%)	6.3	11.8	11.2	7.6	6.5

Source: FAO, "Commodities," Fishery and Aquaculture Statistics Yearbook, each vol.

Fishery products are key trade items for North Korea. By exporting the products, North Korea earns foreign currency, but it imports fish that are not caught in North Korea in smoked or processed form. The proportion of exports in fishery products in North Korea has decreased since 2005 (Table 4-5) but the amount still exceeds that of imports to North Korea. In South Korea, imports have increased, with a decrease in exports since 1990 (Table 4-6).

Since North Korea has to earn foreign money for economic development by exporting fishery products, and the fishery production in South Korea falls short of domestic demand, it is necessary to take measures to ease the imbalance between supply and demand of fishery products in South Korea; one such measure would be to ship fishery products from North Korea to the south, thereby decreasing transport distance.

Table 4-5. Import and Export Revenue of Fishery Products in North Korea

(unit: million USD)

Division		1995	2000	2005	2006	2007
Imports	Total imports	135,120	160,481	261,238	309,383	356,846
	Fishery products	843	1,411	2,384	2,769	3,056
	Proportion (%)	0.6	0.9	0.9	0.9	0.9
Exports	Total exports	125,058	172,268	284,419	325,465	371,489
	Fishery products	1,722	1,504	1,193	1,089	1,226
	Proportion (%)	1.4	0.9	0.4	0.3	0.3

Source: UN Comtrade DB.

Table 4-6. Import and Export Revenue of Fishery Products in South Korea

(unit: million dollars)

Division	1995-1997	1997-1999	1999-2001	2001-2003	2003-2007
Production	347,229	291,212	269,917	269,200	268,700
Exports	59,481	55,962	67,343	90,996	123,368
Edible	381,568	206,073	182,984	202,872	169,420
Population	45,954	46,617	47,343	48,782	49,540
Supply per person	16.9	9.4	8.2	9.0	7.2

Source: Ministry of Food, Agriculture, Forestry, and Fisheries, "Fishery Product Import and Export Statistics" (2008).

4.2. Assessment of Fisheries Production Potential of North Korea

Since North Korea does not release public statistics on food production, there is no option but to rely on estimates by the Rural Development Administration and FAO and non-official estimates by the North Korean authority.

North Korea's industry structure is characterized as having a high proportion of agriculture, forestry, fisheries, and mining industries, and a relatively low proportion of manufacturing and other service industries compared to South Korea.

4.2.1. Marine Resources in North Korea

North Korea has a good environment for a fisheries industry, as it borders both the East Sea and West Sea. The data published by North Korea report a total of 650 species consisting of about 530 kinds of aquatic animal and plant species, and about 120 types of inland water animals and plants. Among these, aquatic animals and plants suitable for fisheries are reported to be composed of 75 types of fish species, 20 types of shellfish, 15 kinds of marine algae, and 10 types of others, 120 types in total.

The main fish species (Table 4-7) and fisheries production (Table 4-8) by sea areas in North Korea are as follows, based on estimates by the Ministry of Unification.

Table 4-7. Main Fish Species by Sea Area in North Korea

Division	The eastern coast of Korea		The western coast of Korea	
	Fishery resources	Main fishing ground	Fishery resources	Main fishing ground
Fish	Theragra chalcogramma	Gangwon Province coast	Larimichthys polyactis	North Pyeongan Province, Hwanghae Province
	Scomber japonicus	The whole coast	Miichthys miiuy	The whole coast
	Clupea pallasii	The whole coast	Scomberomorus niphonius	Hwanghae Province
	Gadus macrocephalus	The whole coast	Salangichthys microdon	North Pyeongan Province, mouth of the Yalu river
	pleuronectes platessa	The whole coast		
	Serila quinqueradiata	The whole coast	pleuronectes platessa	The whole coast
Crustaceans	Liocarcinus vernalis	Gangwon Province south	Shrimp	The whole coast
Shellfish	Crassostrea gigas	Gangwon Province coast	Meretrix lusoria	South Pyeongan Province, Hwanghae Province
	Patinopeten yessoensis	The whole coast	Crassostrea gigas	The whole coast
Mollusks	Todarodes paci-ficus	South Hamgyeong Province coast	Tapes philippinarum	The whole coast
Seaweed	Undaria pinnatifida	Gangwon Province, North Hamgyeong Province	Tegillarca granosa	The whole coast
Other marine animals	Holothuroidea	The whole coast	Undaria pinnatifida	Hwanghae Province
	Anthiocidaris crassipina	Gangwon Province, South Hamgyeong Province		

Source: DPRK, *Central Yearbook*.

In terms of East Sea fishery production by species becoming the center of the fisheries production, 146,100-168,100 tons of fish is estimated to be produced every year, consisting mainly of 50,000 tons of squid and pollack, 20,000 tons of sardine and mackerel each, 5,000 tons of cod, and 3,000 tons of octopus and Pacific saury each.

Table 4-8. Fish and Shellfish Production in North Korea (unit: tons)

Fish	Production	Crustacean, Shellfish	Production
Total	146,100-168,100	Total	9,750-10,150
Theragra chalcogramma	28,000-50,000	*Haliotis discus*	100
Scomber japonicus	20,000	*Holothuroidea**	500
*Todarodes paci-ficus**	50,000	*Scapharca broughtonsii*	300-700
Sardinops melanostictus	20,000	*Patinopeten yessoensis*	200
Clupea pallasii	10,000	*Atrina(Servatrina) pectinata*	50
Gadus macrocephalus	5,000	*Batillus cornutus*	300
Arctoscopus japonicus	2,000	*Corbicula fluminea*	800
Paralichthys olivaceus	500	*Myrilus edulis*	300
pleuronectes platessa	500	*Anthiocidaris crassipina**	2,000
swellfish	200	*Polinices didyma*	3,000
Lophiomus setigerus	800		
Stephanolepis cirrhifer	200		
*Enteroctopus dofleini**	3,000		
Mya arenaria oonogai	500		
Pampus argenteus	200		
Cololabis saira	3,000		

*classified as fish when caught by fishing boat
Source: Insider data.

4.2.2. Fisheries Yield in North Korea

It is assumed that North Korea has about 1,500 powered fishing vessels. According to FAO estimates on the type and size of North Korean powered fishing vessels, the main vessels are sized at about 450 tons. North Korea calls this the one-size-fits-all fishing vessel, claiming to have established a multipurpose fishing system. These powered vessels are used as compound vessels with trawls and fishing nets. It is known that there are around 900 small, 30-ton trawling vessels and fish trap vessels, mainly used for blue crab fishing in the West Sea (Table 4-9).

Table 4-9. Status of North Korean Vessels by Type (unit: 000 GT (vessel))

Division	Oil-tanker	Dry cargo ship	General cargo ship	Passenger boat	Fishing boat	Other	Total
1980	78 (5)	34 (2)	79 (19)	-	39 (8)	-	231 (34)
1985	171 (4)	64 (5)	231 (43)	5 (1)	41 (16)	-	513 (69)
1990	13 (2)	79 (6)	292 (55)	8 (1)	50 (25)	-	442 (89)
1995	116 (3)	107 (9)	408 (88)	21 (3)	63 (40)	-	715 (143)
2000	6 (6)	63 (5)	489 (111)	24 (4)	67 (46)	4 (4)	653 (176)
2005	69 (40)	187 (30)	889 (306)	29 (9)	80 (55)	4 (5)	1,258 (445)
2006	61 (31)	168 (22)	718 (219)	24 (6)	79 (57)	4 (5)	1,053 (340)
2007	90 (32)	162 (19)	628 (180)	12 (5)	89 (59)	5 (6)	986 (301)
2008	106 (36)	137 (17)	630 (173)	12 (4)	90 (58)	8 (8)	983 (296)

Source: "World Fleet Statistics," *Lloyd's Register of Shipping*, each year.

4.2.3. Aquaculture Yield in North Korea

The recent domestic and international news releases regarding North Korea include a substantial amount of news on the North Korean aquaculture industry, which indicates that the North Korean authority places emphasis on its aquaculture industry, and thus the industry has been strengthened in North Korea.

North Korea's great effort in aquaculture is viewed as an attempt to offset the decreasing fisheries production from the ocean due to decrepit fishery facilities and deteriorated economic conditions, and to provide side dishes and protein to its people.

The North Korean aquaculture industry can be evaluated on the level of simple production structure by focusing on minor items like tropical catfish and kelp.

1) Freshwater Aquaculture

The North Korean authority revolutionized its aquaculture industry in the late 1990s by expanding the construction of fish farms for all kinds of fish, including 100 ha of tropical catfish in each province and 20-30 ha in each city and district. As a result, around 200 fish farms and catfish farms were constructed, repaired, and expanded in North Korea, and the size of these farms reaches thousands of ha, according to North Korea.

The most successful freshwater fish farms in North Korea are the tropical catfish farms, which are assumed to be scattered across the country. Recently, North Korea published data indicating that the daily catfish consumption reaches as much as 1 ton. Based on this information, North Korea's tropical catfish farming is assessed to be on track.

2) Sea Aquaculture

With a sudden decline in the fish catch in the 1990s, North Korea transformed its fisheries policy from catching to growing and fully supported the sea aquaculture industry as well. As its seafood gained popularity as an export item, its sea aquaculture industry began to flourish.

Thanks to efforts by the government authority, the size of sea fish farms increased every year, to about 5,000 ha as of August 2007, and 24,473 ha of fish farms are planned for construction in the future.

3) Shellfish Aquaculture

The main shellfish species farmed in North Korea are ark shell, short-necked clam, top shell, abalone, and clam. North Korea fosters its aquaculture industry to earn foreign currency, and partially fosters an aquaculture of fish species that includes sea bass and sea bream.

Large-scale aquaculture is in operation for abalone, top shell, and clam, particularly in the Ongjin area of the west coast. The Marine Animal Research Institute in the Sea Aquaculture Office of the West Sea developed an artificial culture technique for swellfish and sea cucumber and selected the test site to apply the technique to production. A study is currently in progress to observe how the farming status may be affected by different geographical features and temperatures of the sea.

4) Seaweed Aquaculture

The main marine algae species cultivated in North Korea are kelp, laver, and sea mustard, which are farmed to provide side dishes for North Koreans. Sea aquaculture offices located on the east and west coasts have significantly increased the harvest yield of kelp per hectare by expanding the nutritional area of kelp through high-density planting. However, experts in South Korea point out that this type of farming method hampers the quality of the product.

The leading seaweed farming area in North Korea is along the coastline of the East Sea from the bay of Hamheung to Wonsan, where several fish farms are established. It is known that farms are also established on the west coast, annually producing hundreds of tons of marine algae species such as kelp and sea mustard, as well as shellfish.

In the aquaculture industry in North Korea, advantages include ease of securing farming areas once they are approved by the North Korean authority; cost of labor is cheaper than in South Korea; and the water temperature is suitable to cold sea fish and shellfish farming. Among the disadvantages are that the quality of management is considerably low by nature of the regime, and many materials, including maintenance vessels, are lacking.

4.3. Local Specialties and Expected Competitiveness of the Fisheries Industry in a Post-Unification Era

Based on the existing distribution of cities and industrial infrastructure, precedent studies analyzing the status of North Korean territory indicate 11 cities as hubs in North Korea, as follows (Table 4-10).

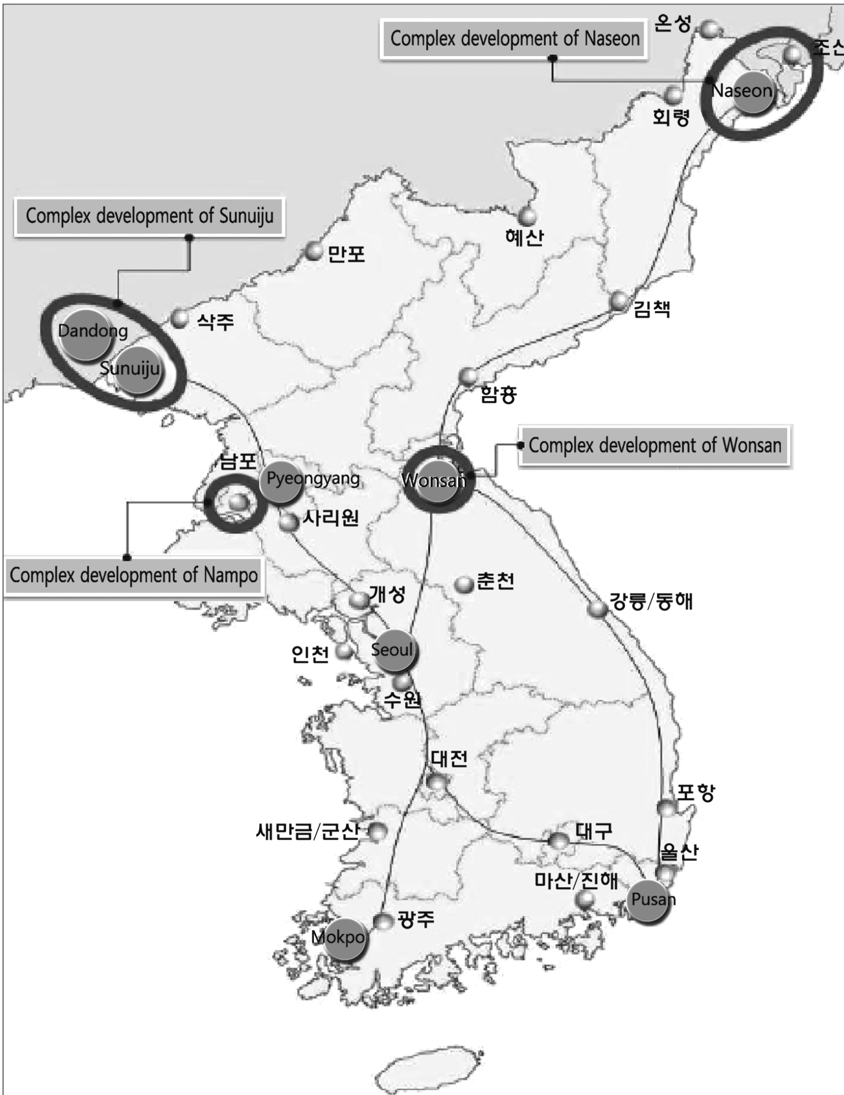
Table 4-10. Key Areas and Hubs in North Korea

Key Areas (Province)	Selection of Hub
South Pyeongan	Pyongyang, Nampo
North Pyeongan	Sinuiju
South Hamgyeong	Hamheung
North Hamgyeong	Cheongjin, Naseon
Hwanghae	Haeju, Gaeseong
Gangwon	Wonsan
Jagang	Hyesan, Manpo

Among the major cities in North Korea, Nampo and Sinuiju have the highest potential to open as hubs in the future. During the 2nd Inter-Korean Summit Talk in 2007, the joint development of vessel repair shops was already agreed upon. In addition, as North Korea and China agreed in June 2011 to jointly develop Hwanggeumpyeong and Nasun in Sinuiju as zones for economic trade, the two cities' development potential can be said to be high.

While the West Coast areas, including the cities, make up only about 37% of the total, they can be regarded as key areas since they contain about 62% of the total North Korean population (Figure 4-1).

Figure 4-1. Key Potential Hubs, including Nampo and Sinuiju



4.3.1. Nampo Special Zone

Among the factories made for the shipbuilding industry are the Nampo Shipyard and the Nampo Vessel Factory in the harbor area. The Nampo Shipyard is the largest shipyard on the West Coast of North Korea, with an area of about 273,000 square meters and 7,000 employees. Its main products are 14,000-ton and 20,000-ton freighters, 1,500-ton destroyer escorts, 82-ton guard ships, and dredging vessels. Nampo is also the main fisheries base on the West Coast of North Korea and houses the Nampo Fisheries Office, Yeongnam Fisheries Office, and Oncheon Fisheries Office, which supply fishery products to Nampo and Pyongyang as well as to all of North Pyeongan Province (Table 4-11).

Table 4-11. Major Public Enterprises in the Agriculture and Fisheries Industry of Nampo

Industry	Feature	Factory and Enterprise
Agriculture	• Great significance in producing grains and vegetables • High level of farm mechanization in the rural economy of Onchun County • Important crops: rice, maize	• Rice, maize: entire Nampo city • Wheat, barley: Yonggang County, Chunrima County, Gangseo County • Soybeans: Oewoodo area, Chunrima County, Gangseo County • Vegetables: Chunrima County, Gangseo County, Oewoodo area
Animal husbandry	• Newly developed industry after liberation • Main livestock: pigs, goats, sheep, rabbits, chicken, ducks, cows • Meat, eggs, and milk largely account for the livestock products	• Nampo chicken farm, Nampo pork plant • Gangseo chicken farm, Gangseo pork plant • Daean chicken farm, Daean dairy farm

Industry	Feature	Factory and Enterprise
Fruit-growing	• Main products: apples, peaches, pears, grapes, persimmons	• Apples: Oewoodo area, Sangseo County, Onchun County, Yonggang County • Peaches: Gangseo County, harbor area, Yonggang County, Onchun County • Pears: Gangseo County, Onchun County

Source: The Institute for Peace Affairs, *Encyclopedia of North Korean Geography and Culture* (2004).

4.3.2. Sinuiju Special Zone

Sinuiju is also a city where the agriculture and fisheries industry advanced as in Nampo. The main fishery product manufacturers are Sinuiju Fisheries Cooperative and Amnok Fisheries Cooperative (Table 4-12).

The cities in North Korea are projected to have various kinds of challenges and opportunities after unification. Particularly, cities with potential for the light, service, and fisheries industries will have development advantages relative to other cities because they have better access to the global market from their location.

Putting these conditions together, Nampo and Sinuiju in North Korea have relatively competitive locations and infrastructures for urban growth.

Table 4-12. Main Factories and Public Enterprises in Agriculture and Fisheries in Sinuiju

Industry	Feature	Factory and Enterprise
Agriculture	• Farmland accounts for 55% of the total area of the city. More than 30% of the farmland is located in alluvial plains near the Amnok river and Samgyo Stream • Important crops: rice, maize, soybeans, sorghum	• Rice: Nammin, Ryucho, Tosung, Sungseo, Baekto, Samgyo • Maize: Sangdan, Hadan, Majun, Songhan • Soybeans: Samnyong, Jeungje, Sunsang • Vegetables: Sangdan, Hadan, Majeon, Nammin, Songhan, Baekto, Tosung, Sukseong, Rakwon
Fruit-growing	• Main products: pears, peaches	• Sinuiju Orchard: Samnyong Village
Animal Husbandry	• Chicken farms and pork plants are equipped with modern facilities	• Chicken farm, pork plant: Sunsang Neighborhood, Hadan Village • Duck farm: Hadan Village
Fisheries	• Main fisheries products: halibut, Chinese herring, gizzard shad, anchovy, sand lance, gray mullet, shrimp	• Sinuiju Fisheries Office • Sinuiju Fisheries Cooperative • Amnok River Fisheries Cooperative • Fish farm: Dongha Neighborhood

Source: The Institute for Peace Affairs, *Encyclopedia of North Korean Geography and Culture* (2004).

4.4. Fishery Policies in Preparation for Unification

During the 4th ministerial meeting in 2000 the fisheries sector looked like a promising choice for one of the top 8 upcoming cooperation tasks, and in July 2005 the North-South Fisheries Cooperation Committee was formed. It was hoped that North Korea would be less reluctant to cooperate, given that the meeting place would be mainly offshore or in open waters and therefore would require little contact with outsiders. On the other hand, open waters presented the possibility of a military clash, and thus the fisheries' cooperation would provide both opportunities and risks. Despite any risks, however, the North Korean side is in urgent need of self-sufficiency in fisheries. Table 4-13 demonstrates the changing trends in North Korean fisheries policy.

Like policies for other industries, the North Korean fisheries policy aims to provide animal proteins to the people in an effort to establish a self-supporting economy and to earn foreign currency under the central planning and control system. The North Korean policy can be divided into 5 levels:

i) On level 1, North Korea adopted a socialist system in which the fisheries sector was nationalized and a socialist economic system was established. The fisheries production goal was 650,000 tons, the real production was 690,000 tons.

ii) On level 2, North Korea aggressively promoted a policy to comprehensively develop its fisheries industry under its 1st 7-year plan. The main policy was to modernize fishing equipment by taking steps that included powering sailing vessels and building power vessels, expanding fishing boat repair shops, and developing shallow-water fish farms. The production goal was 1.2 million tons, but real production came to only 800,000 tons.

iii) On level 3, the economy advanced dramatically with efficient economic policies on foreign capital and 3 technology revolutions. The main policy was to secure a scientific fishing system to aggressively develop marine resources by expanding the infrastructure of deep-sea fisheries and discovering new bases. The policy also aimed to facilitate mechanization of fishery product processing and to strengthen processing and storage facilities, such as expanding facilities for refrigeration in fish railway carrier vessels and establishing cold storage for customers. The production goal was 1.6-1.8 million tons, and actual production was 1.6 million tons.

iv) On level 4, when North Korea professed Juche, or self-determination, the goal was to modernize and scientize the economy, and the fisheries policy followed suit with fisheries production, modernization of fishing equipment, and the establishment of a scientific fisheries production system. The production goal was 3.5 million tons, and the actual production of around 3.5 million tons satisfied that goal.

v) On level 5, North Korea aimed to complete the shipbuilding bases under construction on the east and west coasts earlier than expected, develop offshore and coastal fisheries and deep-sea fisheries at the same time, and organize a large-scale vessel fleet by dedicating national funds, technology, and labor force to these goals. The fisheries production goal was 5 million tons, but actual production reached only 2.19 million tons. It seems that the overall difficulties in the economy since the mid-1990s caused a severely adverse effect on the fisheries sector as well as elsewhere. However, North Korea maintains its focus on fisheries production (offshore and coastal fisheries and aquaculture) in an effort to solve the food problem and earn foreign currency.

Table 4-13. Changing Trends in Fisheries Policies in North Korea

Stage	Specific Business Plan	Primary Measures	Fisheries Products	
			Goal	Outcome
Stage 1 (1947-60)	• 2-year plan for national economy (1945-50) • 3-year plan for economic development (1954-56) • 1st 5-year plan (1957-61)	• Nationalize fisheries production activities and organize fisheries management agencies • Establish new vessel factory, shipbuilding yard, fishing gear manufacturing plant • Nurture shallow-water fish farming industry • Build up the fisheries production infrastructure	1965: 650,000 tons	122,000 tons • 1957: 580,000 tons • 1960: 690,000 tons • 1962 plan for fishing 800,000 tons
Stage 2 (1961-70)	1st 7-year plan (1961-70): 3-year extension	• Modernize fishing facilities: power fishing vessel completed • Expand deep-sea fishery • Develop shallow-water fish farming	1-1.2 million tons	840,000 tons (Estimated by South Korea)
Stage 3 (1971-77)	6-year plan (1971-77): 1 year extension (adjustment period)	• Automate, semi-automate fishing equipment • Aquaculture • Expand fishing infrastructure • Fleet operation of deep-sea fishery	1.6-1.8 million tons • Fish: 2.7 million tons	1.6 million tons (published in Dec. 1977) • Fish: 1.3 million tons
Stage 4	2nd 7-year plan (1978- 84) • Announced top 10 goals for establishing socialism (1980)	• Reorganize the system and policy of fisheries administration (1978) • Manufacture large-scale and all-purpose vessels • Expand fish processing facilities and distribution equipment • Advance techniques for shallow-water fish farming • Release artificial seeds	1984: 3.5 million tons • Fish: 2.7 million tons	3.5 million tons (announced by North Korea) • Fish: 1.65 million tons (estimated by Korea Institute for National Unification)

Stage	Specific Business Plan	Primary Measures	Fisheries Products	
			Goal	Outcome
Stage 5	3rd 7-year plan (1987-93): 1984-86: adjustment • Suggested to fall largely short of the goals of the 2nd 7-year plan	• Modernize and use scientific methods in fisheries • Proactively establish fish farms and diversification of aquaculture • Nurture deep-sea fisheries • Comprehensively promote all kinds of fisheries in processing industry • Establish industrial area • Proactively promote fish farming	1989: 5 million tons (10 prospective goals) 1993: 11 million tons (3rd 7-year goal)	1989: 2.19 million tons (estimated by Korea Institute for National Unification)

Source: Economic Unification, vol. 96, 2009.

4.4.1. Status and Problems of the North Korean Fisheries Industry

1) Decrease in Marine Resources

From 1960 to 1980 production steadily increased at North Korean fisheries, but since the 1990s production has continued to drop. There are about 800 types of marine resources in the inland waters and sea waters of North Korea, and it is known that the economic resources for fisheries comprise over 100 species in total, including 75 types of fish, 20 kinds of shellfish, and 15 types of seaweed. However, the trends and main fishing areas of profitable fish species have not been properly utilized. In particular, Chinese fishing boats legally or illegally operating in the waters in North Korea are rapidly increasing in scope. These Chinese fishing vessels may have huge impacts on marine resources due to their use of bull trawlers, which fish the waters intensely. Operations such as these by Chinese boats are severely exhausting the marine resources in North Korean waters. The North Korean regime has transferred the development rights of offshore fishing areas or aquaculture in such a way that it is not possible even to estimate the current condition of marine resources.

2) Lack of Fishing Infrastructure

The decrepit facilities of North Korean fishing vessels have been an issue on which the infrastructure of the fishing industry hinges. According to the FAO, most of the fishing boats are self-built fishing vessels equipped with North Korean engines, except for those in operation that were brought in by foreign investors and joint venture enterprises or joint companies with the Pro-Pyongyang Confederal System of Korean Residents in Japan or China. Such fishing vessels have extremely low fuel efficiency and lack freezing or cooling facilities for fish storage. The outdated vessels make the operation of vessel repair shops difficult. Even the retained vessels stop operating due to the lack of oil and parts or other malfunction under the North's intensifying economic difficulties. At this point the North Korean yield can be said to be significantly limited due to the lack of fishing vessels.

Moreover, the fishing industry is highly dependent on foreign oil, as oil is needed for the engine, freezer, and generator as well as the fishing net, fishing gear, and the vessel itself. In this regard, fishing activity is inseparable from oil procurement, and the cost of oil makes up a high proportion of the total cost of fishing. North Korea attempts to acquire sufficient oil despite the global oil price spike and US sanctions against North Korea. The oil shortage has become one of the causes of the decline of yield in the fishing industry in North Korea.

3) Lack of Aquaculture Infrastructure

The North Korean aquaculture industry is focused on seaweed and shellfish, including sea mustard, laver, kelp, oysters, and short neck clams, mostly grown by the sprinkle or stone-bed method without the need for particular facilities or equipment. The target species and method of aquaculture are currently stagnant, and thus it is time to develop compatible target species that will grow in the East Sea, West Sea, and inland waters, each with relevant technologies. Despite the recently promoted policy to boost the fish farming industry, North Korean aquaculture cannot flourish due to the lack of seeds, though the country receives some seeds and seed shellfish from China. Aside from that, North Korea lacks farm facilities, small-scale collecting boats, and gear to vitalize the aquaculture industry.

4) Lack of Fishery Product Distribution, Processing Facilities, and System

North Korea's 5 deep sea fishery bases on the East Coast, Wonsan, Heungnam, Sinpo, Gimchaek, and Cheungjun, have fish-landing facilities such as large freezers and exclusive railway carriers. However, these facilities are decrepit and function only at 30%, operating under poor conditions due to the lack of oil and electricity in recent years. In particular, with the lack of ice-making facilities for fishery product distribution, processing, and transportation, fishing vessels entering the harbors in North Korea must provide their own ice for the fishery products they acquire. Also, there is a weak awareness concerning the commercialization of fishery products in North Korea, and salt has served as a preserving agent for fishery products on ships. Based on these factors, the quality management method, freezing level, and hygiene conditions of processing factories in North Korea are assessed as very underdeveloped.

5) Higher Dependency on China

The dependency of the North Korean fisheries industry, one of the biggest exporting industries in the country, on China has increased dramatically in recent years. Around 45% of North Korea's total export revenue to China is composed of fisheries products such as fish, crustaceans, and mollusks, and in turn the seeds and seed shellfish are offered by China to strengthen the infrastructure of North Korea's aquaculture industry. Recently, fishing gear and fishing nets have been shipped from China for barter.

The problem is that North Korea's dependency on China is not based on economic demand in North Korea, but on the possibility of Chinese long-term advancement strategies. As North Korea's lifestyle is being Sinicized, such advancement into North Korea by China cannot be regarded as a simple matter.

4.4.2. Progress in Inter-Korean Fisheries Cooperation

The inter-Korean cooperation in fisheries was first mentioned in the 4th North-South Korea Ministerial Meeting held in December 2000. In 2005, the North-South Fisheries Working Group Meeting was held through the 10th Inter-Korean Economic Cooperation Promotion Committee, during which agreements in 6 areas were adopted in the fisheries sector (Table 4-14).

The inter-Korean fisheries cooperation resulted in:

(1) Providing facilities for fishery products and floating infrastructure in a humanitarian manner and promoting cooperation;

(2) offering 2,000 tons of salted sea mustard reserve (2.3 billion won), 780,000 pieces of dried laver reserve (3 billion won) from the South in 2001, live fish transport trucks and others worth 0.5 billion by Fish.com, Inc., in 2004;

(3) undertaking the project in Gangwon Province to protect and increase salmon resources from 2001; and

(4) working up to about 3.8 billion dollars of total trade volume between the two Koreas over 5 years. Such economic exchange is a win-win approach for economic cooperation that will mutually benefit North and South Korea, putting an end to the one-sided aid to North Korea, and can be regarded as an improvement over the current level of economic cooperation.

Table 4-14. Progress in Inter-Korean Fisheries Cooperation

Meeting	Subject	Remarks
4th ministerial meeting	North Korea proposed to provide part of the fishing area in the East Sea	Dec. 16, 2000
1st Inter-Korean Economic Cooperation Promotion Committee meeting	Proposed common fishing waters and measures for aquaculture	Dec. 26, 2000
15th ministerial meeting	Agreed to form the Fisheries Cooperation Committee and hold a meeting in July	June 21-24, 2005
10th Inter-Korean Economic Cooperation Promotion Committee meeting	Held the 1st meeting in Gaeseong from July 25-27	July 9-12, 2005
1st Inter-Korean Fisheries Cooperation meeting	• Promoted common fishing waters in specific areas of the West Sea • Agreed to mutual cooperation to prevent illegal fishing operations by Chinese fishing boats in the West Sea • Promoted cooperation in production, processing, distribution, and technology of fisheries products • Jointly promoted development of excellent species • Cooperation achieved by using the quota for the 3rd country	July 25-27, 2005 Agreed on 6 provisions
3rd General-level Talks Meeting	• Failed to conclude the agreement	March 2-3, 2006 Panmunjeom

4.4.3. Inter-Korean Fisheries Cooperation Measures

Considering the current issues and challenges of the North Korean fisheries industry based on the situation observed above, the possibility of North-South cooperation can be summarized as follows:

(1) To provide fishing materials in return for fishing operation permission by the North in parts of open fishing areas

(2) To avoid joint fishing operations in offshore waters within the joint fisheries where direct contact would be expected between the fishermen of each country

(3) To invest in North Korean joint venture enterprises such as fish freezing and processing plants

(4) To provide short-term direct government assistance to improve North Korea's fishing yield

(5) To designate common fishing waters and promote joint fishing operations along with assistance

(6) To launch joint companies and build fishery product processing plants

North Korea is expected to continue requesting the fisheries' cooperation via the conversation channel between the authorities and the private sector. The priority task after the joint fishing operation is to provide fishing boats and materials by South Korean ships for a certain period in the open water, with little human contact. Also, for inland aquaculture, it may be better to focus on attracting investment in a way to divide profit only instead of the South Korean workers continuing to stay in North Korea.

As in the 3rd General-level Talks, a political decision by the North Korean leadership must precede designation of common fishing waters near the Northern Limit Line (NLL).

4.4.4. The Political Tasks behind Fisheries Cooperation

The urgent issues raised during joint talks regarding the fisheries sector at the 1st North-South Fisheries Working Group Meeting in June 2005 consisted of joint fishing waters, fishery production, distribution, technical exchange, and fishery product processing, which were evaluated in that order. Detailed information is as follows:

1) Cooperation Measures for Joint Fishing Waters

The issues demanding consideration during the negotiations with North Korea on common fishing waters consisted of early eradication of illegal Chinese fishing; guaranteeing sailor protection and securing safety of vessels; and the economic feasibility and availability of fishing operations in the fishing areas in North Korea. Unless such illegal fishing operations by Chinese vessels are eradicated early, cooperation for joint fishing waters was projected to be difficult to achieve.

In this regard, the common fishing waters sector was assessed as requiring a larger government than private sector role. Table 4-15 indicates the viable measures for common fishing waters by assistance, fishing waters cooperation, and the promotion method, clearly demonstrating that more government assistance is required to encourage cooperation by North Korea.

Table 4-15. Viable Cooperation Measures for North-South Joint Fishing Waters

Category	Cooperation Measures
Assistance	• Financial assistance for fishing vessel, gear, and equipment requests of North Korea • North Korea provides administrative convenience and technical assistance
Cooperation on Fishing	• Designation of North-South Korea common fishing waters (East Sea) • Payment of fishing fee exceeding the fee for Chinese fishing vessels • Introduction of the quota system • Seeking joint measures on vessels and sailors (joint embarkation) / agreement on the number of the vessels and sailors participating in the joint fishing • Promotion of specific rotational fishing method by period and TAC by fishing species • Given the differences between North and South Korea in vessel power, technology, and joint fishing waters, going out fishing before sunrise and coming into the harbor after sunset • Setting principles of joint distribution of production • Simultaneous fishing of North and South Korean vessels in the fishing areas • Since South Korea may be concerned that common fishing waters near the NLL will mean a decrease in catch, common fishing waters are limited to waters in the middle of the sea by North Korea, and only for sedentary fishery products rather than anadromous ones. South Korea provides incentives to North Korea
Promotion Method	• Promotion of separate non-military cooperation measures • Access to North Korea through private companies or NGOs • Prior agreement on prevention measures for illegal fishing by Chinese fishing vessels • Cooperation among the highest-ranking officials of North Korea • Prior implementation of adequate resource research on the common fishing waters

2) Cooperation Measures for Fishery Production, Processing, and Distribution

The fishery production, processing, and distribution sectors are those that should be primarily promoted by the private sector, having expectations of revitalization based on the efforts of the private sector. Among the three sectors, fishery production, distribution, and processing should be preferentially promoted in this order (Table 4-16).

Table 4-16. Cooperation Measures on North-South Fisheries Production, Processing and Distribution

Category	Cooperation Measures on Technological Exchange in Fisheries
Aquaculture	• Scallop farming • Kelp farming and processing / laver farming • Shellfish (sea cucumber, Venus clam, abalone, short neck clam) farming • Flat fish farming • Stream bank and spray cultivation • Advanced inland water aquaculture • Exchange and transfer of aquaculture technology • Joint research on high quality cold-water fish farming • Development of competitive aquaculture species • Mutual training/dispatching of relevant researchers such as aquatic cultivation engineers
Fishery Resources	• Production and releasing of fisheries seed (salmon, abalone) • Providing shellfish seed for sea mustard, laver, and mussel • Joint management measures of salmon resources • Joint research on basic parts (resource) of North Korean waters • Management of industrially valuable anadromous resources (cod, salmon, squid, blue crab)

Category	Cooperation Measures on Technological Exchange in Fisheries
Information and Technology exchange	• Technological cooperation for joint management of internationally protected animal species such as whales • Cooperation on fishing techniques for anadromous fish • Technological training (commissioned education for North Korean workers in South Korean institutes) • Equipment support for fisheries research and educational institutes in North Korea • Human exchanges between North and South Korean university research institutes on fisheries • Information sharing between North and South Korea on fisheries technology

The reasons for the primary promotion are to address the food shortage issues of North Korea; to motivate the North Korean fishermen to participate; to establish mutual trust between the North and South through production; and to emphasize that fishery processing and distribution will be impossible without production of the goods. The production of fishery products secures competitiveness based on cost savings, and distribution achieves high profitability and builds new trust through the fishery product exchange. Since fishery imports already account for a large part of the domestic market, North Korean fishery products may need free distribution.

3) Cooperation Measures for Fisheries Technology Exchange

The high-quality varieties of species should be jointly developed to improve the yield of fishery products, and cooperation measures for technology exchange in fisheries should include direct aquaculture, technology, and human exchange in the aquaculture sector.

Cooperation measures on marine resources may include the production of fisheries seed and stocking of fisheries, seed shellfish assistance, joint investigation on marine resources in North Korean waters, and management of and catching techniques for migratory resources (Table 4-17).

Table 4-17. Measures for North-South Technology Exchange and Cooperation in Fisheries

Category	Cooperation Business
Fisheries Production	• Common fishing waters / joint farming • Farming items: shellfish, kelp, salmon, trout, Venus clam, short neck clam • Supporting farming and fishing techniques, shellfish seed, seed species • Large-scale release of salmon • Building inland or sea fish farm • Promotion of aquaculture development after pilot program tailored to regional characteristics • Stream bank cultivation available on sea cucumber and shrimp • Any method available upon mutual agreement, wheher fishing or farming • Squid jigging in the East Sea • Production of competitive farming species
Fisheries Production	• Fishing blue crab in the West Sea • Inland and sea waters seed business • Inshore set net fishing in the East Sea • Joint management business of marine resources with neighboring countries Russia, China, and Japan • Equal division between North and South Korea of total fish catch, excluding total expenses in fishing by ordinary sailors in the waters of North Korea • Gill net, trawl net in the West Sea • Dispatch of researchers, teachers, and workers, and domestic training by South Korea • Sedentary fishery products insufficiently produced in domestic waters such as blue crab and short neck clam • Joint operation of scallop farms • Fishing operations in North Korean waters

Category	Cooperation Business
Fishery Product Processing	• Freezing/cooling • Blue crab freezing • Steamed short neck clam freezing and vacuum packaging / short neck clam packaging • Processed adductor muscle of scallop freezing • Shellfish processing such as ark shell • Fishery product processing using cold sea fish (pollack, snow crab, red snow crab) • Simple dry processing • Canning • Pollack and dried pollack drying • Exchange of processing techniques • Export of processed East Sea crab • Building kelp processing factory / kelp processing • Expansion of processing distribution facilities, equipment (using South Korean capital) • Pollack roe extraction • Pickled / salted processing • Alternative caviar product processing • Fish meat paste and jelly product / crab stick processing • Building processing complex for deep sea fishery products (Chinese, Russian, Japanese market expansion) • Standardization of aquaculture and product quality

Aside from the shipment project of fishery products from North Korea, the mutually promoted cooperation project comprises 7-8 projects, including joint North-South fishing in the West Sea by Haeju Co., joint venture enterprises for joint fishing in the East Sea, a joint company for joint fishing of red snow crab in the East Sea by Anseung Distribution Co., joint venture enterprises for joint fishing by Fisheries Cooperatives in Gosung district, a cooperation project with the National Federation of Fisheries Cooperatives, and a scallop aquaculture project with Taeyeong Fishery and LG International. However, the performance of those projects is insignificant. Unlike agricultural cooperation, which has a small, short-term impact on the domestic agricultural industry, fisheries cooperation features immediate short-term ripple effects on the fisheries industry. Figure 4-2 demonstrates measures to improve the North-South fisheries cooperation system.

Figure 4-2. North-South Fisheries Cooperation System

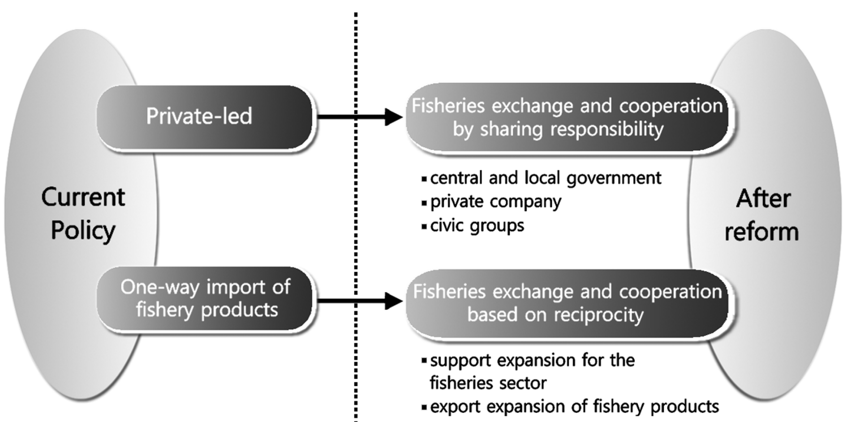


Table 4-18 lists stages of action and the roles of government and the private sector in North-South fisheries cooperation.

Table 4-18. North-South Fisheries Cooperation by Stage

Cooperation Division (Role)		Initial stage	Mid stage	Long stage
Agenda of North-South fisheries	Joint fishing (Government>Civilian)	———	———	——→
	Prevent illegal fishing (Government>Civilian)	———	———	——→
	Fishery Products production (Civilian>Government)	—	———	——→
	Fishery Products distribution (Civilian>Government)		———	——→
	Fishery Products processing (Civilian>Government)		———	——→
	Technology exchange of Fisheries (Government=Civilian)		———	——→
	The 3rd world fishing advance cooperation (Government=Civilian)		—	——→
Private Business	Import Business	———	———	——→
	Investment Business	———	———	——→

4.4.5. Circumstances of North Korean Fisheries Development in a Post-Unification Era

It may not be easy, practically speaking, to proceed with the North-South fisheries cooperation project in the desired South Korean way. First, bilateral agreement on fisheries cooperation development is expected to be reached between the neighboring countries of China and Russia regarding marine resource development as well as bilateral agreements on fisheries, marine environment protection, marine scientific investigation, and marine salvage issues. In this regard, the question of how to handle these agreements is highly likely to occur after unification.

North Korea and China have engaged in fisheries trade through a military and economic alliance since reaching the "North Korea-China Amicable Cooperation and Mutual Alliance Pact." The representative elements of cooperation between them are to develop fishery grounds in North Korean waters and to advance into the aquaculture industry. The West Sea of North Korea is known to have abundant marine resources and thus contains the main fishery grounds. Such marine resources are very important to North Korea and China. The West Sea is also attractive for its non-living resources, petroleum and natural gas. Therefore, China intends not only to secure fishery and marine resources in the West Sea but also to expand its territorial waters and/or place the area within the sphere of Chinese influence as a measure of national security.

Under this agreement, a private Chinese company sends fishing vessels to fisheries in North Korean waters, where they prepare the vessel, fishing gear, sailors, fuel, and food, and North Korea is responsible for the management and operation of sea areas, ports, and freezer and cooling storage. Payment is made to North Korea through a usage fee from the Chinese company, or 30% of production. With sea farming, China makes the entire investment and takes responsibility for production management and facilities, while North Korea recoups 20% of the fish in return for providing a labor force and various public services. In other words, the fisheries agreement may be called a joint venture enterprise. North Korea and China concluded the North Korea-China Fisheries Pact in 2004, and Chinese vessels seem to be moving to the East Sea areas of North Korea; one medium-sized shipping company from China is identified as having obtained the right to use Najin port for 2 decades. This critical issue cannot be neglected by South Korea, which seeks North-South fisheries cooperation after unification. China's fisheries trade, and the resultant overfishing, is rapidly surging, passing through the formal channels with the government or relevant agencies.

North-South exchange and cooperation was aggressively promoted in 1998 when South Korea implemented its Sunshine Policy as a way for North Korea to improve the North-South exchange and cooperation by easing the tension between the two with an attitude of reconciliation. However, after North Korea blew up the Cheonan warship and shelled Yeonpyeong Island in 2011, the inter-Korean relationship deteriorated, whereas China eased the food shortage in North Korea by expanding economic and trade cooperation, thus further strengthening the North Korea-China relationship. Given the situation, the mid- to long-term fisheries pact between North Korea and China is likely to be a constraint to the rights of a unified Korea under international law. Since the pact between Chinese companies and the North Korean regime is an international agreement to grant concessions to the nation and foreign private companies for resource development, it may be deemed an economic development pact. Because the issue of exclusive rights with China presents a challenge to a unified Korea, there is a clear necessity to draw up measures concerning usage of marine resources in North Korea after unification.

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05 Food Supply and Demand Outlook in Post-Unification Korea

5.1. Food Supply and Demand Outlook for North Korea

To calculate the food supply and demand of Korea in a post-unification period, it is necessary to separately project North Korea and South Korea's food supply and demand after unification and then combine the outlook results.

5.1.1. Method of Predicting Food Supply and Demand in North Korea

Although there are numerous papers and reports discussing the North Korean food situation, only a few researchers have predicted the food supply and demand in North Korea in a post-unification scenario. The best research on this issue comes from the Korea Rural Economic Institute (KREI) (1997) and a study by Kwon Tae-jin with estimates of the minimum food requirements for North Korea (2010). The Korean Agricultural and Rural Research Institute (KARRI) research assumed the year 2000 as the point of unification. The demand for food included edible food, seed, feed, and processing. The demand for edible food was estimated by combining the projected edible food demand for each food item. The demand for feed was found by calculating the food consumption per livestock products after estimating the number of heads per species. The demand for processing was calculated for the outlook period 2000-2001 by applying the estimates of the average proportion of processed food for the 3 years 1994-1996.

The research by Kwon Tae-jin applied the daily minimum calorie intake to North Korea's daily food demand, and the amount of food production subtracted from the estimated minimum food demand was assumed as the food production shortage in North Korea. The method of estimating food production against the minimum daily calorie intake was applied by the Ministry of Unification. It is to estimate the minimum daily intake based on calories, project the food demand per usage, and finally calculate the food demand by combining the estimates together. The minimum daily calorie intake applied by the Ministry of Unification assumed consumption to be 1,600 kcal per person per day, which equals an annual consumption of 167 kg. The normal calorie consumption is 2,130 kcal per person daily, or 222 kg of food annually.

Another method is to project the food requirement of North Korea based on the assumption that people will consume food in the way they consumed food in the past, by applying the previous food consumption trends of North Korea. Generally, trends are estimated by regression analysis. However, estimating the food demand of North Korea in a post-unification period based on regression analysis assumes that previous trends in production and consumption will be consistently maintained, even after unification. However, it is unrealistic to assume that food consumption in North Korea will maintain a consistent pattern after unification. In other words, significant changes are apt to occur in the structure of food supply and demand of North Korea, so the estimation of future food consumption based on a simple trend is likely to cause a widely divergent error in future food estimates.

The best estimation of the North Korean food demand in the post-unification era applied in precedent research uses a method based on daily calorie intake, thereby reducing assumption to a minimum level.

The estimate of North Korean food production in a post-unification era used here follows the method that was applied in the above-mentioned research conducted by the Korea Rural Economic Institute (KREI) (1997). To predict the food production of North Korea, it is necessary to estimate how cultivation area and yield may change after unification, since food production is calculated as cultivation area multiplied by the number of bundles.

To predict the arable land size of North Korea after unification, the factor of increases in arable land should be figured first. Because the forests of North Korea should be preferentially restored after unification, dry fields exceeding 16-degree slopes are assumed to be slated to revert to forest land. Also, it is assumed that the conversion of farmland for rice will decrease, and farmland for other grains, including maize, will decrease in both farmland conversions and slope areas. In this way, reclamation is considered to be one of the factors of arable land increase, and the returning of the dry field slopes to forests and farmland conversion are considered to be factors of arable land decrease. To predict how much land North Korea will convert to farming after unification, South Korea's farmland usage trends from 1970 to 1990 will be applied to North Korea in a post-unification scenario.

The number of bundles, farming materials including fertilizer, agricultural chemicals, and agricultural machines will be reliably supplied, fine species will be planted, forests will be restored, disaster prevention systems will be strengthened, and unit production will largely increase in a gradually vitalized market economy.

It is assumed that the point of increase in the number of bundles, due to the system transition in North Korea, would be the year 2017, 6 years after unification. A study by Go Jae-mo (1997) found that in China the factors of increase in yield under a changed system can be divided into technological factors and system transitional factors, making up 73.6% and 26.4%, respectively, of the total increase in bundle number. To determine how much increase the technological factors would make, this method applies the number of bundles of rice in South Korea in the mid-1970s, and to predict the increase in the number of bundles of grain after 2017, South Korean trends are applied.

5.1.2. Assumptions regarding the Food Supply and Demand Outlook for North Korea

Assumptions are needed to properly predict the food supply and demand in North Korea because of uncertainty regarding the point of Korean unification. Several basic assumptions are required in order to forecast the food supply and demand of North Korea after unification.

There might be several opinions regarding the time of Korean unification, but this study assumes unification will be achieved in 2015. The period estimated in this evaluation is 10 years. Therefore, the prediction period of North Korea's food supply and demand in a post-unification era comprises the 10 years after unification, which is from 2015 to 2025.

As mentioned above, the estimate of food supply and demand in North Korea in a post-unification period requires an estimate of North Korea's food consumption based on daily calorie intake. There might be several assumptions regarding North Korean food consumption. For example, it may be assumed that North Koreans consume the minimum daily per capita calorie requirement immediately after unification and gradually increase their consumption of calories to a normal amount after 10 years. Otherwise, it may be assumed that the food ration, which has failed to be given in its normal amount, normalizes directly after unification, and calorie consumption gradually increases. However, by considering more realistic scenarios, this study presents the following 2 alternatives for estimating food demand.

- Alternative 1: The North Koreans are assumed to take the minimum daily calories in 2015, immediately after 2015, and then gradually increase caloric intake to a normal amount of calories within 10 years, by 2025.

- Alternative 2: The North Koreans are assumed to consume food in 2025 to the level of food consumption by South Koreans in 1980 as North Korean food rations are normalized and the economy is gradually integrated into a market economy in 2015, directly after unification.

In order to predict the annual food demand, the food demand by usage, which determines the total food demand, should be estimated individually and summed up together. Food demand may be divided into foods, feed, seeds, and others by individual usage. To figure out the per capita grain consumption for feed and seeds, South Korea's daily grain consumption (feed and seed) from 1970 to 1980 is applied to the comparison period (2015-2025).

The prediction of the North Korean population in the future requires using prediction data released by established organizations. Among the credible data for prediction of the North Korean population are National Statistical Data (Nov. 2011) and "2011 Global Urbanization Outlook" by the United Nations Department of Economic and Social Affairs (UN DESA). The outlook data for the North Korean population are strikingly similar. However, as the recent UNDESA data of "2011 Global Urbanization Outlook" reference the Statistics Korea (KOSTAT) data, this paper will use the estimates of the North Korean population in a post-unification period provided by Statistics Korea (KOSTAT).

5.1.3. Current Conditions of Food Supply and Demand in North Korea

The food situation in North Korea has not yet improved. North Korea has created and implemented various measures during the 15 years since the period known as the March of Hardship, from 1994 to 1997. Despite annual assistance from international organizations and South Korea, the food shortage in North Korea has continued.

There may be several reasons for the unresolved food shortage in North Korea, but the fundamental reasons are the severance of relations with the Soviet Union upon its collapse, the failure to tackle the underlying problems of North Korea's command economic system, and significantly reduced food production in times of natural disaster, including droughts, floods, and typhoons. Weather disasters caused much less food production than usual in 1996, 1997, 2000, and 2007. In these situations North Korea had to depend on foreign food aid to make up for the shortage. Another fundamental problem is that unit production cannot be increased due to the absolute lack of agricultural inputs such as fertilizer, pesticides, agricultural machinery, and energy such as oil. It is difficult to maintain agricultural production because landslides cover farmland when it rains due to devastated forests. However, the biggest fundamental problem is the absence of incentives for higher production due to the communist economic system. South Korea may import food from overseas when its production falls short. However, North Korea must depend on foreign food aid because of the absolute lack of foreign currency to import food. Foreign aid has been reduced and suspended many times because of a series of issues, such as attempts to develop nuclear power, that trigger tension on the Korean peninsula. In turn, food shortages lead to the malnutrition of the people and death by starvation.

Table 5-1 shows the food supply and demand in North Korea from 1994 to 2008. For 15 years North Korea produced an average of 4.03 million tons and consumed an average of 5.28 million tons, indicating an average shortage of 1.28 million tons. Particularly in 1995, 1997, and 2000, production fell short by 1.70 million tons of required consumption due to the weather disasters. Figure 5-1 demonstrates North Korea's food supply and demand and the amounts of shortage from 1994 to 2008. As Table 5-1 shows, the problematic factor of North Korean food supply and demand rests heavily on a consistent production shortage of even the minimum level of consumption, which results in food shortages vulnerable even to a small weather disaster.

Table 5-1. Status of Annual Food Supply and Demand in North Korea (1994/1995-2008/2009)

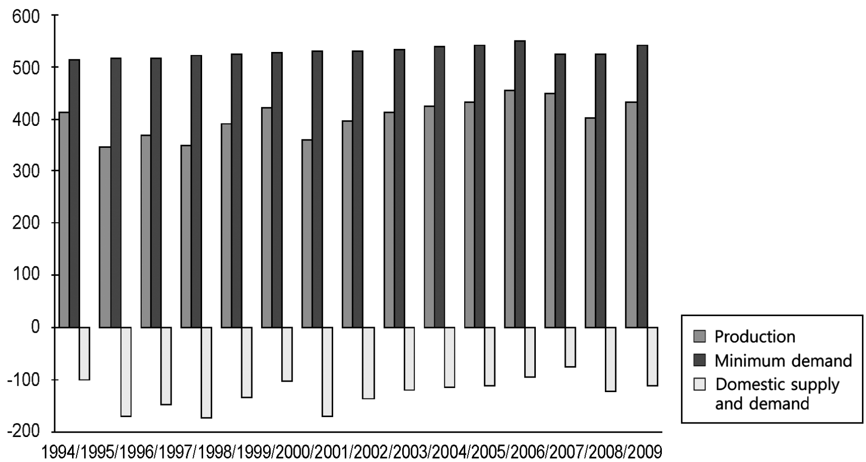
(unit: 0,000 ton)

Crop Year	Food Supply And Demand In North Korea		Shortage
	Production	Minimum Demand	
94/95	413	512	-99
95/96	345	515	-170
96/97	369	517	-148
97/98	349	521	-172
98/99	389	523	-134
99/00	422	526	-104
00/01	359	529	-170
01/02	395	531	-136
02/03	413	533	-120
03/04	425	539	-114
04/05	431	542	-111
05/06	454	548	-94
06/07	448	524	-76
07/08	401	524	-123
08/09	431	542	-111
Average	403	528	-125

Note: The crop year (November-October) is applied for domestic supply and demand.

Source: Statistics Korea (KOSTAT), Production; Korea Rural Economic Institute, Minimum demand.

Figure 5-1. Current Status of Annual Crop Supply and Demand in North Korea ('94/'95-'08/'09) (unit: 0,000 ton)



5.1.4. Food Supply and Demand Outlook for North Korea in a Post-Unification Era

Table 5-2 is the result of the food demand estimate for North Korea after unification and under the assumptions made above. In a separate application of the population estimate by Statistics Korea (KOSTAT) and the UN, the annual food demand varies. In 2015, KOSTAT estimated that the North Korean population will be 24.78 million and that the annual per capita food consumption will be 167 kg, supposing that the North Koreans consume only the minimum daily calories. The annual food demand of North Korea will be calculated as population multiplied by food intake, and thus the annual food demand in 2015 will be 4.138 million tons. When applying UN estimates of the North Korean population, the annual food demand in 2015 will be 4.149 million tons. The annual food demand in North Korea from 2015 to 2025, which is supposed to encompass the point of unification according to this method, will increase from 4.138 million tons to 5.754 million tons on the basis of the population estimate by KOSTAT, or increase from 4.149 million tons to 5.733 million tons based on UN statistics (Table 5-2).

Table 5-2. Outlook on Edible Food Demand in North Korea in Post-Unification Korea

Year	Estimated population		Daily intake (kcal)	Annual intake (kg)	Annual consumption[1] (000 ton)	Annual consumption[2] (000 ton)
	KOSTAT[1] (000 person)	UN[2] (000 person)				
2015	24,779	24,845	1,600	167	4,138	4,149
2016	24,897	24,945	1,653	173	4,295	4,303
2017	25,014	25,045	1,706	178	4,452	4,458
2018	25,132	25,145	1,759	184	4,612	4,614
2019	25,250	25,244	1,812	189	4,772	4,771
2020	25,368	25,344	1,865	195	4,934	4,929
2021	25,484	25,449	1,918	200	5,097	5,090
2022	25,598	25,542	1,971	206	5,260	5,249
2023	25,709	25,636	2,024	211	5,425	5,409
2024	25,816	25,730	2,077	217	5,589	5,571
2025	25,917	25,824	2,130	222	5,754	5,733

Notes:

1) is created based on North Korean population estimates supplied by KOSTAT.

2) is created based on North Korean population estimates supplied by UN DESA.

As a result of estimating non-edible food demand for seeds, feed, and other, the demand for seeds in 2015 and 2025 is reduced from 128,000 tons to 75,000 tons, the demand for feed is increased from 449,000 tons to 1.809 million tons, and the demand for other is increased from 124,000 tons to 177,000 tons. Therefore, the non-edible food demands increased significantly, from 701,000 tons in 2015 to 2.061 million tons in 2025 (Table 5-3).

Table 5-3. Non-Edible Food Demands (Seeds, Feed, Other)

Year	Population	Seeds	Feed	Other	Total (000 ton)
2015	24,779	128	449	124	701
2016	24,897	123	585	129	837
2017	25,014	117	721	135	973
2018	25,132	112	857	140	1,109
2019	25,250	107	993	145	1,245
2020	25,368	102	1,129	151	1,382
2021	25,484	96	1,265	156	1,517
2022	25,598	91	1,401	161	1,653
2023	25,709	86	1,537	166	1,789
2024	25,816	80	1,673	172	1,925
2025	25,917	75	1,809	177	2,061

Notes:
① The data are based on per capita consumption in South Korea from 1970 to 1979.
② 2% of food consumption is applied to "other."

The estimates on North Korean food demand in a post-unification era are summarized in Table 5-4 below. In scenario 1, in which North

Koreans take in the minimum calorie amount in 2015 and gradually increase consumption to the normal level of calorie intake in 2025, the food demand in North Korea will increase from 4.839 million tons in 2015 to 7.815 million tons in 2025. In scenario 2, in which North Koreans receive normalized food rations in 2015 and consume the calorie equivalent to the South Korean calorie consumption in 1980, the food demand is estimated to increase from 5.286 million tons in 2015 to 7.604 million tons in 2025 (Table 5-4).

Table 5-4. Food Demand in North Korea

Year	Food demand						
	Food		Seeds	Feed	Other	Total	
	(1)	(2)				(1)	(2)
2015	4,138	4,585	128	449	124	4,839	5,286
2016	4,295	4,681	123	585	129	5,132	5,518
2017	4,452	4,777	117	721	135	5,425	5,750
2018	4,612	4,872	112	857	140	5,721	5,981
2019	4,772	4,968	107	993	145	6,017	6,213
2020	4,934	5,064	102	1,129	151	6,316	6,446
2021	5,097	5,160	96	1,265	156	6,614	6,677
2022	5,260	5,256	91	1,401	161	6,913	6,909
2023	5,425	5,351	86	1,537	166	7,214	7,140
2024	5,589	5,447	80	1,673	172	7,514	7,372
2025	5,754	5,543	75	1,809	177	7,815	7,815

Notes: Demand=(Food+Seeds+Feed+Other)
(1) indicates scenario 1 data, (2) indicates scenario 2 data

To predict the food consumption in North Korea after unification, one must predict how the cultivation areas and number of bundles will change in the post-unification period. The area of food cultivation in North Korea after unification is estimated to decrease from 1.614 million ha in 2015 to 1.343 million ha in 2025, while the number of bundles is predicted to increase from 976 kg/ha to 1,907 kg/ha, making the total food production increase from 4.268 million tons in 2015 to 6.371 million tons in 2025 (Table 5-5).

Table 5-5. Outlook for Food Production in North Korea after Unification (2015-2025)

	Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Total	Cultivation area (000 ha)	1,614	1,587	1,560	1,533	1,506	1,479	1,451	1,424	1,397	1,370	1,343
	Yield units (kg)	976	1,069	1,162	1,255	1,348	1,442	1,535	1,628	1,721	1,814	1,907
	Production (000 ton)	4,268	4,478	4,689	4,899	5,109	5,320	5,530	5,740	5,950	6,161	6,371

The total food supply and demand in North Korea after unification is summarized in Table 5-6. According to scenario 1, in which the calorie intake changes from minimum to normal, the North Korean food demand in 2015 is estimated at 4.839 million tons. However, production is estimated at 4.268 million tons, indicating a lack of food supply by 571,000 tons. In 2025, the demand is estimated at 7.815 million tons and production at 6.371 tons, or a

1.444 million-ton deficit in supply. In alternative 2, in which North Korean food rations are normalized at the point of unification, and the calorie consumption in 2025, 10 years after unification, is equivalent to the calorie intake of the South Koreans in 1980, the supply is estimated to lack 1.018 million tons in 2015 and 1.333 million tons in 2025.

Table 5-6. Outlook for Food Supply and Demand in North Korea after Unification (2015-2025)

Year	Food Demand and Supply			Shortage (Demand-Supply)	
	Demand		Supply	(1)	(2)
	(1)	(2)			
2015	4,839	5,286	4,268	571	1,018
2016	5,132	5,518	4,478	654	1,040
2017	5,425	5,750	4,689	736	1,061
2018	5,721	5,981	4,899	822	1,082
2019	6,017	6,213	5,109	908	1,104
2020	6,316	6,446	5,320	996	1,126
2021	6,614	6,677	5,530	1,084	1,147
2022	6,913	6,909	5,740	1,173	1,169
2023	7,214	7,140	5,950	1,264	1,190
2024	7,514	7,372	6,161	1,353	1,211
2025	7,815	7,604	6,371	1,444	1,333

Notes:
(1) indicates scenario 1 data.
(2) indicates scenario 2 data.

5.2. Food Supply and Demand Outlook for South Korea

5.2.1. Prediction Method of Food Supply and Demand for South Korea

Although the outlook for how food supply and demand in South Korea may change after 2015 can provide basic data for future domestic food policies, little research has been released on the future of domestic food supply and demand. Food policies have focused only on the domestic rice issue to date, and there has been no controversy over food imports from overseas markets to fill in shortages. However, it is important to predict trends in the domestic food supply and demand in the mid- and long-term, especially considering the recently unstable global grain market and the prospect of unification. Predictions for domestic food supply and demand can be broadly divided into 2 methodological camps: the manner of estimating overall domestic food supply and demand in consideration of the mutual connection among subsectors within the agricultural sector, and the manner of predicting the domestic food supply and demand using past trends in food supply and demand. This study aims to both of these methods; specifically, the KREI KASMO (Korea Agricultural Simulation Model 2011), which considers mutual relationships among agricultural sectors, and a regression analysis on previous food consumption data in the food balance sheet.

The KREI KASMO is an estimation model for the agricultural sector developed and operated by the Korea Rural Economic Institute. The KREI KASMO is composed of 6 sectors of estimation: macroscopic variables, input costs, cultivation, animal husbandry, farming population, and total amount, with each sector mutually connected. The KREI KASMO is a partial equilibrium model for the domestic agricultural sector and regards the global market and non-agricultural sector market as exogenous variables.

In the main macroscopic variable sector, the real GDP and per capita disposable income are predicted. To predict macroeconomic variables, economic growth rate, consumer price growth rate, interest rate, exchange rate, consumer price index, and producer price index are required, and these data are provided by relevant agencies such as the Korea Bank, Statistics Korea (KOSTAT), the OECD, and Global Insight, Inc. The global oil price was obtained from the "Annual Energy Outlook" of the US EIA (Energy Information Administration), and the total domestic population was found in the population outlook estimate of KOSTAT. The global grain and livestock prices used estimates from the US FAPRI (Food and Agriculture Policy Research Institute) and the KREI (Korea Rural Economic Institute). The input prices sector predicts the prices of farming tools, feed, agricultural electricity and heating, seed, fertilizer, agricultural chemicals, manufactured materials, agricultural wages, and farmland rents. The prices of farming tools, feed, agricultural lighting and heating, seed, fertilizer, agricultural chemicals, and manufactured materials are estimated using the previously forecasted macroeconomic variables, and the agricultural wages and farmland rents are predicted in connection with the cultivation sector and macroscopic variables.

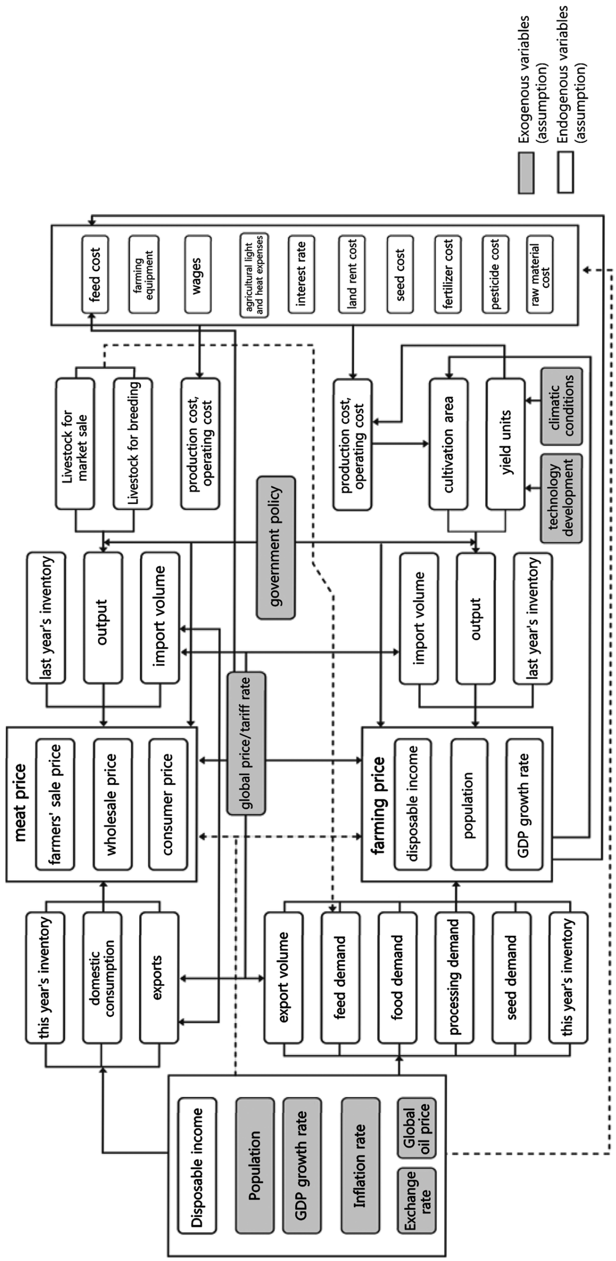
The cultivation sector is divided into grain, vegetables, fruit-vegetables, fruit, and special crops, and each item comprises the functions of the cultivation area, number of quantity, demand and import demand, and identity of supply and demand to create the supply and demand outlook by item and equilibrium price. The cultivation sector is largely categorized into summer cultivated crops, fruit trees, and winter cultivated crops: The summer and winter cultivated crops are estimated with a system of simultaneous equations reflecting the trade-off that producers face in terms of crop choice. Fruit trees constitute 6 types of crops: apple, Asian pear, grape, tangerine, sweet persimmon, and peach. Each crop has its own supply and demand but the substitutability among crops is reflected in the supply and demand for each crop. The livestock products are categorized into Korean cattle, milk cow, dairy products, pig, chicken, layer chicken, and duck, and the dairy products are divided into cheese, butter, powdered milk, fermented milk, and condensed milk. The supply function, such as the number of animal heads, is a biological model reflecting the survival rate by age, and the demand function, including the demand and import demand function, is estimated with an econometric model, drawing the supply and demand outlook and equilibrium price by the type of livestock. The total amount of the agricultural sector has been set to calculate the total amount index, including agricultural production revenue, income, and added value, using estimates of agricultural factors, production, and price by commodity. In this sector, the variables of agricultural economy are estimated to predict farm income, direct payment per farm household; and the outlook on total arable land, including arable land size, used arable land size, and arable land usage rate, trade balance (export, import), and self-sufficiency rate are calculated by summing up the estimates of subsidiary items.

KREI KASMO 2011 includes 45 crop commodities and 9 livestock items, for a total of 54 items. Among these, the potato is divided into spring, summer, and autumn; Chinese cabbage and radish are divided into spring, summer, autumn, and winter; scallions are separated into spring onion and chive; and dairy products comprise 5 categories: cheese, butter, fermented milk, condensed milk, and powdered milk (Table 5-7). These items make up 97.0% of total agriculture, including 96.3% of the cultivation industry and 98.1% of the animal husbandry industry by production revenue in 2009. Items for cultivation account for 95.0% of the total area by land area.

Table 5-7. KREI KASMO Target Items

	Category	Items	Notes
Cultivation Sector (45)	Crops (7)	Rice, Barley (barley, wheat), Mixed grains (maize), Legumes (soybean), Starchy roots (potato, sweet potato)	Potato: Spring, Summer, Autumn
	Vegetables (13)	Leafy vegetables (Chinese cabbage, cabbage), Root vegetables (radish, carrot), Condiment vegetables (red pepper, garlic, onion, green onion, ginger), Kimchi, Spinach, Lettuce	• Chinese cabbage and radish: Spring, Summer, Autumn, and Winter • Green onion: big green onion, spring onion
	Fruit-vegetables (9)	Watermelon, Oriental melon, Cucumber, Squash, Tomato, Strawberry, Melon, Eggplant, Green pepper	Paprika can be included in future
	Fruits (8)	Apple, Asian pear, Grape, Peach, Sweet persimmon, Tangerine, Import fruits (orange, other tropical fruits)	Other tropical fruits: HS code 0801-0804, lemon
	Special crops and others (8)	Sesame, Perilla, Peanut, Ginseng, Green tea, Floriculture (cut flower, pot flower, other), Mushroom, Medicinal crops	
Livestock Sector (9)	Korean cattle, Milk cow, Dairy products, Pig, Chicken, Layer chicken, Duck, Honey, Feed crops		Dairy products: cheese, butter, fermented milk, condensed milk, milk powder (prepared, whole milk, nonfat milk)

Figure 5-2. The KREI-KASIMO 2011 Model Structure



5.2.2. Estimates of Food Supply and Demand in South Korea

Using the KREI KASMO, food supply and demand in South Korea is estimated as demonstrated in Table 5-8. The South Korean food demand is estimated at 24.183 million tons in 2015 and 24.058 million tons in 2025, a slight decrease. That is, it is projected that South Korea will maintain its food supply and demand at the level of 24 million tons for 10 years after 2015. By commodity, maize accounts for the largest portion, at 10.02 million tons, followed by rice, wheat, and soybeans, in order (Table 5-8).

Table 5-8. Outlook for Food Supply and Demand in South Korea by Item

(unit: 000 ton)

Item	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
rice	5,391	5,354	5,319	5,290	5,253	5,217	5,191	5,166	5,141	5,099	5,066
barley	398	401	402	404	406	407	408	409	410	412	414
wheat	4,787	4,702	4,634	4,580	4,527	4,483	4,446	4,417	4,393	4,372	4,356
maize	10,020	10,135	10,282	10,373	10,428	10,433	10,440	10,450	10,464	10,481	10,497
soybeans	2,022	2,038	2,054	2,060	2,068	2,075	2,080	2,086	2,092	2,097	2,102
starchy roots	1,091	1,093	1,097	1,100	1,106	1117	1,122	1,129	1,137	1,144	1,151
other	474	474	476	476	476	475	474	473	473	472	472
total	24,183	24,197	24,264	24,283	24,264	24,207	24,161	24,130	24,110	24,077	24,058

The factors composing domestic food supply and demand are basic inventory, domestic production, imports, and other. The key factor is imports, which makes up two-thirds of the total food supply and demand, while the remaining one-third consists of domestic production and inventory. This portion of domestic food supply and demand by source will change little after 2015 (Table 5-9).

Table 5-9. Outlook for Food Supply and Demand in South Korea by Source

(unit: 000 ton)

Source	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
basic inventory	2,396	2,376	2,364	2,370	2,378	2,353	2,343	2,345	2,351	2,358	2,363
production	5,592	5,574	5,556	5,541	5,520	5,505	5,493	5,481	5,468	5,438	5,419
imports	15,721	15,773	15,868	15,896	15,890	15,874	15,851	15,831	15,818	15,809	15,804
other	474	474	476	476	476	475	474	473	473	472	471
total	24,183	24,197	24,264	24,283	24,264	24,207	24,161	2,4130	24,110	24,077	24,058

The following is the estimate for South Korean food demand by regression analysis. The data for the regression analysis comprise food consumption from 1970 to 2010 (for 41 years) as recorded on the food balance sheet. The food consumption of South Korea from 2015 to 2025 was predicted by applying the time-series data to the following equation.

$$Q_d = a + bPR + cIN + dPOP + \varepsilon \qquad \text{(Equation 5-1)}$$

where Q_d is the demand for food, PR is the price of the farm products, IN is the Gross National Income, and POP is the population.

Equation (5-1) was estimated by transforming the dependent variable (food consumption) and independent variables (population, gross national income, farm price index) in the logarithm form. The function of the demand for food in South Korea was in practice estimated using Equation (5-2) below, with the resulting coefficients reported:

$$\ln Y = 65.65 - 3.50\ln X_1 + 0.47\ln X_2 - 0.27X_3, \text{ with an estimated } R^2 = 0.92$$
$$(3.00)\ (2.64)\ (4.06)\ (4.55) \qquad \text{(Equation 5-2)}$$

where Y is the demand for food, measured as a three-year moving average, X_1 is population, X_2 is gross national income (in nominal terms), X_3 is the farm sale price index, and the numbers in parentheses are the t-values for each coefficient.

Table 5-10 indicates the calculated estimates of the South Korean food demand from 2010 to 2030.

Table 5-10. Outlook for Food Demand in South Korea (2010-2030)

(unit: 000 ton)

Year	Demand	Year	Demand
2010	22,741	2021	23,831
2011	22,089	2022	23,980
2012	22,398	2023	24,134
2013	22,669	2024	24,280
2014	22,837	2025	24,442
2015	23,013	2026	24,628
2016	23,139	2027	24,835
2017	23,281	2028	25,062
2018	23,432	2029	25,301
2019	23,562	2030	25,549
2020	23,693	-	-

5.3. Food Supply and Demand Outlook for the Korean Peninsula

The combination of food supply and demand estimates for North and South Korea projects the total food supply and demand on the Korean peninsula. However, since 2 methods were applied for South Korean estimates, the KREI KASMO and regression analysis, and North Korea reviewed 2 alternatives for its food supply and demand predictions, the total estimates of food supply and demand for the Korean peninsula will produce 4 different results, each according to a given assumption. First, in the case where the South Korean food demand is estimated by applying the KREI KASMO supply and demand model and the North Korean food demand is predicted by applying scenario 1 (changed from the minimum calorie consumption to normal calorie consumption), the total food demand on the Korean peninsula is estimated at 29.022 million tons in 2015 and 31.873 million tons in 2025. The food supply in 2015 and 2025 is estimated at 28.451 million tons and 30.429 million tons in 2015 and 2025, respectively. As a result, the total food shortage on the Korean peninsula, even considering foreign imports, is forecast at 16.292 in 2015 and 17.248 million tons in 2025. In terms of alternative 2 (changed from ordinary food ration to the calorie consumption of South Korea in 1980), the total food shortage on the Korean peninsula is estimated at 16.739 million tons and 17.037 million tons in 2015 and 2025, respectively (Table 5-11).

Table 5-11. Outlook for Food Supply and Demand on the Korean Peninsula (KREI KASMO)

(unit: 000 ton)

	Korean Peninsula					Imports (3)	Food shortage on the Korean peninsula	
	Food demand		Supply	Food shortage				
	scenario 1	scenario 2		scenario 1 (1)	scenario 2 (2)		(1)+(3)	(2)+(3)
2015	29,022	29,469	28,451	571	1,018	15,721	16,292	16,739
2020	30,523	30,653	29,527	996	1,126	15,874	16,870	17,000
2025	31,873	31,662	30,429	1,444	1,233	15,804	17,248	17,037

In estimates of the South Korean food supply and demand through regression analysis, the total food demand on the Korean peninsula is estimated at 27.852 million tons in 2015 and 32.046 million tons when applying scenario 1 to the estimation of the North Korean food supply and demand. As the food supply estimates of 2015 and 2025 are 28.451 million tons and 30.429 million tons, respectively, the total food shortage on the Korean peninsula is predicted to be 15.122 million tons in 2015 and 17.421 million tons in 2025 when considering the foreign import volume. Meanwhile, in scenario 2, the total food shortage on the Korean peninsula (including foreign import volume) is estimated at 14.551 million tons and 16.188 million tons in 2015 and 2025, respectively (Table 5-12).

Table 5-12. Outlook for Food Supply and Demand on the Korean Peninsula (Regression Analysis)

(unit: 000 ton)

	Korean Peninsula					Imports (3)	food shortage on the Korean peninsula	
	Food demand		supply	food shortage				
	scenario 1	scenario 2		scenario 1 (1)	scenario 2 (2)		(1)+(3)	(2)+(3)
2015	27,852	27,281	28,451	-599	-1,170	15,721	15,122	14,551
2020	30,009	29,013	29,527	482	-514	15,874	16,356	15,360
2025	32,046	30,813	30,429	1,617	384	15,804	17,421	16,188

5.4. Summary and Policy Implications

This study predicted the food supply and demand levels in North and South Korea, separately as well as together, for 10 years after 2015, which is the date range designated as the point of unification. The main research results follow.

First, the per capita food demand of North Korea in 2015 and 2025 was projected to be 195.3 kg and 301.5 kg, respectively. Therefore, the food demand per person in North Korea was estimated to increase by 54%.

Second, in terms of the North Korean food supply and demand record from 1994 to 2008, North Korea annually lacked food by 760,000 tons to 1.72 million tons. The North Korean food shortage for 10 years after unification (2015-2025) was estimated to increase from 570,000 tons to 1.44 million tons (scenario 1) or from 1.02 million tons to 1.33 million tons (scenario 2).

Third, in terms of the food supply and demand proportion per item in South Korea in 2015, maize accounts for 41.4%, rice 22.3%, wheat 19.8%, and soybeans 8.4%, with maize making up the highest proportion, followed by rice, wheat, soybeans, and root and tuber crops, in that order. The composition by commodity was estimated to remain at similar levels over the 10-year span.

Fourth, according to scenario 1, South Korea's per capita food demand in 2015 was estimated to increase by 3.5%, from 454 kg to 470 kg, in 2025. The comparison of the per capita food demand between North and South Korea shows that after unification the gap in food demand for North and South Korea decreased from 2.3 times to 1.5 times.

Fifth, South Korea's food import volume after unification was estimated at 15.72-15.80 million tons, and the total food shortage on the Korean peninsula (North Korean supply shortage + South Korean imports) was projected to reach 15.12-17.42 million tons.

In terms of policy implications, it is vital to increase food production both in North and South Korea since a significant food shortage is predicted after unification. To increase food production, rice self-sufficiency should be achieved first. To that end, South Korea must maintain its current rice production system, which requires the preservation of paddy fields. North Korea needs to achieve a self-sufficient rice production system, for which the primary focus must be on increasing rice yield. The total rice production goal for the Korean peninsula after unification should be set at 7.249 million tons, with South Korea expected to produce 4.775 million tons of rice by maintaining its rice yield of 5.10 tons/ha and increasing rice production areas to 955,000 ha. North Korea must produce 2.474 million tons of rice by increasing its rice yield to 4.34 tons/ha (85% of the South Korean output).

Second, self-sufficiency in edible soybeans should be improved. To secure farmland areas for self-sufficiency in edible soybeans, North Korea must convert 300,000 ha of 503,000 ha of its maize cultivation area to soybean production and 300,000 ha of terraced farms to forests. The North must also set a production goal for edible soybeans of more than 625,000 tons by increasing its 161,000 ha of soybean cultivation to 460,000 ha and improving soybean yield from the current level of 1.16 tons/ha to match the level of South Korea's 1.65 tons/ha. Additional requirements include the development of high yield varieties for usages such as soybean paste, tofu, and soybean sprouts; the use of production technology for labor-saving mechanization and scaling up; and the establishment of irrigation facilities that will facilitate reliable production of soybeans.

Third, to reduce the dependency on foreign concentrated feeds, self-sufficiency in forage must be improved. In particular, a foundation for quality production of forage needs to be built in the maize zone in North Korea. Forage should be cultivated across 200,000 ha of the total 503,000 ha of the maize cultivation area, and pasture land with a grazing system needs to be established in order to produce maize for feed and whole-crop silage.

Fourth, excellent farmland should be strictly preserved. Since 2007, quality farmland areas have been on the decline under a deregulation policy. However, it is essential to preserve excellent farmland in order to expand and maintain food production.

Finally, it is necessary to establish a comprehensive food policy in preparation for Korean unification. Currently there is none. Preparation for potential emergency food shortages should entail specific scenarios applicable to the early stages of unification as well as several situations in the longer term after unification. Specific measures must be delineated for each scenario. In addition, measures to resolve the North Korean food shortage issue before unification must be sought so as to minimize the cost of securing food in a post-unification period. To that end, it is necessary to designate special agricultural zones, applying the same method to agriculture as found in the Kaesong Industrial Complex. This effort will contribute to resolving North Korea's food shortage issues, simultaneously using the zones as food hubs to prepare for future unification.

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06 Status of the Food Industry in North and South Korea and Food Security Functionality

The food industry plays an important role in national food production and distribution along with the agriculture and fisheries industries. While South Korea has sufficient data related to their food industry, North Korea does not have enough food industry data.

6.1. Status of the Food Industry in South Korea

As South Korea joins the ranks of advanced countries with over 20,000 dollars of GDP, there have been huge changes in the dietary patterns of its people. The South Koreans are sensitive to global trends, which require high quality as well as convenience in food products, functional food related to well-being, safety assurances, and organic products. The size of the food industry in South Korea increased about twice, from 70 trillion won in 2001 to 133 trillion won in 2010 over 10 years (Table 6-1). The food and drink manufacturing industry was valued at 65.4 trillion won (57.1 trillion won excluding feed), and the food service industry was valued at 67.6 trillion won. The food distribution industry was composed of 88.5 trillion won of food and drink and tobacco wholesale industries (85.3 trillion won excluding tobacco) and 61.3 trillion won in the food retail industry, for a total of 146 trillion won. Compared to the 51 trillion won of the total production of agriculture, forestry and fisheries, the economic size of the food industry is remarkably large. The production revenue of the food manufacturing industry was 40.4 trillion won (2009), accounting for 3.8% of 1,063 trillion won of GDP and making up 15.2% of 265.8 trillion won of the GDP in the domestic manufacturing industry. The number of workers engaged in the food manufacturing industry in South Korea has reached 230,000 as of this writing.

Table 6-1. Changes in the Size of the Food Industry in South Korea (2001-2010)

(unit: billion won)

Category	2001	2005	2010
Manufacturing (A+B)	70,326.1	89,895.9	133,012.0
Food and drink manufacturing industry (A)	36,080.5	43,668.2	65,446.2
Excluding feed	32,081.3	39,058.7	57,120.5
Food service	34,245.6	46,252.5	67,565.8
Food distribution industry (C+D)		90,224.3	146,690.4
Food and drink and tobacco wholesale industries	42,182.0	50,520.0	88,527.0
Excluding tobacco (C)	38,793.6	47,566.4	85,386.9
Food and drink and tobacco retail industries	9,779.1	8,957.9	12,674.1
Excluding tobacco	9,650.4	8,835.7	12,593.0
Food retail industry (D)	-	42,657.9	61,303.5
Manufacturing, food service, Distribution (A+B+C+D)	-	180,145.0	279,702.4
Agriculture, forestry and fisheries	37,821.2	41,322.2	50,949.0

Notes:

① After 2010, Statistics Korea (KOSTAT) economic census revenue (for companies with more than 10 employees). Before 2009, Statistics Korea (KOSTAT) survey on mining and manufacturing industry for (companies with more than 10 employees).

② Statistics Korea (KOSTAT) economic census revenue (restaurant and bar industry).
③ Statistics Korea (KOSTAT) retail sales statistics (food: processed food + non-processed food + fishery products).
④ Agriculture, forestry and fisheries production revenue of Ministry of Food, Agriculture, Forestry and Fisheries.

6.1.1. Food Manufacturing Industry in South Korea

In terms of the size of the food manufacturing industry of South Korea by type, the production of food and drink was 28.1 trillion won; cooking utensils, containers, and packaging, 4.3 trillion won; food additives 1.2 trillion won; and supplemental food 0.8 trillion won, amounting to 34.5 trillion won in total in 2010 (Table 6-2). The statistical data was released by the Korea Food and Drug Administration, not including the milling industry and parts of the livestock processing industry such as packaged meat, which is managed under the Ministry of Food, Agriculture, Forestry, and Fisheries. The food industry of South Korea continued to grow with an annual growth rate of 7-8%.

Table 6-2. Food Production Status by Type in South Korea

(unit: 0.1 billion won, %)

Category		2009	2010	2010 ratio
Food	production	263,521	281,141	81.3
	growth rate	7.5	6.7	
Cooking utensils, containers and packages	production	39,847	43,698	12.7
	growth rate	10	9.7	
Food additives	production	12,382	12,781	3.7
	growth rate	24.4	3.2	

Category		2009	2010	2010 ratio
Supplemental food	production	6,972	7,862	2.3
	growth rate	18.5	12.8	
Total	production	322,722	345,482	100.0
	growth rate	8.6	7.1	

Source: Korea Food and Drug Administration, "Production record of food and food additives," each year.

According to the data from the Korea Food and Drug Administration, the number of companies in the food manufacturing industry increased from 3,575 in 2001 to 4,269 in 2010, 81% of which are small companies with fewer than 50 employees. The number of mid-sized companies, with 50 to 299 employees, accounts for 18% of the total companies, but takes 55% of total sales. The number of large companies, with 300+ employees, accounts for less than 1% of the total, while taking up 15.6% of total sales (Table 6-3).

According to the data released by Statistics Korea (KOSTAT), the industry with the highest number of food manufacturers was the kimchi manufacturing industry, with 230 companies in operation, followed by the laver manufacturing industry, with 178 companies, and the packaged meat industry with 151 companies. Except for feed, market milk ranks first at 2.5447 trillion won on the basis of the amount of sales, followed by packaged meat with 2 trillion won, and chicken with 1.9582 trillion won (Table 6-4). The rice milling industry produces products worth 1.6474 trillion won with 114 companies. Beer is produced in 6 companies, worth 1.879 trillion won, indicating the beer industry is now comprised of large companies.

Table 6-3. Company Size by Number, Employees, and Sales

	The number of companies		The number of employees (000 person, %)		Sales (billion won, %)	
	2001	2010	2001	2010	2001	2010
Total	3,575	4,269	158.7	169	36,081	65,446
Fewer than 50 employees (%)	79.6	81.3	36.5	42.4	20.9	29.4
50-299 employees (%)	18.9	17.8	43.9	45.8	55.9	54.9
Over 300 employees (%)	1.5	0.9	19.6	11.8	23.2	15.6

Table 6-4. Main Production Items of Food and Drink Manufacturing Industry

(unit: million won)

	Sorted by companies	No. of companies	Amount of sales		Sorted by sales	No. of companies	Amount of sales
1	Kimchi	230	945,522	1	Assorted feed (for cattle)	95	3,138,167
2	Laver	178	474,993	2	Market milk	40	2,544,695
3	Packaged meat	151	2,000,268	3	Assorted feed (for pigs)	54	2,014,672
4	Mixed spices	133	740,088	4	Packaged meat	151	2,000,268
5	Other meat products	119	709,518	5	Chicken	37	1,958,271
6	Rice(polished)	114	1,647,391	6	Beer	6	1,879,068
7	Lunch box	103	343,920	7	Assorted feed (for chicken)	41	1,690,464
8	Prepared food	98	307,428	8	Rice(polished)	114	1,647,391
9	Packaged poultry	96	565,953	9	Soju	19	1,475,720
10	Assorted feed (for cattle)	95	3,138,167	10	Fermented milk	43	1,468,695

Flour is the second-highest production food after rice, at 1.149 trillion won with 1.63 million tons of production, and the next-highest production food is white sugar, at 715.6 billion won with 1.25 million tons of production, and the next is instant food and carbonated drinks, both with 1.11 million tons of production (Table 6-5).

Table 6-5. Ranking of the Most Frequently Consumed Foods (2009)

Ranking	Food category	Food items	Production amount (tons)	Amount of sales (100 million won)	Export (million dollars)
1	Other foods	Wheat flour	1,633,622	11,490	4.3
2	Sucrose, Sugar	White sugar	1,249,516	7,158	128.1
3	Other foods	Ready to eat foods	1,113,579	1,715	0.1
4	Beverages	Carbonated drinks	1,112,575	10,547	9.7
5	Beverages	Mixed beverages	522,623	6,182	25.5
6	Beverages	Fruit and vegetable beverages (heat)	490,163	5,095	18.2
7	Edible oil	Soybean oil	373,623	5,578	4.4
8	General processed foods (nonstandard)	Other processed foods	373,299	8,339	68.2
9	Taffies	Starch syrup	372,994	2,225	0.1
10	Breads and Rice cake	Rice cakes	352,322	2,934	2.6
11	Noodles	Fried noodles (in a bag)	351,697	12,863	51.6
12	General processing foods (nonstandard)	Grain products	345,405	4,198	9.5
13	Soybean Curd and Starch Jelly	Tofu, Bean curd	336,484	4,248	0.0

Rank-ing	Food category	Food items	Production amount (tons)	Amount of sales (100 million won)	Export (million dollars)
14	Seasoning Food	Sauces	327,987	6,170	9.2
15	Kimchi group	Baechu (cabbage) kimchi	324,499	4,996	75.3
16	Other foods	Other starches	259,936	1,327	14.6
17	Fructose	High fructose corn syrup	257,414	1,276	4.1
18	Breads and Rice cake	Breads	252,608	7,096	3.2
19	Salted foods	Pickles	221,140	2,900	3.8
20	General processing foods (nonstandard)	Processed marine products (fish)	219,587	7,072	165.4

Source: Korean Food and Drug Administration, "2009 Food and Food Additive Production Record" (2010).

The national food industry has become large-scale, having seen an increase in the number of companies with over 1 trillion won of sales to 13 companies in 2011. The CJ CheilJedang Corp. is ranked first, with 4.4210 trillion won of annual sales (3.9 billion dollars), second is Nongsim Co., Ltd., with 1.9796 trillion won (1.7 billion dollars) and third is Paris Croissant Co., with 1.5733 trillion won (1.4 billion dollars) (Table 6-6). However, these comprise not even one-twentieth of the world's biggest food companies, such as Nestle with 89.2 billion dollars and Unilever with 60.2 billion dollars.

Table 6-6. Sales Ranking of South Korean and Global Food Companies (as of 2011)

Rank-ing	Ranking in South Korea		Global Ranking	
	Company name	Sales (one hundred thousand won)	Company name	Sales (100 million USD)
1	CJ Cheiljedang Co., Ltd.	4,421,058.4	Nestle	89.2
2	NONGSHIM Co., Ltd.	1,970,686.4	Coca-Cola	46.5
3	PARIS CROISSANT Co., Ltd.	1,573,366.2	PepsiCo	66.5
4	LOTTE CHILSUNG BEVERAGE Co., Ltd.	1,564,311.0	Anheuser-Busch Inbev	39.0
5	LOTTE CONFECTIONE RY Co., Ltd.	1,521,967.4	Unilever	60.2
6	OTTOGI., Ltd.	1,513,049.7	Kraft Foods	54.4
7	Dongsuh Food Co., Ltd.	1,500,948.7	Tesco	99.1
8	Daesang Corp.	1,392,912.8	Philip Morris International	31.1
9	NONGHYUP FEED Co., Ltd.	1,254,244.6	British American Tobacco	23.9
10	TS Corporation Co., Ltd.	1,243,820.4	McDonald's	27.0
11	Namyang Dairy Product Co., Ltd.	1,202,937.3	Wesfarmers	58.4
12	Dongwon F&B Co., Ltd.	1,099,094.8	Imperial Tobacco Group	23.7
13	Oriental Brewery Co., Ltd.	1,073,545.8	Japan Tobacco	29.1
14	The Hitejinro Co., Ltd.	984,947.0	Danone	25.0
15	Korea Yakult Co., Ltd.	956,015.7	Altria Group	16.6

*Global Ranking: based on the sum of Forbes data, considering sales, revenue, profits, and assets, all together.

The global food market is estimated to be valued at 4.2779 trillion USD (as of 2010), consisting of 1.8317 trillion dollars' worth of the European market, 1.021 trillion dollars of the Asia-Pacific market, 0.9383 trillion dollars of the North American market, 0.3716 dollars of the Latin American market, and 0.1172 dollars' worth of the Middle Eastern and African markets. As of 2007, the food manufacturing industry of South Korea ranked 15th in the world, valued at 37.8 billion dollars, and Japan ranked 2nd with 244.6 billion dollars' worth of the food industry.

South Korea is the 25th largest food trading county in the world, with the amount of food trade at 16.57 billion dollars (2007). However, South Korea's amount of food imports is 13.5 billion dollars and food exports only 3 billion dollars. Japan is the 9th largest food trader in the world, with 55.16 billion dollars in food trade, 3.3 times bigger than that of South Korea. Japan is not much different from South Korea as its trade is also focused mainly on food imports, valued at 51.8 billion dollars, with only 3.3 billion dollars of exports.

In terms of the import and export status of agri-food in South Korea, the amount of exports increased 2.7 times, from 2.8 billion dollars in 2001 to 7.7 billion dollars in 2011. Among these are 5.4 billion dollars of agriculture, forestry, and livestock products and 1.3 billion dollars of fishery products. However, exports of agri-food make up only 1.4% of total exports. Meanwhile, imports increased 3.3 times, from 10.1 billion dollars in 2001 to 33.2 billion dollars in 2011, accounting for 6.3% of the total national imports, which indicate an unfavorable balance of trade in agri-food (Table 6-7).

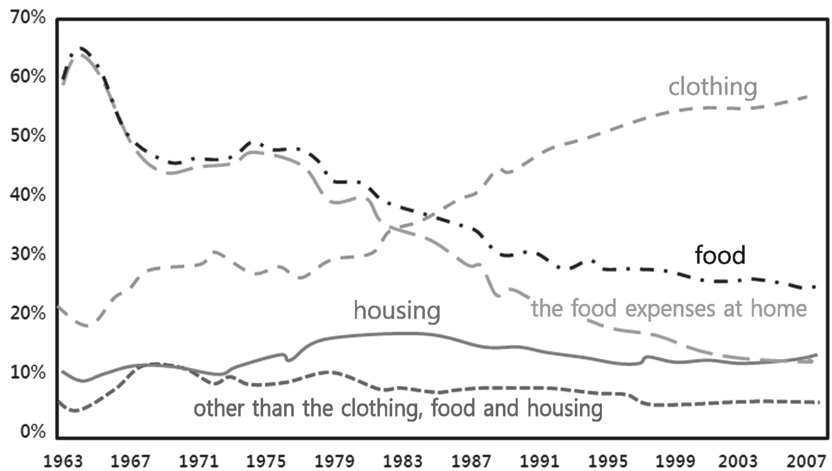
Table 6-7. Agri-Food Imports and Exports by Year (unit: million USD, %)

Category	2001	2005	2009	2010	2011
Agri-food Exports	2,851.5	3,415.8	4,809.3	5,880.0	7,691.3
(% of the total export amount)	1.9	1.2	1.3	1.3	1.4
Agriculture, forestry, and livestock products	1,579.9	2,221.5	3,298.1	4,081.8	5,383.5
Fishery products	1,271.8	1,194.3	1,511.2	1,798.1	1,307.8
Agri-food Imports	10,079.2	14,275.7	21,240.9	25,787.2	33,184.0
(% of the total import amount)	7.1	5.5	6.6	6.1	6.3
Agriculture, forestry, and livestock products	8,452.8	11,888.5	18,346.5	22,329.9	28,994.1
Fishery products	1,630.9	2,387.1	2,894.4	3,457.3	4,189.9

6.1.2. Food Service Industry in South Korea

Consumption patterns regarding living expenses in urban households in South Korea have changed. Food expenses have continued to decrease since the 1980s, reaching a level of 25%, while clothing and housing expenses have not changed much, standing at about 5-10% each. However, expenses other than clothing, food, and housing have rapidly surged and now exceed 50%, suggesting the consumption pattern of advanced countries. In particular, among food expenses, eating-out expenditures have surpassed expenses at home (Figure 6-1). As mentioned in the total industry size, the production revenue of the food manufacturing industry is 65.4462 trillion won, whereas the food service industry recorded 67.5658 trillion won of revenue, outperforming the food manufacturing industry.

Figure 6-1. Changes in Consumption Patterns regarding Clothing, Food, and Housing Expenses in Urban Households (1963-2008)



The total number of businesses in the restaurant and bar industry has reached 585,000, but these are mostly small, as the annual average sales revenue per shop is 150 million won. The average annual sales revenue of Korean food restaurants, half of the total restaurants, is a low 110 million won, while chicken delivery shops (27,700 units) and snack bars (44,400 units) come in at 72 million won and 53 million won, respectively, most of them small-scale shops. Bakeries (13,800 units) and pizza or hamburger restaurants (12,700 units), which are mostly franchises, record a relatively high average annual sales revenue of 240 million won (Table 6-8). It seems to be clear that to franchise food businesses it helps to enter the global market. In particular, the Korean Wave, such as K-pop culture, has promoted the globalization of Korean foods since 2008.

Table 6-8. Number of Businesses and Sales Revenue per Industry

(unit: billion won(B), million won(B/A))

Industry	Number of Shops (A)	Sales Revenue (B)	Sales Revenue per Shop (B/A)
Restaurant and bar	585,297	67,566	155.2
Food Service	425,856	55,527	130.4
General restaurant	317,908	39,913	125.6
- Korean food	281,551	32,284	114.7
- Chinese food	21,071	2,569	121.9
- Japanese food	6,259	1,754	280.2
- Western food	7,997	3,052	381.6
- Other foreign foods	1,030	255	247.6
Dining hall	4,647	3,568	767.8
Catering service	449	132	293.0
Other restaurants	102,852	11,914	115.8
- Bakery	13,883	3,461	249.3
- Pizza, hamburger, sandwich, and similar restaurants	12,774	3,050	238.8
- Chicken delivery	27,782	2,013	72.4
- Snack bar and Gimbap restaurants	44,447	2,372	53.4
- Other restaurants	3,966	1,019	256.9
Bar and nonalcoholic beverage shop	160,441	12,039	75.0
- Bar	129,640	9,535	73.5
- Nonalcoholic beverage shop	30,801	2,504	81.3

6.2. Status of the Food Industry in North Korea

North Korea has promoted a policy of increasing food products since July 2009 by launching a Ministry of Food and Daily Necessities for the food industry, which was managed by the Ministry of Light Industry. The launch, despite the fact that the existing Ministry of Agriculture and Fisheries was managing agro-fishery production, emphasizes the importance of basic food resources and supplies of raw materials and demonstrates an effort to control the expansion of individual food production. Under the centralized, planned production system, the North Korean food industry is mainly composed of state-owned factories that follow the commands of a central leader. However, since the July 1st Action in 2002, which allowed individuals to sell handmade products at direct sales stores or markets, handmade production by individuals has expanded. Handmade food products like soy sauce, soybean paste, cooking oil, sugar, cookies and biscuits, fermented fish, dried fish, beer, liquor, ice cream, sauces and pastes, confections and sweets, and beverages are traded in the market all the time. Such handmade food products are estimated to have replaced a substantial amount of the food supply that had been produced by the government in the past.

Most raw materials are domestically supplied, while a few of them are imported. Fruit, vegetables, wild fruit, wild plants, beef, chicken, and pork are supplied by orchards, collective farms, ranches, and non-collective farms. The fishery processing factories supply fishery products caught in the East and West Sea through the fisheries offices. Liquor and soft drink commodities also are mostly supplied by domestic sources, whereas a majority of wheat for the milling industry is dependent on imports. Local factories use locally-grown products as a commodity. However, under the economic downturn and on-going difficulties in the supply of raw materials and electricity, the food supply to citizens has been suspended. Factories have not been operating properly, not only in local areas but also in central zones. Under the circumstances, an increasing number of residents are procuring basic food items on their own, and a large number of the handicraftsmen of food production have emerged and led the food market distribution.

The main products in the North Korean food industry are processed maize products, primary processed foods with long-term storage difficulty, and snack foods (confections, bakery goods, beverages, and liquor). Instant foods, powdered milk, and instant noodles may be produced, but in a very small volume. Despite setbacks like old production facilities, lack of electricity, and unstable voltage, the biggest obstacle in North Korea's food crisis is that food commodities are difficult to obtain.

Food and drink products account for a large part of the total export volume of North Korea, at 4.9% in 1996 to 5.1% in 2008. Agro-fishery products constituted a substantially large proportion of the total North Korean export volume, from 18.5% in 1996 to 37.6% in 2002, but plunged to 10.6% in 2008 (Table 6-9).

Table 6-9. Proportion of Agro-Fishery Products and Food and Drink Products among Total Exports of North Korea (%)

	1996	2002	2008
Agro-Fishery Products	18.5	37.6	10.6
Food and Drink Products	4.9	8.4	5.1

6.2.1. Food Processing Factories in North Korea

1) Grain Processing Factories

These factories produce starch and starch sugar (starch syrup, glucose) from maize and stand as the most important food processing factory, with one established in each province. Cooking oil and confections are produced using corn. As of 2005, the maize yield of a grain processing factory was 100,000 tons of starch, 224,000 tons of starch syrup, and 72,000 tons of glucose. Since then, the real yield is assumed to have slightly declined. North Korea uses "August grass," a chrysanthemum-family plant high in sugar, as an alternative sweetener to saccharin or sugar to make jam, sweets, and soft drinks. It is highly likely to be stevia. Pyongyang Agriculture University announced in March 2010 that it had developed new varieties of the grass with a sugar content two times higher than previous varieties. The grain processing factory also produces "Brick Cookies," the side ingredients of starch syrup and cookie dough, which are named after their bricklike hardness.

2) Milling Factory

The flour processing capacity of North Korea is estimated at 450,000 tons annually, including 100,000 tons from Pyongyang General Milling Factory, 150,000 tons from Nampo Milling Factory, and 20,000 tons from Haeju Milling Factory. The Pyongyang General Milling Factory was constructed in 1979 and has produced over 50,000 tons of food products, including bread, confections, instant noodles, and yeast. Yield is known to have largely decreased due to the reduced operating rate of the milling factory.

3) Sauce and Paste (*Jang*) Factory, Food Materials Factory

This type of factory mainly produces soybean paste, soy sauce, oil, sweets, confections, beer, and liquor, and is recently being automated. Pyongyang Sauce and Paste Factory has an annual yield of 30,000 tons of soybean paste and 3,200 kl of soy sauce. Nampo Food Materials Factory has a monthly yield of 100 kl of fish sauce. Pyongyang Ryongsung Food Materials Factory, built in 2009, has an annual yield of 200 tons of seasoning soy sauce, sesame oil, rice vinegar, perilla oil, red-pepper seed oil, red-pepper paste, and pickled perilla leaf. However, a large decrease in the production of sauces and pastes due to the shortage of raw materials, as in the grain processing factories, basic food products, including soy sauce and soybean paste, have not been produced in the same quantity, thus leaving people to depend on the private market and self-production. Oil, liquor, and beer are supplied to each household in the amount of 0.5 kg on national holidays only, and 1 kg of sweets and confections per person are offered to preschoolers on the birthdays of Kim Il-sung and Kim Jong-il.

4) Fisheries and Meat Processing Factories

North Korean fisheries' processing capacity is estimated at 410,000 tons annually (2009). Gimchaek Fisheries Processing Factory in North Hamgyeong province has an annual yield of 10,000 tons, and

Sinpo Fish Canning Factory in South Hamgyeong province has an annual yield of 12,000 tons. Although processed and canned meat and fishery products are being produced at Waesang Processing Factory in Gangwon Province, Pyongyang Canning Factory, Sariwon Meat Processing Factory, and Gangseo Side Dish Processing Factory, most of these products are offered to soldiers, hotels, and executives of the Communist party, and only 1 kg of pork per year is distributed to ordinary people, without any other supply of processed meat or fishery products.

5) Milk, Vegetables, and Fruit Processing Factories

North Korea produces few dairy products. It is known that children in urban areas consume soybean milk, while some of the children in rural areas drink locally-produced milk. Under the assistance of the UNDP, a yogurt factory supposed to yield of 1,500 tons of yogurt and 12,000 tons of drinks such as fruit juice was built in April 1990, but there is no data regarding the real production volume. Until the 1970s dairy production had been relatively stable with the Poongcheon Fruit Processing Factory (annual yield 17,000 tons), Hwangjoo Fruit Processing Factory (annual yield 1,500 tons) and Bookcheong Fruit Processing Factory (annual yield 4,000 tons), but production has been known to be suspended at these factories. Although processed vegetable products are supposed to be produced at Sinpo Canning Factory and Yongsung Meat Processing Factory, most North Korean defectors have testified that they had never eaten processed vegetable products.

6) Condiment, Beverage and Liquor Factories

North Korean condiments include flavoring, soda, and vinegar, the last two of which are produced in local factories. In the 1970s the condiment production facilities for MSG and amino acids were adopted from Japan.

The production volume of all kinds of soft drinks in North Korea is estimated at around 700,000 kl (as of 1990), composed of 380,000 kl of soda pop, 120,000 kl of general soft drinks, including fruit juice and soda, and 300,000 kl of other soft drinks. However, it is known that none of the products are distributed to the residents. It is said that only those who visit Samjuyon on the way to Mount Baekdu can have the opportunity to taste blueberry juice.

Famous North Korean liquor companies include Pyongyang Soju, Gaeseong Ginseng liquor, and Blueberry liquor brewed by local specialty shops using locally grown ingredients, but residents are provided Soju brewed primarily by acorns and maize at local food factories. Wonju, Yongsung, Yeongyang, Hyesan, Oncheon, and Daedonggang are among the beer factories; Daedonggang Beer Factory, constructed in October 2009, is North Korea's first draft beer factory, with an annual yield of around 70,000 kl.

7) Cigarette Factories

North Korea's annual cigarette consumption per adult is 4 kg, the 3rd largest in the world following Cuba and Bulgaria, more than twice the average of 1.9 kg. The highest premium North Korean cigarettes, including "Baekdusan" and "Yeonggwang," although specially produced at the Mansumugang Research Institute, are heavy and high in tar because of the low quality cigarette papers and filters. Ordinary people mostly smoke a cigarette named “Maracho” (rolled cigarette), rolled with tobacco leaves purchased in the marketplace or self-grown.

8) Salt Farms and Salt Factories

North Korea’s annual salt yield is about 700,000 tons, which accounts for only half of the total demand, thereby causing a chronic shortage in table salt. Most of the salt produced is used for munitions factories and industrial purposes, and thus residents are rarely provided salt. In the 2000s, salt farms such as Eodaejin Saltern (Youth Saltern on August 1) and Wonsanman Saltern were constructed in eastern coastal areas where natural salt production was not possible. Due to the chronic salt shortage, salt is precious in the northern inland areas, including Jagang, Yanggang, and South Hamgyeong provinces.

6.2.2. The Food Industry as Reported by North Korean Media (2010-2011)

1) 2010 (Korea Institute for National Unification, “2010 Overall Evaluation of North Korean Economy and 2011 Outlook.”)

- **Jan. 13:** On-site instruction by Kim Jong-il at the newly established pork plant in alliance with Force 131 of the DPRK army

  Jan. 14: Pyeongcheongbong General Food Materials Factory Ground Breaking Ceremony

Jan. 23: Suseongcheon General Food Materials Factory Ground Breaking Ceremony

Jan. 25: On-site instruction by Kim Jong-il at the pork plant in alliance with Force 567 of the North Korean People's Army; National Science Academy Fish Farming Laboratory, newly-bred fine breed "Eiyook Silverfish"

- **Feb.:** Food material factories construction and commercial network establishment projects are in progress in several areas, including Songdowon General Food Materials Factory (about 400 food products are produced through about 20 production processes) in Wonsan, Gangwon Province, and Suseongcheon General Food Materials Factory in Cheongjin, North Hamgyeong Province

- **March 5:** "2009 Communism Competition Purification Championship Flag Ceremony" at pork plant in North Pyeongan Province, Sariwon Chicken Farm, Gwangpo Duck Farm

  - Developed soft soybean curd using lactic acid bacteria (anti-cancer activity) by National Science Academy Food Material Laboratory
  - Succeeded in breeding a new variety of "August Grass" by researchers of Pyongyang Agriculture University
  - Developed drink products using microorganisms by Patriotic Compound Microorganism Research Center, including the anticancer drink "Dew" and a compound lactic acid drink

- **April:** Constructed Samilpo-style General Food Material Factories (Samilpo Specialty Factory implemented industrialization in processing special food products) across the country, including Jeongbangsan General Food Materials Factory in North Hwanghae Province, Baeksung General Food Materials Factory in South Pyeongan Province, and Cheongbong General Food Materials Factory in Yanggang Province
  - Completed research tasks to increase meat and egg production by developing fine breed black spotted milk cow and increasing the production of milk twofold

- **May 18:** On-site instruction by Kim Jong-il at the newly built large-scale potato farm (Dukpo area, Baekam distict in Yanggang Province)

  May 19: On-site instruction by Kim Jong-il at Daeheungdan group (Baeksan Pork Farm, Daeheungdan Potato Processing Factory, Daeheungdan town, and newly built noodle shop)
  - Increased yield twofold by adding facilities (construction for modernization), including orchard areas over 4 times wider cultivated on Daedonggang Fruit Tree General Farm and recent adoption of fermentation tank at Pyongyang Daedonggang Beer Factory (about 150 tanks in Pyongyang)

- **June:** Completed construction to expand the yield of Daedonggang Fruit Tree General Farm
  - Developed highly effective nanotechnology-based “agricultural germicide” by Agricultural Science Academy

- **July:** Started producing salt at newly established salt farm near Gaeseong city
  - Increased goat, rabbit, and milk production during the first half of this year by workers in the animal husbandry sector in North Hwanghae Province

- **Aug. 7-8:** Participated in a factory alliance enterprise within Jagang Province (Jangjasan General Food Materials Factory)

  Aug. 26: Sent appreciation to alliance enterprises that contributed to technological reform; on-site instruction by Kim Jong-il at Pyongyang Grain Processing Factory
  - Overachieved first half-year plan in the animal husbandry sector (meat and egg production) in Jagang, North Pyeongan and South Hamgyeong Provinces
  - Expanded yield three times or more by implementing CNC (Computerized Numerical Control) at Pyongyang Grain Processing Factory

- **Sep. 24:** Constructed confectionery division at Pyongyang Grain Processing Factory
  - Bred new varieties of rice suitable to double cropping in the agricultural sector

- **Oct. 28:** Ground Breaking Ceremony at Sunheung Food Materials Factory with expanded yield
  - Adoption of "Spirulina Spawn" project in progress in the food and livestock sector

- Developed new products of soda pop and juice at Baeksong General Food Materials Factory in Pyeongsung

- **Nov. 22:** On-site instruction by Kim Jong-il at Yongyeon Coast Fish Farming Office and Yongjeong Fish Farm
  - On-site instruction by Kim Jong-il at Yongho Duck Farm
  - Aggressively adopted "Circular Purification Production System" of agriculture and animal husbandry in the agricultural sector
  - Adopted green houses such as Pyongyang Greenhouse Farm and eco-friendly "hydro-dispersive agricultural pesticide"
  - Established and repaired storage and production process at Patriotic Vegetable Processing Factory (Sa-dong area in Pyongyang)
  - Modernized with as computerization
  - Established sturgeon farming system in the West Sea and succeeded in sea fish farming

- **Dec. 3:** On-site instruction by Kim Jong-il at Musan Mining Alliance Enterprise and Musan Food Materials Factory in North Hamgyeong Province
  - On-site instruction by Kim Jong-il at Hweryeong Food Processing Factory in Hweryeong in North Hamgyeong Province

- **Dec. 11:** On-site instruction by Kim Jong-il at reformed and expanded Pyongyang Flour Processing Factory, Sunheung Food Materials Factory and Hyangmaru Daeju Restaurant

  Dec. 15: On-site instruction by Kim Jong-il at Daedonggang Eel Farm in alliance with Force 522 of the North Korean

People's Army

Dec. 19: Gathering to fulfill the on-site speech by Kim Jong-il at Pyongyang Flour Processing Factory

Dec. 25: Employee Gathering for the on-site speech by Kim Jong-il at Daedonggang Eel Farm

- 2010 Production Achievements in Food and Daily Necessities: Completed 112% of plan to produce consumer goods. On August 2, implemented CNC for several factory processes, including Pyongyang Grain Processing Factory; reformed technology at local factories, including Haeju Basic Foods Factory and Byeoksung Food Materials Factory
- Increased yield 3 times for confections and 10 times for Gangseo mineral water thanks to modernization in the food industry
- Reformed about 400 local factories in each province, city, and district
- Cho Jung-Yong (Ministry of Food Industry) announced 2010 production results, including early fulfillment of yearly plans at about 860 factories under the Ministry of Food Industries

2) Achievements in the Food Processing Sector in North Korea in 2011

- Year of Light Industry, 2011
- Focused intensively on the food processing sector in surrounding areas of Pyongyang
- Focused particularly on the achievement of Daedonggang Fruit Tree General Farm (constructed "Daedonggang Fruit Tree

General Processing Factory” to produce vinegar, soda pop, and juice on the farm)

- Achieved good results in the food processing sector linked to the animal husbandry sector
- Reformed Pyongyang Dudan Duck Farm to a “large-scale meat production and processing base”
- Emphasized that Daedonggang Pork Plant “achieved compu processes with introduction of integrated automatic system”
- Began construction of chicken and wheat pancake production process at Geumsung Food Materials Factory
- Achieved good results in confectionery and food material production using starch syrup production process and factories in several areas including Baesong General Food Materials Factory and Songdowon General Food Materials Factory
- Advertised the modernization of Sunhong Food Materials Factory in Pyongyang, and Sunhong-brand food products received good reviews
- Ground breaking ceremony at sauces, paste, and pickling division and Kimchi division at Patriotic Vegetable Processing Factory in Pyongyang

3) Achievements in North Korean Fisheries and the Animal Husbandry Sector in 2011

- Emphasized achievements in fish farming in the fisheries sector following 2010
- Little news coverage on achievements in fisheries

- Established "Comprehensive Fish Farming Laboratory," a place on the East Sea where research on salmon and sturgeon and farming and processing fish can all be accomplished in situ
- Established "Circular Purification Production System" in the animal husbandry sector
- Expanded farms to increase pork and duck farming and achieved good results in the relevant food processing sectors
- Ryongcheon Pork Plant under construction in North Pyeongan province
- Reformed Pyongyang Dudan Duck Farm to a "large-scale meat production and processing base"

4) Achievements in the North Korean Non-Food Agricultural Sector in 2011

- Achieved good results in the urban fruit tree sector, including the Daedonggang Fruit Tree General Farm and the greenhouse vegetables sector
- Completed about 1,000 ha on Daedonggang Fruit Tree General Farm since its launch in 2008
- Achieved creation and modernization of fruit tree farms in many areas
- Started construction for modernization of Pyongyang Fruit Tree Farm
- Completed construction of the 1st and 2nd stages of modernization of Gosan Fruit Tree Farm in Gosan district, Gangwon Province (1,000 ha)

- Scientized and integrated fruit production by introducing drip-irrigation facility
- Began construction of modernized, organic compound fertilizer factory in Pyongyang

Source: Korea Institute for National Unification, "2011 Overall Evaluation of North Korean Economy and 2012 Outlook."

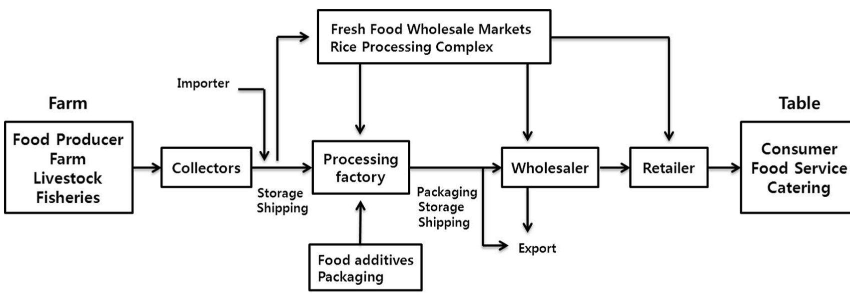
6.3. Food Security Function of the Food Industry

The food industry plays a leading role in the food supply chain by processing the agro-fishery products produced by the primary agriculture and fisheries industries into food materials and storing and distributing them. The food industry also serves the important function of supplementing food shortages by importing food from the global market. The food security function of the food industry is particularly significant in a situation where food self-sufficiency is difficult to achieve due to high population density and little arable land. In addition, the food industry may be able to develop overseas farms, which would be a long-term strategy for solving the food shortage on the Korean peninsula, thus leading to improved national food security.

6.3.1. Food Supply Chain and the Food Industry

Only half a century ago when most Koreans were farmers, food supply had to be achieved by the agriculture and fisheries industries. However, as most people now live in cities due to rapid industrialization and urbanization, a gap in time and space has grown between food producers and consumers, requiring a food supply chain that includes processes of collecting, transporting, storing, processing, packaging, distributing, selling, and cooking. It is the food industry that handles these steps. It has been an important task in national food policies to understand, manage, and support the complex food supply chain from farm to table.

Figure 6-2. Food Supply Chain

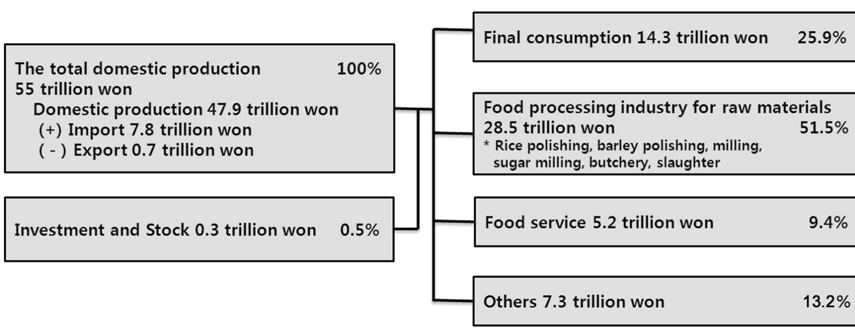


The food industry is the principal agent of food security and is closely linked to the agriculture and fisheries industries. The South Korean government has implemented a Food Industry Promotion Act (enacted in Dec. 2007, partially revised in July 2011) to strengthen the partnership between the agriculture and fisheries industries and the food industry and to support and foster the food industry. In 2008, the Lee administration renamed the Ministry of Agriculture, Forestry, and Fisheries the Ministry of Food, Agriculture, Forestry, and Fisheries and formalized support for the food industry, putting it in a position equivalent to agriculture, forestry, and fisheries.

As mentioned above, while the production revenue of South

Korean agriculture, forestry, and fisheries was 50.949 trillion won in 2010, the sales revenue of the food industry reached 133.012 trillion won. In 2009, the food manufacturing industry recorded 47.9 trillion won in domestic production, 7.8 trillion won in imports, and 0.7 trillion won in exports among a total domestic production revenue of 55 trillion won. Among the total production, 51.5% is used for food materials in the food processing industry, 25.9% for final consumption at home, and 9.4% for the food service industry (Figure 6-3).

Figure 6-3. Size of the South Korean Food Industry



Note: Domestic Production of 47.7 trillion won includes raw material imports of flour, sugar, starch, starch syrup and cooking oil, processed domestically.

Source: KREI, "2009 Input-Output Table."

6.3.2. Raw Materials Importation Function of the Food Industry

Although it is important to reliably supply agro-fishery products required for the food industry by the agriculture and fisheries industries, South Korea is dependent on imports for most of the raw materials in its food industry, with 27% self-sufficiency in grain and

50% self-sufficiency in total food energy. This means that raw material imports account for half of the total food, and thus this vast import capacity of the food industry serves as a key element in national food security.

In light of being in a food situation largely dependent on imports, like Korea, Japan has actively implemented policies to support the food industry that emphasize the importance of food security. Japan enacted its Basic Law on Food, Agriculture, and Rural Areas in July 1999 and legislated to strengthen the role of the food industry and the connection between the agriculture and food industries. Comparing measures taken by South Korea and Japan to resolve a potential food crisis, Japan focuses more on continuous development of the food industry and securing consumer trust in food security than does South Korea (Table 6-10).

Table 6-10. South Korea-Japan Comparison of Preparation in Case of Food Crisis

South Korea	Japan
• Increased food self-sufficiency due to the expansion of domestic food production	• Secured consumer confidence in food safety
• Sought stable income sources such as expanding futures market, long-term contracts	• Strengthened connection with farming based on domestic produce
• Operated stock management system	• Continuous development of the food industry
• Overseas agricultural development	• Revitalized domestic market
• Reformed the relevant systems including early alarm system	• Strengthened overseas business foundation, including overseas agricultural investments
	• Promotion of international cooperation

6.3.3. South Korea's Overseas Agricultural Development

With an absolute shortage in food production, the South Korean government promoted agricultural migration to Latin American countries, including Paraguay, Argentina, Brazil, and Chile in the 1960s and 1970s, establishing factories in local areas in those countries, but the project failed due to the lack of local information and preparation. From the 1980s, South Korea started on overseas farm development on the private level. In 1981, Sun Kyung Group succeeded in harvesting maize from a developed maize farm of 3,300 ha in Washington State in the US, but ended up selling the harvest at a low price because of the failure to get an overseas distribution network. At that time, distribution facilities in the US were dominated by grain majors, and the Sun Kyung Group could not secure any available elevators or transportation facilities.

In 1994, the Continental Development Corp. (CEO Jang Duk-jin) intended to establish a 38,000 ha farm in the triangle plain field in Heilongjiang province, China, to cultivate soybeans, but it would have required enormous amounts of infrastructure since the farm is located in a wetland. The company abandoned the project and ended in bankruptcy. In the 1990s, many companies jumped into the development of food bases in China, Russia, and the Maritime Province of Siberia (Yunhaiju), but most of them withdrew due to the lack of preliminary investigation and failure to secure distribution networks. The failure of South Korea's overseas agricultural development is mainly attributable to lack of attention or policy assistance by the government. This becomes clear when comparing the characteristics of overseas agricultural development in the early stages between South Korea and Japan (Table 6-11).

Table 6-11. South Korea-Japan Comparison of Overseas Agricultural Development Characteristics in the Early Stages

Category	South Korea	Japan
Immigration	Population dispersion, national interest	Transfer of development power
Overseas Agricultural Development	• Insufficient preliminary research • Relatively large scale	• Sufficient in-advance research • High value-added small complex
Financial Support	• Excessive expense for moving procedures • Self-paid transportation expense	• Minimum expense for procedures • Supported transportation expenses and reserve fund
Follow-up Management	Lacking, almost nothing	• Indirect assistance • Creating settlement environment
Relevant Government Agency	Ministry of Health and Welfare, Ministry of Foreign Affairs and Trade, Economic Planning Board, Ministry of Employment and Labor, Ministry of Justice	Ministry of Foreign Affairs, JICA

In 2010, Korea Agro-Fisheries & Food Trade Corp. formed the International Grain Task Force and tried to advance into the overseas grain distribution sector. Although the shipping company "STX Pan Ocean" promoted grain storage at the port of Portland in the western US and established elevators to export grains in partnership with Itochu Ltd. and Bunge, it was not easy to achieve these steps due to the dominance of major grain companies. At issue was the lack of experts in futures trading of grains in the futures market in South Korea. In the 1970s, South Korean government officials or employees of large companies were sent to the US futures exchange but returned to Korea in 2 to 3 years with no outcome. The Japanese workers stationed in the futures exchange had to work there until retirement so that they learned thoroughly and became international futures trading experts. This seemingly small difference made Japan a superpower in the global grain market in 30 to 40 years, while South Korea ended up buying grains at a high price from Japanese grain trading companies.

With the surge in global grain prices in 2007 and 2008, there has been increasing awareness of the food crisis in South Korea and growing interest in securing raw materials by revitalizing overseas agricultural development. In 2010, 52 private companies advanced overseas and secured 297,000 ha in 18 countries, and agricultural products are cultivated on 57% of that land, or about 170,000 ha (Table 6-12). Eight companies or organizations have entered the Maritime Province of Siberia, including the Hyundai Corporation, Daesunjinrihoe, and Univera.

Table 6-12. Current Status of Overseas Agricultural Development of South Korean Companies

Continent	Countries	No. of Companies	Major Crops
Russia	Yunhaiju (6), Rostov (1), Ussuriysk (1)	8	Wheat, Soybeans, Maize, Barley
CIS	Ukraine (1), Kyrgyzstan (3), Tajikistan (1), Uzbekistan (1)	6	Soybeans, Maize, Potatoes
Asia	China (10), Indonesia (9), Cambodia (10), Mongolia (7), Philippines (5), Laos (4), Vietnam (3)	48	Wheat, Soybeans, Maize, Cassava, Potatoes
Latin America	Brazil (3), Uruguay (1)	4	Wheat, Soybeans, Maize
Other	New Zealand (1), Australia (1), Madagascar (1)	3	Maize

Hyundai Corporation has expanded the size of its farm in the Yunhaiju area of Russia and promoted the introduction of farm products into South Korea. It also is seeking farmland for maize and soybeans in Latin America and reviewing entrance into the rice and dairy industries. Daewoo International has taken over the shares of palm oil companies in Indonesia and done business in rice production on demand in China, the US, and Thailand. Samsung C&T has established a joint cooperation for grain distribution in Chicago and promoted the production of biodiesel. LG International has promoted additional acquisition of overseas farms aside from the palm oil farms in Indonesia (Table 6-13).

Table 6-13. Current Status of Grain Resources Development of South Korean General Trading Companies

Company	Development Progress
Daewoo International	• Promoted rice farming business in Cambodia. Took over the shares of palm oil companies in Indonesia • Rice production on demand in China, US, and Thailand
Hyundai Corporation	• Expanded the size of farm in the Maritime Province of Siberia. Promoted introducing farm products in South Korea • Sought maize and soybean farmland in Latin America. Reviewed advancing into the rice and dairy industries in the region
Samgsung C&T	• Established a joint venture corporate body for grain distribution in Chicago, US. • Promoted production of biodiesel • Reviewed establishing additional grain distribution company in Southeast Asia and US
LG International	• Promoted acquisition of additional overseas farms aside from the palm oil farms in Indonesia • Reviewed entering into business relevant to grain resources such as biomass development

6.3.4. Cases of Japanese Overseas Agricultural Development

Japan has steadily supported overseas agricultural development as a national policy, including agricultural migration to Brazil from the 1960s. With grain crises and increased passage fares in 1963, and the US embargo on soybeans in 1973, the Japanese government recognized the importance of securing stable overseas grain resources. The government has diversified food-importing countries and actively promoted investigation and research, technology assistance and financial assistance through JICA (Japan International Cooperation Agency), the Japan Bank for International Cooperation, and related associations. As a result, the size of overseas arable land for cultivating crops in a direct or indirect way amounts to 12 million ha, 3 times larger than Japan's domestic arable land. The Japanese government supports the overseas agricultural development project by allocating an annual budget for the corporation "Overseas Agri-Development Association" established under the Ministry of Agriculture, Forestry, and Fisheries. If a private company wants to invest in overseas agriculture, the cost for an environmental investigation is covered 50% by the national treasury and 50% by the company. Highly needed feed grains such as maize and soybeans are secured by contractual cultivation with local farms rather than direct participation. Particularly, to prevent the criticism of "building colonies overseas," they adopt joint investments with locals in many cases.

Among the annual Japanese consumption of assorted feed commodities of 24 million tons, 30% is directly imported by Zen-noh (Japanese Agricultural Cooperation), and the rest by general trading companies (35%) and feed companies (35%). Zen-noh and Mitsubishi have directly purchased the entire commodity through their local subsidiaries in the US, and general trading companies including Mitsui, Marubeni, and Itochu are buying grains in the US from grain majors.

Zen-noh, a Japanese agricultural cooperative, recognized the problem of grain supply and demand after the surge in grain price caused by extreme global weather conditions in the early 1970s. Thus the Zen-noh Grain Corporation (ZGC) was established. It began construction on a grain elevator at the Port of New Orleans in the US in 1979 and completed it in 1982. After acquiring CGB in 1988, Zen-noh and Itochu formed a partnership with a 50% share each and expanded their grain elevators into the Mississippi valley and inland areas of the US. The entire amount of grain to transport to Japan was shipped from the elevators at the port, offering a storage capacity of 108,862 MT (metric tons) and a shipment capacity of 3,266 MT. Over the past decade these grains have supplied 8.5 million tons of the 29 million tons of the average annual amount of grain imports in Japan, accounting for approximately 30% of total Japanese feed grain imports. The trading is based mainly on BASIS rather than the C&F FLAT transaction, which enables Japan to supply grain at a lower price than grain majors when global grain prices spike. During the sharp rise in global grain prices from late 2006 to 2008, member companies were supplied grains at prices about 10% lower than average (Table 6-14).

Table 6-14. South Korea-Japan Methods of Purchasing Feed Grains

Category	South Korea	Japan
Import Volume	8-9 million tons	15-16 million tons
Purchasing Method	• Public competitive bidding: 74% • Private contract: 22% • Basis: 4%	• Public competitive bidding: 2% • Private contract: 8% • Basis: 90%
Tariff	Concession tariff 328% (in-quota tariff 1.8%)	Free tariff (except for corn powder)
Pros and Cons of Purchasing	• Leads to the lowest price at point of purchase and transparency of purchasing • Difficulty in catching the point of purchase and remaining risks due to intensive purchasing on specific days	• Reduced price risks with dispersion of purchase period • Possibility of intensified competition with gaps in purchase price per purchaser

In Mitsui & Co., the Grain Maintenance Division and Feed and Livestock Division of the Food Retail Headquarters have been dealing with the importation of soybeans, wheat, and maize and have been engaged in the grain sales business in the global market as well as imports. Korea is an important client. The company has expanded overseas business primarily through M&A. WISELY, where Mitsui is a major shareholder, invested 50% in partnership with the biggest US agricultural cooperative to establish VENTURA FOODS, the largest processed oil and fat food manufacturer in the US, and operated the jointly-invested company. It has expanded investment in local agricultural development in Brazil and operated a grain export base in Brazil.

In Mitsubishi, the Agro-Fishery Headquarters in the Living Essentials Group led the overseas grain business, establishing a farm products cargo collecting hub in the US and Australia to supply commodity processing companies. It sells the raw materials of flour, sugar, starch, cooking oil, and feed to consumers.

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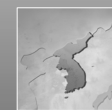
07 Changes in Size and Development of the Food Industry in a Post-Unification Era



Upon unification of the Korean peninsula, Korea would become a country with a population of 72 million and size of 220,258 km^2 (South Korea 99.720 km^2 and North Korea 120,538 km^2). Unification would be a golden opportunity for the food industry in South Korea, which needs to extend into overseas markets for continuous growth as the domestic market becomes saturated. Unification of the two Koreas would create a new market of 22 million people (the North) who share both language and food culture.

7.1. Prediction of Changes in Food Industry Size in a Post-Unification Era

The demand for processed food products after unification has been predicted by type using a simple assessment based on population increase. The formula used for assessment is presented below. Given the lack of production data in North Korea and the insignificant amount of North Korea's real production, the change in the size of the food industry in South Korea was estimated based on the assumption that the South Korean yield meets the demand of both North and South Koreans.

- Productivity of South Korea = A
- Production Yield of South Korea = B
- Food Demand after Unification (C) = B + North Korean Demand (against population proportion)
- Additional Demand after Unification (D) = C - B
- Operating rate of South Korean Food Factories = B/A × 100 (%)
- Operating rate of Food Factories after Unification = C/A × 100 (%)

Table 7-1 shows estimates of the amount of grain and its products required after unification, including ramen, Korean noodles, bread, snacks, and confections, as well as legume products such as tofu and soy milk. In the case of ramen, the South Korean food industry produces a total of 351,000 tons with an operation rate of approximately 48%. Since the demand for ramen after unification would increase to 525,000 tons, South Korea should be able to meet the required quota by raising the operating rate of ramen factories to 72.7%.

In the case of Korean noodles, South Korea produces a total of 741,000 tons with a factory operating rate of 39%. Considering the required amount of noodles is estimated to be 1.10 million tons after unification, South Korea can satisfy the additional demand if its factory operating rate is raised to 58%.

As for breads (cakes), South Korea produces 113,000 tons with a factory operating rate of 50%. South Korea can meet the additional demand by increasing the factory operating rate to 75% for 169,000 tons of post-unification demand for breads.

The production of loaf breads and rice cakes in South Korea is 1.08 million tons at an operating rate of 48%. The post-unification demand for these items is estimated at 1.62 million tons, which can be met by South Korea with an increased factory operating rate of 72%.

Table 7-1. Predicted Supply and Demand of Processed Grains and Legumes Products after Unification

Category	Foods	Maximum production capacity of South Korea (tons/year)	Production of South Korea (tons/year)	Factory operat-ing rate (%)	Post-unification demand (tons/year)	Additional production require-ments (tons/year)	Factory operating rate after unification (%)
Grain Products	ramen	722,961	351,697	48.65	525,787	174,090	72.73
	Korean noodles	1,903,519	741,531	38.96	1,108,589	367,058	58.24
	bread (cakes)	225,014	113,255	50.33	169,316	56,061	75.24
	loaf breads and rice cakes	2,271,911	1,088,267	47.90	1,626,959	538,692	71.61
	snacks and confections	1,412,903	511,421	36.20	764,574	253,153	54.12
Legume products	tofu	711,017	336,484	47.32	503,044	166,560	70.75
	soymilk	774,052	174,444	22.54	260,794	86,350	33.70

For snacks and confections, South Korea produces 511,000 tons of products at a very low operating rate of 36%. In order to supply the additional 764,000 tons of post-unification demand, South Korea would be required to raise the factory operating rate to 54%.

South Korea produces 336,000 tons of tofu with a factory operating rate of 47%. It would be enough to increase the factory operating rate in South Korea to 70% in order to supply the additional demand of 503,000 tons tofu after unification.

For soy milk, the factory operating rate in South Korea is 22%, and the post-unification demand can be supplied by increasing the operating rate to 33%.

Table 7-2 shows estimates on the post-unification supply and demand of processed meat, vegetables and beverages. Since the operating rates of factories for these food items are relatively low in South Korea at present, it is expected that a rise in the operating rates of existing factories would suffice to supply the increased demand for these processed foods in a post-unification scenario. In general, the food factories have low operating rates for processed food items due to seasonality and the low storage stability of raw food materials.

Table 7-2. Prediction of Post-Unification Supply and Demand of Processed Meats, Vegetables, and Beverages

Category	Foods	Maximum production capacity of South Korea (tons/year)	Production of South Korea (tons/year)	Factory operating rate (%)	Post-unification demand (tons/year)	Additional production requirements (tons/year)	Factory operating rate after unification (%)
Processed meats	Processed meat	376,172	183,854	48.87	274,862	91,008	73.06
Vegetables	Kimchi	1,465,828	426,834	29.12	638,117	211,283	43.53
Beverages	Carbonated drinks	5,061,362	1,112,575	21.98	1,663,300	550,725	32.86
	Coffee	1,328,578	403,225	30.35	602,821	199,596	45.37
	Tea	4,171,485	236,987	5.68	354,296	117,309	8.49

7.2. Outlook for the Food Ingredients Industry in a Post-Unification Era

7.2.1. Milling Industry

Flour production in South Korea came to 1.6 million tons in 2009, produced by 8 major milling companies. The wheat for milling is entirely dependent on imports, mainly from the US and Australia. Because of the full dependency on wheat imports, the milling factories are generally located at or near the ports. Incheon Harbor and Busan Harbor are the 2 primary locales for wheat importation, and mills are distributed throughout these areas (Table 7-3, Figure 7-1).

North Korea's flour production was estimated to be 450,000 tons as of 2005. Pyongyang Flour Factory, Nampo Milling Factory, and Haeju Milling Factory are confirmed to be in operation, and it is presumed that wheat is imported mainly through Nampo Harbor. Although there is not enough data to gauge the level of wheat self-sufficiency in North Korea, it is speculated to be higher than that of South Korea. It is expected that the post-unification demand for flour will increase to 2.38 million tons.

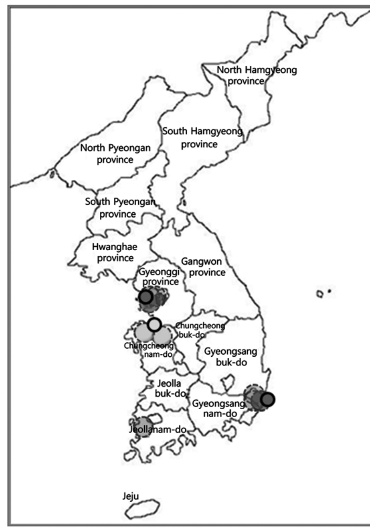
Table 7-3. Current Status of Milling Industries in North and South Korea

	South Korea	North Korea
Flour production	1.6 million tons	450,000 tons
Import ports (wheat)	• Incheon Harbor 1.3 - 1.4 million tons • Busan Harbor 600,000 - 700,000 tons • Pyeongtaek Harbor preparation	Nampo Harbor
Milling factory	• Daehan Flour Mills Co. - Incheon, Busan • Dongaone Co. - Incheon, Busan • Korea Flour Mills - Dangjin • Samhwa Flour Mills Co. - Incheon • Youngnam Flour Mills Co. - Busan, Yangsan • Daesun Flour Mills Co. - Yeongdeungpo, Hampyeong	• Pyongyang Flour Factory 100,000 tons • Nampo Milling Factory 150,000 tons • Haeju Milling Factory 20,000 tons

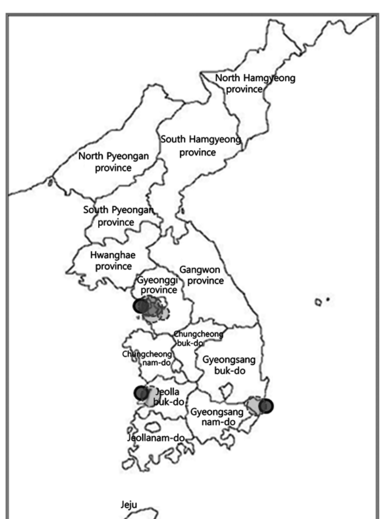
Figure 7-1. Staple Food Importing Port (●) and Location of Food Processing Factories in South Korea (●)

<Raw sugar industry>

<Milling industry>



<Starch sugar industry>



7.2.2. Starch Sugar Industry

The starch sugar industry is a major food ingredient industry that produces starch and sweeteners such as starch syrup, fructose, and glucose from maize. In South Korea, factories are located in port areas since the entire volume of maize processed in the country is imported as a raw material (annually 8 million tons, including maize for feed). On the other hand, since North Korea uses domestically-grown maize (annually 1.7 million tons) as a raw material, and therefore grain processing factories are established in each province to produce starch sugar as well as to serve as general food production complexes making traditional cookies that use starch sugar as a raw material.

In South Korea, 4 companies - Daesang Co., CJ Cheiljedang Co., Samyang Genex Co., and Corn Products Korea, Inc. - produce a total of 373,000 tons of starch syrup and 257,000 tons of high-fructose corn syrup. North Korea produces 100,000 tons of starch, 224,000 tons of starch syrup and 72,000 tons of glucose in total from each grain processing factory established in each province, indicating the production volume per capita is not much different from that of South Korea (Table 7-4). Considering the volume of sugar production in North Korea is not large, starch sugar appears to be the main sweetener in North Korea.

Table 7-4. Current Status of the Starch Sugar Industry in North and South Korea

	South Korea	North Korea
Starch sugar production	• Starch • Starch syrup 373,000 tons • High-fructose corn syrup 257,000 tons	• Starch 100,000 tons • Starch syrup 224,000 tons • Glucose 72,000 tons
Importation Ports (Corn)	• Incheon Harbor • Gunsan Harbor • Ulsan Harbor	
Starch sugar factories	• Daesang Co. - Gunsan • CJ CheilJedang Co. - Ansan • Samyang Genex Co. - Incheon, Ulsan • Corn Products Korea, Inc. - Bupyeong, Icheon	• Grain processing factory - established in each province

7.2.3. Raw Sugar Industry

The entire volume of raw sugar is imported and refined in South Korea. The CJ Cheiljedang Co. started the sugar refinery business in 1953 at Busan Harbor, followed by Samyang in Ulsan and TS Corporation in Incheon.

In 2009, the white sugar production in South Korea reached 1.25 million tons, recorded as the second biggest production of a food material, after flour (Table 7-5). Little is known about the sugar refinery industry or sugar production in North Korea.

Table 7-5. Current Status of the Sugar Refinery Industry in North and South Korea

	South Korea	North Korea
Raw sugar production	1.25 million tons	
Importation Ports (Raw sugar)	• Incheon Harbor • Ulsan Harbor	
Raw sugar factories	• Samyang Co. - Ulsan • CJ Cheiljedang Co. - Incheon • TS Corporation - Incheon	

7.2.4. Cooking Oil Industry

The cooking oil industry in South Korea uses the hexane extraction method to produce soybean oil and soybean hulls from raw soybeans. Soybean hull production is an important element of feed. In 2009, South Korea produced a total of 370,000 tons of soybean oil from three factories: CJ Cheiljedang Co., Ottogi Ltd. and Lotte Samgang Co., Ltd. Since the production of soybean oil is solely dependent on soybean imports, oil processing plants were established at harbors importing soybeans (Table 7-6). It is presumed that North Korea might produce sesame oil or perilla oil by the traditional method of oil extraction by pressing; no data has been released on soybean oil production using hexane extraction.

Table 7-6. Current Status of the Cooking Oil Industry in North and South Korea

	South Korea	North Korea
Cooking oil production	370,000 tons	
Importation Ports (Soybean)	Incheon Harbor	
Cooking oil factories	• CJ CheilJedang Co. - Incheon • Ottogi Ltd. - Anseong • Lotte Samgang Co., Ltd. - Cheonan	

7.3. Status of North Korean Ports

7.3.1. West Coast Zone: Nampo Harbor and Sinuiju Harbor

1) Nampo Harbor

Like Like Incheon Harbor, Nampo Harbor is a lock-system port located 30 km from the mouth of the Taedong River. It is a representative port of North Korea that has overcome the substantial difference between high and low tide on the West Coast. With the large-scale West Sea Lock Gate constructed in 1986, Nampo Harbor has greatly improved the work capacity of the sea and river, allowing vessels to sail to Pyongyang, Songnim, Daean, Jedori and other cities. The port has 9 docks, about a 10-meter depth of draft, a 13- to 27-meter depth of anchorage draft, 4 piers, a pier for coal only, and a pier for cement only. With 7 million tons of loading and unloading capacity, as well as 20,000 tons of anchorage capacity, it is the biggest port of trade in addition to being a naval port.

Located in the vicinity of Pyongyang, the capital city, and North and South Pyongan Provinces, which have a relatively large population, Nampo Harbor has advantages in establishing raw sugar processing facilities using the existing port infrastructure.

Figure 7-2. Major Ports of North Korea

Despite a need for rearrangement, Nampo Harbor seems to be the right place for factories processing raw sugar, starch sugar, and flour milling. The harbor is in a favorable location for reinforcing thermal power generation, electric power facilities, and/or new facilities in 2 existing areas at the port, and also to draw partly on the electricity of South Korea. Considering the proximity of existing sugar refinery facilities in Incheon, Nampo Harbor may not be efficient in terms of logistics costs. Nonetheless, it has certain advantages, given the strategic and existing military perspectives.

2) Sinuiju Harbor

Sinuiju is a transportation hub of both water and land located in the Amnok (Yalu) River Basin, serving as the terminal station of Gyeongui Railroad. It is a gateway of international transportation connecting to a fleet of Chinese vessels through a railroad bridge over the Amnok (Yalu) River to Europe via the South Manchurian Railway and the Siberian Railway. Water transportation on the Amnok (Yalu) River allows 500-ton vessels to sail against the stream using the full tide and small ships to ply between Hyesanjin and Sinuiju Harbor. However, there is a huge disadvantage to this trading port since it is iced over to a depth of 1 meter during the winter and experiences shallow waters and excessive silt accumulation due to extremely low tides the rest of the year.

Since it is geographically close to the 3 northeast provinces in China, Sinuiju Harbor may meet the demand for sugar in North Korea and China with the possibility of exporting sugar to the Russian Far

East and Mongolia. In addition, being far from the Incheon Harbor of South Korea, the port is strategically favorable for covering the large population in North and South Pyeongan Provinces and North and South Hamgyeong Provinces in terms of balanced regional distribution and development. It is highly likely that the port will be designated "a new special economic zone," which makes it worthwhile to consider its connection with existing economic zones.

New facilities and/or reconstruction of facilities should be invested in to develop Sinuiju Harbor due to its current poor infrastructure. In addition, improvement of anchorage facilities and infrastructure is needed because of the silt accumulated from the Amnok (Yalu) River and the shallowness of the water.

7.3.2. East Coast Zone: Najin Harbor, Sunbong Harbor, Chongjin Harbor, Heungnam Harbor

1) Najin, Sunbong, and Chongjin Harbors

China has implemented a multi-year development project in the Changchun, Jilin, and Tumen regions, having invested 250 trillion won to advance into the East Sea so that the goods produced in China can be exported at a lower cost via the East Sea rather than through Dalian Port in mainland China. Given their proximity to coastal areas, coastal infrastructure, and cheaper costs, Najin, Sunbong, and Chongjin Harbors have been evaluated as adequate trading ports. China has accordingly established diversified industrial plans for using these ports for overseas expansion. Moreover, China has supported the development of the three ports by offering a certain amount of oil and grain aid to North Korea to secure the ports in the deep water of the East Sea. Currently, the 2 highways connecting Hunchun (where the customs office is located) to Najin and Sanhe to Chongjin are under construction for trade with North Korea. The East Sea ports are known to be the best place to import grains and export fishery products and seem to be full of new and old special economic zones. Approximately 300-320 Chinese companies are participating in the Najin Special Economic Zone, as the region has virtually limitless significance and possibility. For example, this area is well-suited for building processing factories for fishery products from the East Sea. The export volume of marine resources from North Korea was highest in the 2000s.

Chongjin Harbor has several advantages as a trade port: there is little difference between high and low tide, limited damage from typhoons, and harbor water that does not freeze in winter. With the Komal peninsula projecting toward the East Sea at the center, the east side has been developed to be an outer port, while the west side is used as a trade port. Because the facilities and equipment have been improved since 1974, Chongjin Harbor, located in front of the Chongjin Industrial Complex, serves as an industrial port as well. In 1995, ship vessels of around 20,000 tons could enter the harbor, but recently even 10,000-ton ships find it difficult to enter the port due to a lowered water level (about 7.5 m). Among the main harbor facilities are 5.27 km of pier, 17.4 km of railway inside the harbor, 8.8 million tons of loading and unloading capacity, and 20,000 tons of anchorage capacity.

Najin and Chongjin Harbors, equipped with complete facility settings, have advantages in loading and unloading imported raw materials such as raw sugar and maize, and also in establishing factories for starch and raw sugar refining and milling. FTA agreements with China and Russia are expected to take effect at the point of unification of the Korean peninsula. Meeting the preference of Russians for sweets, the ports' location is well placed for constructing factories that process sugar, snacks, and confections as well as other foods. In addition, it is likely that these areas will be highly attractive to the Japanese for relocating some of their manufacturing factories.

2) Heungnam Harbor

Heungnam Harbor, an important ice-free port in the East Sea, is located in the South Hamgyeong Provincial Heungnam Industrial Development zone, including Heungnam Fertilizer Factory. Heungnam Harbor is considered to be an attractive trading port due to its 6.7-7.9 m water depth surrounding the dock and an anchorage draft of 12 m in depth. The main roads in Heungnam city include the Hamheung-Seohojin road, the Seohojin-Yeonpo Sansang road, and the Seohojin-Twejo road. The network of roads is organized in all directions in this emerging industrial city. It is expected that a special economic zone will be newly established in Hamheung and Wonsan as an industrial complex, making the area a major hub for trade between North and South Korea.

7.4. Status and Outlook of Electricity Supply on the Korean Peninsula

7.4.1. Status of Electricity Supply in South Korea

The total electricity usage in South Korea (as of the end of November 2011) was composed of 56% for manufacturing factories (industrial) and 44% for general purposes (household). The electricity supply in South Korea depends on mass production, that is, large-scale nuclear power generation, hydropower generation, and/or thermal power generation. With the blackout experienced immediately after the Chuseok (Korean Thanksgiving Day) holidays in September 2011, a problem in the electricity supply of South Korea has surfaced. It is forecast that the possibility of blackouts in the winter season from 2011 to 2012 is almost a 100% likelihood (since there is expected to be an increase in demand for electricity during the wintertime more so than immediately after Chuseok). It has been noted that the back-up power may decrease below 4 million kW during most of the winter season, and that backup power may even drop to 530,000 kW in the second or third week of January 2012.

This substantial decrease in backup power supply is partly because the usage of electric heating such as electric space heaters or electric pads has continued to rise, using up to 18.1% in 2004 and sharply increasing to 25.4% in 2010. Due to excessively low electricity prices, the mass production and consumption of electric heaters has perpetuated in South Korea. This is attributable to an unreliable effort to control power generation and sales under the separate systems of the power generator (Korea Electric Power Corporation) and the power traders (business offices). It is necessary, as in weather forecasting, to operate a regular prediction function by improving the power usage prediction system and also to reduce prediction errors on power demand, which is currently up to 2 million kW per day, by actively communicating with end-users.

Surveys on business activities in South Korea in 2010 indicate that there were a total of 11,301 domestic companies with 300 million won of capital and more than 50 regular employees each. Among these, 48%, or 5,411 companies, are manufacturers requiring vast amounts of electricity consumption. The proportion of manufacturing to total power consumption being 56% demonstrates that a large number of industrial factories with high power consumption are gathered in South Korea, and this is so due to the recognition of long-term low electricity costs in Korea. Unless the South expands power generation by increasing power plants, there will be a huge disruption in industrial development in North and South Korea, which may push back the point of unification by 10, 15, or 20 years. It is particularly important to establish preliminary plans to remedy the situation, as it takes 7-8 years to build power plants.

In conclusion, large-scale power plants must be expanded to a degree sufficient to generate a large amount of electricity, which may take substantial time (7-8 years). Without enough preparation for an improved power supply in South Korea, the industrialization plan in North Korea if Korea achieves unification in 10 years may be disrupted. If it is impossible for South Korea to supply extra power during the early investment period after unification, the impact would be tremendously negative, not only on the food industry but also on the overall industries of North Korea.

7.4.2. Status of Electricity in North Korea

As energy is mainly dependent on coal, there is a serious lack of electricity in North Korea. However, if the pipeline project for Russian natural gas, which is under discussion at the international level, is completed and becomes operational at the point of unification, North Korea may use the natural gas as well, thus compensating for the shortage of electricity. In this regard, securing essential natural gas to industries as an energy source is expected to resolve the issue at first. However, a large investment may be required for power generation using gas, coal, liquefied gas, synthetic gas (Dusan Heavy Industries & Construction), or small generation facilities (Hyundai Heavy Industries), despite their short construction period: Power generation is divided into mass production and small-scale production depending on the construction period. Investing in the North Korean food industry would best be achieved in a stepwise manner, that is, dividing investment into primary (short-term) and secondary (long-term) projects based on the construction of power generation.

7.5. Outlook for the Food Industry in a Post-Unification Era

7.5.1. Food Manufacturing Industry Outlook

As of 2010, the operating rate of the food processing factories in South Korea is at 48-49%, which indicates that substantial operating capacity remains available, even after considering the peak season and off-season. In this regard, a divided investment is expected to start at an early stage of unification while supplying products produced in South Korea to North Korea as long as electricity conditions permit. Since there is a time gap between 2010 and the point of unification, it is expected that highly efficient, large-scale machines may partially replace food processing facilities in South Korea. The expected unification time frames are 2020, 2026, or 2030, during which time South Korea will have entered the early stages of becoming an advanced, industrialized nation. This would facilitate changes in factory operating hours and weekly work hours to match that of advanced countries, which in turn would force older equipment and facilities to be replaced by highly efficient, large-scale ones. The capital investment required for these developments will lead to changes in the food manufacturing business such as the development of high value-added products and new products produced by advanced technologies appearing on the market. In addition, from a global perspective, free trade agreements (FTAs) between South Korea and countries such as China, Japan, and ASEAN countries will take effect in this time period, which will further accelerate investment not only in replacing equipment and facilities in food manufacturing factories, but also in establishing overseas plants in foreign countries.

Recently, the Korea-EU FTA took effect in 2011, and the Korea-US FTA came into force in 2012; a Korea-China FTA is anticipated to take effect by the end of 2015. These FTAs are expected to promote the progress of a Korea-Japan FTA and other global business environmental changes, particularly centered on South Korea. These changes may subsequently spark the interest of global or multinational food companies in business opportunities in the East Asia region. Global food companies may want to invest in the food manufacturing factories in South Korea unilaterally or through mergers and acquisitions. Other possibilities of interest would include thorough strategies to more closely target Chinese and Japanese markets and comprehensive strategies to aggressively enter the market for Southeast Asian countries. These would in turn accelerate investments in the food processing factories in South Korea to make them more globally oriented even during the pre-unification time period.

According to global market analyses on the agricultural and food industries, the Ministry of Food, Agriculture, Forestry, and Fisheries of South Korea foresees its total global food market reaching 6.4 trillion dollars in size by 2017 and thus regards the food industry as a business of strategic focus to be further developed, considering its large contribution to overall national development. Accordingly, the Ministry has implemented several national plans for enhancing the development of the food industry in South Korea. The plans include fostering 300 domestic agricultural and industrial companies with a convergence of agriculture, industry, and commerce; stabilizing consumer prices by reducing retail margins; vitalizing the development of industrial technology by networking 213 agricultural technology centers and universities; and promoting capacity-building for 1 million skilled professionals. Particular efforts are being made to facilitate the procurement of raw materials and create 10 times higher added value by the processing of rice for various commodities. The Ministry also plans to expand and support food-related departments in universities in order to intensively foster 10 food items, including seasoned laver and paprika. The Ministry also has strategic goals to grow cyber transactions from 260 billion won in 2010 to 1 trillion won by 2017 and to achieve globalization and a higher competitive edge in the food industry.

Since it will take at least 6 months, and up to 1-2 years at most, to research the need for raw or minor ingredients and the distribution of food in North Korea after unification, comprehensive plans at the government level, such as designating the food industrial complex as falling under the purview of national policies, will not be determined soon, especially due to differences in each company based on type of industry.

7.5.2. Modernization of the North Korean Food Industry

Before preferentially investing in North Korea, each South Korean food industry should consider the North Korean plans to establish a small-scale food industrial complex the width of 198,437 m^2 on a plain in Junjindong, in the Nakrang district of Pyongyang. According to confirmed information on the plan by a North Korean public official, the industrial complex consists of 1) a corn noodle factory (corn noodles are enjoyed in Gangwon Province); 2) a starch syrup factory; 3) a snack factory; 4) a candy and confections factory; 5) a beverage factory; 6) a potato-based ramen factory; 7) a potato-based noodle factory; 8) a potato-based fried food factory; 9) a bakery factory (Choco Pie, chestnut bread, walnut bread); 10) a dumpling factory; 11) a canning factory (fishery products, fruit, and meat); and 12) a cooking oil factory. This plan was designed by high officials of the North Korean regime, including Chun Il-choon, the head of the 39th department of the Labor Party. The food processed in the industrial complex may be for the upper class in North Korea, mainly in Pyongyang. These plans indicate the level of the food industry in North Korea and the will of North Korea to process domestically grown farm products.

7.5.3. Fishery Products Processing Industry

According to South Korean government officials' discussions with experts in North Korea, the Najin and Chongjin areas as well as the Kaesong Industrial Region have emerged as potential places to invigorate investment by private companies in the fishery business. If there is no electricity restriction, the fisheries (fishing, aquaculture included) and their processing industry will be vitalized in the sectors of frozen and cold storage business, fishing ship building (shipbuilding yard), which is not profitable in South Korea, and manufacturing businesses for fishing gear and nets. The processing areas include 1) blue crab freezing; 2) steaming and freezing of short-neck clam / packaging of short-neck clam; 3) freezing of shellfish, including scallops / shellfish processing, including ark shells; 4) processing of pollack, snow crab and blue crab; 5) frozen and cold storage; 6) simple drying; 7) canning; 8) drying of pollack; 9) kelp processing; 10) extraction of pollack roe; 11) pickled / salted fish and shellfish processing; 12) fish meat paste and jelly products / crab stick processing; and 13) aquaculture / fish farm business.

7.5.4. Franchise Industry

In the 1980s the food industry in South Korea grew dramatically, and the fast food industry began at the same time. The starting point of the franchise business era arrived when Lotteria launched its first branch office in South Korea in 1979. KFC, McDonald's, and Pizza Hut soon followed, while BBQ Chicken entered the market in the 1990s. Franchise business requires small initial investment and has the potential to expand branch offices under a well-managed operating system. As of 2010, the franchise business of South Korea is expanding into overseas markets, earning royalties for their operating system.

Since franchise business is fundamentally based on operation or management experience and royalties, entrance into foreign markets is progressing rapidly. After unification, it is expected that the food industry, with little capital and based on personal ownership and entrepreneurship, which has not been the experience of North Koreans, will be actively promoted during the period of industrial investment in short-term primary food processing. It is anticipated that the franchise brands would aggressively focus on rice-based processed products, rice powder, processed products combined with flour, and authentic Korean traditional foods specific to North Korea. North Korea, with the same food culture as the South, will have a wide range of options on food choices, and unique North Korean food products may be developed to meet North Korean demand and be able to move into the South Korean market as well.

The top 100 franchise food items are categorized into (fried/baked) chicken delivery, roasted food, sushi, boiled pork, triangle-shaped Korean laver rolls, gimbab, fusion food, draft beer, soybean sprout soup with rice, pork-on-the-bone soup, health-supplement foods, coffee, shabu-shabu, hamburger, chicken stew with ginseng, organic food, bakeries (Paris Baguette, CJ Tous Les Jours, misc.), pizza, lunch box, ox-bone soup, porridge, Vietnamese rice noodles, ramen, and ddeokbokki, rice cake in hot sauce. These small-scale franchises will play an absolute role in the most critical issue of job creation in North Korea.

As of November 2011, based on the top 100 franchise restaurants, the franchise business in South Korea has 16 trillion won in sales revenue (based on headquarters reports only), 60,000 stores, about 330,000 employees (headquarters, 29,466; branch offices, about 302,540), and 5.5% of directly managed franchise stores over member stores.

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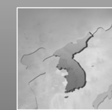
08 Expert Reviews of *Korean Unification and Food Security*



8.1. Kwon Tae-Jin

Director, Center for North Korean and Northeast Asian Studies, GS&J Institute

No one knows when or in what form Korean unification will be achieved. Although many expect unification will come gradually within 20 years, others are doubtful it will happen at all or are uncertain about the timeframe, saying it could even happen overnight. Unification without any preparations for food security may cause unavoidable chaos and food crises.

Assuming that Korean unification will be phased in based on a free democracy and a market economy, we have enough time to prepare for unification. Even if the preparation for unification is somewhat lacking, extreme chaos might be avoidable. However, if Korea were to achieve unification unexpectedly, for example, due to sudden changes in North Korea, and particularly without enough provisions to address the food issue, mass confusion would prevail.

Not knowing when such changes in North Korea might occur, it is important to note each and every one of the necessary urgent actions as well as to simplify possible assumptions in setting up measures for food security. The measures we need to seek under the possibility of sudden changes in North Korea assume that South Korea may intervene in any situation in the North, that such changes will require the involvement of South Korea, and that the situation will become the starting point for Korean unification.

In this scenario, food requirements must be estimated across North Korea as well as by region (province, city, and district) to discuss measures to secure food. Under a sudden change, there will be no need to consider the food rationing system and residents' demands in order to estimate per capita food requirements: From a nutritional point of view, it will be sufficient to assume the minimum food requirement so as not to cause any harm to the health of North Koreans and to overcome the emergency situation. It is reasonable to take an approach based on the minimum food requirement in calories. Such food requirement data has been released by the WFP since 1995. Unlike the WFP, the ROK Ministry of Unification has based the food requirement on the decreased ration system of North Korea, which is conceptually different from the WFP, but not much different from the WFP's estimates. It is deemed appropriate to estimate a wide range of food consumption first, including not only edible food but also food for seed, feed, and processing and waste, and then build measures to supply the shortage in North Korea's food production. North Korea's food agency figures out the population and the amount of food needed for food rations by region to the smallest administrative unit, li, and thus it would not difficult to calculate the food ration requirements by region. However, when preparing measures for emergency food aid, it is important to take an institutional approach, which suggests efficiency of food distribution to North Korean residents through a given channel (agency) and in a given manner rather than via a micromanaging approach. It is necessary to design emergency food distribution measures for all North Korean residents, including ordinary people under the food rationing program, soldiers, and people who work for the collective farms. Also, the food supply method should vary by the target of food rationing.

If assuming a sudden change in North Korea, it is reasonable to presume a demand for emergency food for 2 months, considering the procurement time, transportation, and the number of days needed for distribution. In the case of rice, it commonly takes 2 months to bring rice purchased in the markets in China or Southeast Asian countries to North Korea. Therefore, in the sense of procuring emergency food aid until North Korea can fulfill their food requirements from overseas markets, it is required to stock 2 additional months of food for North Koreans. However, the period of 2 months may not have critical meaning, depending on the point of occurrence of the emergency situation. If it were to occur in spring or summer when there is a large food inventory, the 2 month period would not be significant; rather, the amount of the North Korean food shortage (or the amount to be procured from overseas) would be much more important. The FAO recommends that a nation's optimal stock level of grain be a 2-month supply at the end of the crop year. South Korea operates its food stock system according to this recommendation and sets the optimal size of the public rice reserve at around 720,000 tons at the end of a crop year. Combining the stockpiles aside from the public reserve, the rice stockpile is much higher at the end of the crop year, and the grain stock volume is larger than the figure during a crop year. If considering the possibility of sudden change in North Korea, a reasonable action would be to revise upward the optimal grain stock volume by the amount of the North Korean grain requirement at the end of each crop year.

It is unsuitable to limit the grain species to rice or food grains when preparing for an emergency situation in North Korea. It is important to procure the necessary volume of food for an emergency situation in North Korea, but it may be more important to know how quickly foods can be supplied and how the market is stabilized. Since North Koreans purchase more than half of their food requirements from the market, food security would be half achieved by increasing the food supply through the market, which may stabilize the price. If South Korea were required to supply food to North Korea, the stability of the South Korean market should be considered, since the changes would also affect the South Korean market.

Measures of transportation needs are also essential. Since the current South Korean self-sufficiency in grain (feed grains included) is as low as 26%, 74% of food grain is required to be imported from the overseas market. Therefore, it would be suitable to transport the needed food from overseas directly to North Korea via marine transportation. In this case, it would be reasonable to use the North Korean ports on the East and West Coasts that were used for South Korean food loans to North Korea. In terms of land transportation, stopovers would be designated in the bordering areas of both countries on the East and West Coasts. Then the food aid could be transported to further inland areas, unlike previous food aid. It is also necessary to prepare measures to transport food via train or truck from neighboring China in an urgent situation. Air transportation may be used only in exceptional situations. Whether transporting grains in the South to the North or distributing grain stock within North Korea, it is necessary to establish an integrated transportation support system for the government to solve an emergency situation.

The measures required for food distribution are more crucial than others. It is generally regarded to be most efficient to use the existing public food ration system in North Korea for an emergency food supply. However, it is inappropriate for South Korea to simply supply food and leave all processes to the North Korean food agency, even if the existing rationing system of North Korean were used. If possible, a South Korean-led food distribution would be desirable, and it would be efficient to operate food facilities in large cities to feed hungry people.

It is critical to prepare emergency plans for food in case North Korea experiences a sudden change. In such an emergency situation, one would expect food price spikes as the food demand rises higher than normal and food distribution is distorted with cornering and hoarding. Therefore, even with the food reserve released unlimitedly for a very short term, if it is not well managed there will be food shortages and price spikes. In an emergency situation, the food issue would not be limited to North Korea but would also affect South Korea. Therefore, it is necessary to prepare measures that protect the Korean peninsula as a whole; measures that provide details for emergency food offered through the rationing system and the operation of a direct food facility system, one which uses community facilities such as schools, hospitals, nursing homes, orphanages, and kindergartens to provide food for the hungry in the case of a food crisis.

8.2. Choi Geun-Won

••• Director, Food Management Division, Korea Agro-Fisheries & Food Trade Corp. (aT)

Unification may come suddenly and without notice. There may be no room to examine gains or losses before choices are made. Whether unification becomes a blessing or disaster depends on how closely prepared we are for the event. Experts in unification argue that it is our duty in this era to achieve unification in such a way that it becomes an opportunity, not a disaster, for both Koreas. It is particularly important to establish economic capacity and a social safety net in order to absorb the shocks that would be caused by sudden unification. To that end, it is necessary to prepare food policies for unification on a government level and to establish special agricultural zones like Kaesong Industrial Complex to overcome a potential post-unification food shortage.

aT has accumulated experience and know-how by providing 2.7 million tons of food to North Korea via the agency's management of working-level programs such as rice assistance under a government food loan to relieve North Korean food crises and offering maize assistance under the WFP and the UN from 1997 to 2010. In addition, under article 13 and applicable regulations of the Act on the North-

South Exchange Cooperation, the agency has conducted State trading, promoting North-South exchange by annually importing from North Korea around 2,000 tons of food items such as soybeans, sprout seeds, adzuki beans, and mung beans, and stocking them as a reserve to stabilize the domestic food supply.

If the inter-Korean relationship improves in the future, it would be worth attempting a project of mutual cooperation in which South Korea leads a contract with North Korea for the cultivation of soybean sprouts, adzuki beans, and mung beans, which have been traded in the past, and provides a domestic rice reserve and Minimum Market Access (MMA) rice imports for North Korea in return.

Considering the soil erosion of farmlands and the decrepit production facilities of North Korea, support in the form of fertilizers, agricultural chemicals, and farming equipment from South Korea would be needed to contract a cultivation project. In addition, the issues of high cost and low efficiency in inter-Korean trade have been raised; these are caused by inland transportation problems, excluding marine transportation, and a poor logistics system, including lack of facilities for storage, sorting, processing, and packaging. Other obstacles to a mutual cultivation project have been exposed, such as the inconvenience of using a third country as a channel (location) for trade negotiations between the two Koreas.

Therefore, if a special agricultural zone like the Kaesong Industrial Complex were developed, it could be used as a hub of North-South agricultural cooperation in which to prepare for unification by building the foundation of contract cultivation businesses and farm product trade and thus would attract investment from the private sector.

An action manual detailing how to overcome food shortages in case of sudden unification should be created in concert with the government (the Ministry of Unification and the Ministry of Food, Agriculture, Forestry, and Fisheries), aT, and independent organizations (like the Red Cross). The amount of emergency food that may be needed to stabilize North Korea after unification is estimated at about 1.2 million tons. It is necessary to raise money for food procurement and to secure a system to stock food in South Korea for the North against such an occasion.

In terms of rice, if the market is assumed to open with tariffs after 2014, the MMA volume of 408,000 tons as of the year immediately preceding market opening will be subject to tariffs before being imported by the government. The MMA volume may be used for emergency stock. Measures for procuring other mixed grains and food for feed are projected to be used if the national grain procurement system gets on track: it is currently under aT-led construction to directly import 4 million tons of grain, 30% of the annual grain imports of 14 million tons, until 2020.

If the land cultivating maize in North Korea is converted to soybean production after unification, it is expected to be helpful in enhancing self-sufficiency in soybeans for food use. Nevertheless, there are several concerns to overcome. Although North Korean soybeans used as food are of excellent quality and are non-GMO, they may not be competitive in price with imported soybeans due to the North's small-scale cultivation. Soybeans for food use are mostly used for processing, as in for tofu and soybean paste, and non-GMO soybeans imported under the government tariff quota are priced at 1,020 won per kg. However, since the wholesale price of domestic soybeans is 5,580 won per kg for high quality and 5,300 won for medium quality, the demand for domestic soybeans is limited to health-conscious consumers. Most soybean food manufacturers want quality products but not at a price higher than the government supply price. Another issue is that if North Korean soybeans penetrate the South Korean market at a relatively low price, conflicts with South Korean soybean farmers might arise.

8.3. Kim Kyung-Ryang

••• Professor, Department of Agricultural Resource Economics, Kangwon National University

Regarding the point of unification in this research: Assuming a sudden unification in the current situation, this study suggests that problems and counteractions should be expected for 10 years after unification.

Research scope: It is desirable to discuss the food issue from the perspective of food security by expanding the subject to North Korea's potentialities and the food industry beyond agro-fishery production and food supply and demand.

Definition of unification: Korean unification is at once an opportunity and a means to increase the quality of life of residents in both Koreas, to prevent unnecessary costs resulting from division, and to fulfill the development potential of Koreans.

A. Regarding the current political landscape in North and South Korea

- Only 6 months ago, a huge change occurred in North Korea with the death of Kim Jong-il and the advent of the Kim Jong-un regime. The Kim Jong-un regime is in a dilemma about whether to open its doors and reform. On the one hand, the regime would collapse immediately after reform and instituting an open-door policy, but on the other hand, the national system will soon crumble by not implementing open-door and reform policies.

- Meanwhile, South Korea is in an election period and its policy toward North Korea is in review. The Sunshine Policy implemented by previous President Kim Dae Jung has been criticized for damaging the South Korea-US relationship by neglecting North Korean nuclear development while promoting North-South exchange and cooperation. However, the current South Korean administration is considered inadequate, with impractical policies implemented by officials who poorly understand the situation in North Korea, despite approaching the issue with principle. The next administration must assume the task of taking the unstable and uncertain North Korea in the right direction by building upon the Sunshine and Pressure policies to form a solid foundation for designing a new policy for North Korea.

B. Regarding the Point of Unification

- Food Security and Food Industry Development Strategy before Unification: This is a task that can be tackled by recovering homogeneity between North and South Korea through a robust exchange and cooperation before unification. Since the procedures for unification will serve as an initial condition at the point of unification, it is important to actively prepare for unification now. It is critical to take a general approach that includes strengthening the national defense to suppress the provocations of North Korea, providing nutritional aid to the infants of North Korea, expanding education about unification for students, as well as creating a robust agricultural exchange and cooperation between the two Koreas. The agricultural sector faces a difficult task that will require patience in order to achieve cooperation while protecting the pride of North Korea, removing the burden of collapse of the regime, and at the same time establishing mutual trust. However, there are structural limits to cooperation in the agricultural sector that may delay desired effects, especially if North Korea restricts access by South Korea. Also, there will be difficulties complying with the principles of North-South cooperation projects in agricultural business since the latter is considered to be an industry.

- Food Security and Food Industry Development Strategy at the Initial Stage of Unification: It is necessary to prepare a detailed plan for implementing an emergency food supply for the first 3 to 6 months of unification.

- Food Security and Food Industry Development Strategy for the Mid- to Long-Term after Unification: It is necessary to promote a development strategy for agriculture and the food industries in North and South Korea as well as Northeast Asia. This is at once a crisis and an opportunity.

As the structural reform of the agricultural sector will require a huge sum of money and will take more than 10 years to implement, South Korea and the global market will need to be properly utilized to meet food supply and demand during this period. After unification, Korean agriculture will refer to advancing into Northeast Asian agriculture, and for the short term the balanced development of North and South Korean agriculture will be a national challenge.

C. Regarding Predictions on Food Supply and Demand

- This study attempts to analyze recent statistics and discover the root of predictions regarding the food situation in post-unification Korea. Overall the study is not objectionable, but the limited statistics employed and the unremarkable analysis of causality should be pointed out. In reality, North Korea's food condition is extremely serious, to a degree that cannot be sensed by South Koreans, and extends way beyond the meaning of the statistics. Given that the food situation of the North Koreans has nearly hit rock bottom, particularly concerning nutritional status, any approach to unification must include a fundamental and holistic plan for the food supply and demand of North and South Korea, for the Korean peninsula as a whole is definitely a food importer. After unification, the North Koreans will rapidly experience consumption growth to match that of the South Koreans. Thus there are limits in practice to predicting the supply and demand volume within a united country. In other words, it would be more realistic to predict the supply and demand with the increase in food consumption measured by increase in population and based on the food consumption pattern of the South Koreans.

- In terms of the food issue, the supply and demand system will be maintained only if the political, societal, and physical infrastructure is harmonized as a whole. However, a collapse of even a small part of the system may result in an unstable food situation. Since it is possible to relieve the crisis only if the system as a whole is newly built or renovated, it would be very complicated and difficult to address the issue piecemeal; rather, holistic measures must be established and promoted.

D. Regarding Development of the Food Industry after Unification

- The cases of agriculture and food industry assistance to East Germany during unification and to East European countries after system transformation may be good references. The sudden shift to market economy without preparation caused huge chaos in the agricultural markets of East Germany and other East European countries. The agriculture reforms of the 1990s and the lack of understanding of the new system resulted in very low-efficiency production and distribution. Expectations and interest in the market economy ran high, but the people involved failed to establish a new, advanced distribution system because they neglected to take into account the absolute decrease in purchasing power and in agricultural product distribution, and the occurrence of unemployment. Workers engaged in commercial activities did not have proper awareness of distribution needs. The political desire to escape the existing system was urgent, but adequate preparation in terms of the principles and plans for privatization was lacking. This was coupled with the unconditional hope of the people for rapid privatization. The implementation of reforms created an imbalanced development of the industry as a whole, including a host of side effects. During these chaotic times, some political powers disturbed the flow of reform, proposed unconditional consumer-supporting policies, and thus rejected overall agricultural reform.

- EU assistance in agriculture for the countries that transformed their national system before joining the EU was provided by SAPARD (Special Accession Programme for Agricultural and Rural Development) for the respective areas of production, distribution and processing, rural area development, non-farming income development, education, and systematization. SAPARD is a program on the EU budget with two aims in assisting the structural reform of agriculture and the environment in rural areas of 10 central and eastern European countries that applied for membership in the EU from 2000 to 2006. First is to apply the EU's rules to agriculture, and second is to address the problems that might arise during the development process of agriculture and rural areas.

- The food industry, including the processing of agricultural products, is closely related to the modernization of farming households. Given the impact of bringing indirect support to rural areas through non-farming incomes and increases in employment, it is necessary to prepare for setting in order the details of businesses and their operation. Investing in processing and distributing agricultural products increases the number of processing companies meeting the rules for food security, hygiene, and environmental protection. The goal is to modernize agro-fishery processing companies to achieve high production efficiency, establish and improve the distribution chain, develop high value-added and commercially viable products, promote the association and alliance of producers, and improve the quality and safety of food.

8.4. Yang Seung-Ryong

••• Professor, Food Resource Economics Department, Korea University

The agflation South Korea has recently experienced differs greatly in both scale and quality from the limited-time grain crises of the past. For 30 years, from the 1970s, South Korea has suffered grain shocks four times. The previous crises were caused by temporary imbalances in supply and demand, mostly due to cold weather or drought. With an increase in cultivation area, substitution of demand, and political intervention, each crisis has passed in a few months or a year. However, the spike in grain prices that began in the spring of 2006 is ongoing. Considering said previous cases, this is a very unusual situation.

The agflation triggered by the US bio-energy policy of 2005 implies a structural, chronic food crisis along with climate change. The term "structural" refers to long-term and systematic rather than short-term and temporary. Although not only the fault of more frequent weather disasters disturbing agricultural production, it is becoming more difficult to respond immediately to expanding demand due to restricted cultivation areas, congestion of production technology, and insufficient water resources. In addition, uncertainty in the financial market is steadily attracting speculative capital into the commodities market. If these macroeconomic changes settle into society as a structural problem, the international grain market will be more complicated and unstable for the long term.

This recent agflation is an unprecedented event in which various factors are at work. However, far from accidental, it is the byproduct of an ill-conceived energy policy, irresponsible food policy, and climate change. It is necessary to recognize the magnitude of the problem and accurately analyze the cause, at the same time making efforts to build a world-wide cooperation system. Above all, the government and the people must precisely understand the food problem. The issue of food should not be treated as an average situation but as a crisis demanding implementation of a safety-first principle that will protect food security in a worst-case scenario.

Unification will intensify the importance of the food issue and the difficulty of solving the problem. It is obvious that food security will become the most pressing economic issue in post-unification Korea.

Detailed Comments

- It is difficult to predict the North Korean food supply and demand since it relies on various assumptions. The prediction of total food demand based on minimum calorie intake and outlook by usage is considered appropriate.
  - It is necessary to set a clear definition and reasonable scope of food requirements.
  - There is a lack of consistency across the peninsula since the food in North Korea is composed of rice, wheat, maize, and other, while South Korea produces rice, barley, wheat, maize, soybeans, and root and tuber crops.

- The assumption on the outlook of production yield is unclear.
  - Lack of grounds for an increase in yield 6 years after unification.
  - It is unclear how the year 2017 was calculated.

- A scenario on the point of unification is needed.
  - Grounds for the assumption of unification in 2015 are required.
  - Analysis of the scenario for 2020 is needed.

- Unrealistic North Korean Self-sufficiency
  - It is considered far from reality for North Korea to have 88% self-sufficiency in 2015 and 81% in 2025.

- In this regard, the prediction of self-sufficiency after unification is considered impractical.
  - 56% in 2015 and 55% in 2025

- Unrealistic estimation of the South Korean food demand by regression analysis
  - Population elasticity in demand function prediction: 3.5%
  - Therefore, the equation for demand is estimated to surge from 2015
  - The demand estimates in Figure 5 do not reflect current trends

- Certain institutions and policies must be adopted in order to increase self-sufficiency to prepare for food demand in a post-unification period.
  - It is necessary to adopt a cost-efficient food import system.
  - Systematic management of market risk is needed.

- It is important to adopt a modern distribution system.
  - It is necessary to have efficient pricing and provide a function for quickly discovering transparent prices.
  - It is necessary to determine production and demand according to price signals.
  - A study is needed to establish a public wholesale market and to adopt a modern distribution system in producing areas.

- It is necessary to adopt an early warning system for food security as soon as possible.
- It is urgent to adopt measures for short-term emergency warnings and supply and demand and mid- to long-term measures based on a reasonable and scientific food security index.

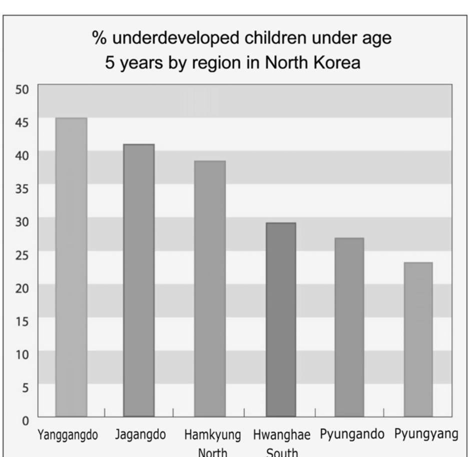
8.5. Kang Myeong-Ok

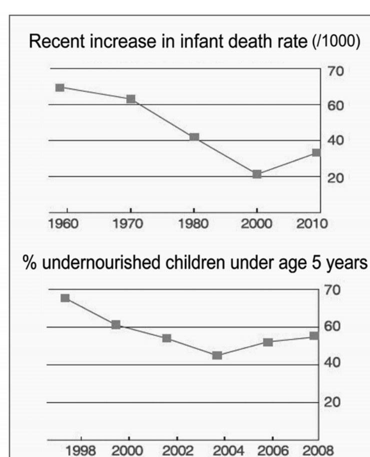
••• Secretary General, The Korean Association of People Sharing Love

This discussion holds great significance for the Korea Food Security Research Foundation, which establishes a foundation for policymaking on food to prepare for the era of national unification ahead of the event. North Korea suffered a march of hardship during which millions died from hunger due to failures in the food supply, followed by repeated famine since 1994. Even today, 3 million infants die of hunger and 8 million people face death by starvation, making the national future gloomy at best.

According to "The State the World's Children" by UNICEF, the death rate of North Koreans under the age of 5 was 120 per 1,000 in 1960, declined afterwards, and has been on the rise again since 1996 due to the food crisis. The "State of World Population 2009" released by UNFPA in November 2009 reported that North Korea ranked 133rd in terms of infant death rate. The malnutrition rate of North Korean children aged 5 and under averages 37%, and as much as 45% in Yanggang province. According to data released by the Humanitarian Information Unit of the US Department of Defense in December 2010, as much as 66% of children under 5 were underdeveloped due to malnutrition in 1998, 51% in 2000, and 43% in 2004. Secretary General Josette Sheeran of the UN World Food Program, who recently visited North Korea, visited South Korea specifically to describe the poverty in North Korea, emphasizing the serious condition that 35-40% of children in North Korea are malnourished. It is relevant to the strategy of unification that such a famine in North Korea is likely to cause many side effects after unification.

It is regarded as pressing and necessary for practical purposes to first conduct a study on the issues, including the food situation in North Korea, where there is structural uncertainty over food supply and demand. This paper may be considered a good example of a study, as it included overall fisheries and food industry rather than limiting itself to the grain sector. Hopefully the study will help form national consensus by suggesting practical measures based on robust research, as well as contribute to policy making.





A. Research on the Food Situation in North Korea

- Comparison of Food and Nutritional Statuses of North and South Korea
  - Nutritional Conditions of North Koreans and their Children
  - It is necessary to develop an alternative crop to maize, which currently accounts for most of the crop production.
  - It is necessary to conduct research on securing milk that contains the necessity nutrients for infants under the trend of increases in livestock in North Korea

B. Future Prospects on Food Supply and Demand after Unification

- Prediction of Food Supply and Demand in Post-Unification Korea
  - Harmonized supply and demand estimates and changes in production environment

- Food Supply and Demand Plan after Unification
  - Evaluation of coping capacity and practicality of alternatives

C. Alternative Proposal

- To establish a foundation for post-unification stabilization before unification
  1) Agriculture: farm plot sizing, seed improvement, special crops, advanced farming methods, irrigation projects.

2) Fisheries: seed shellfish, freezing system, fishing vessel modernization, distribution system.

3) Food: processing system.

8.6. Marc Simkins

••• Dean, Culinary-MBA Program, Woosong University

The opinions of this research on the current food situation in North Korea correctly point out the supply and capacity of North Korean agriculture. In practice, this status was confirmed in an interview with North Korean defectors or through phone calls with family members living in North Hamgyeong province. The situation is very serious in some cases. In rural areas, people earn a living in the form of bartering the produce cultivated on personally owned land in the local marketplaces, while the situation seems much worse in urban areas, which lack any individually cultivated land.

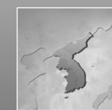
Food security will be the biggest problem after unification. However, in my opinion, based on personal assumptions, I have to wonder about the issue of Korean unification itself first. Most North Korean defectors express a preference for their relationship with China rather than a Korean unification. This may be because of the relationship of protecting and protected countries. While South Korea has hardly had contact with North Korea in supply or trade for the past 6 decades, China has continued to maintain a relationship with North Korea. The relationship is deeply rooted and everyone wants a business partnership with China with a guarantee of reliable progress in business. However, deep-rooted distrust is rampant regarding the relationship with South Korea. This is due to long-term brainwashing, but also stems from negative experiences with South Koreans in China.

The main point is the practicality of unification. The most concerning assumption is that the South Korean conglomerates will contact North Korea and attract investments. In this assumption, a significant amount of restrictions will entail under the current communist ideology and system. Also, since there are few personally-owned lands in North Korea, the important point is what kind of land reform should be established rather than whether or how South Korean companies will invest. Still, the North Korean refugees who went south during the war have argued for claims under the law on property that they owned before the war in North Korea, and the large conglomerates in South Korea are making attempts to buy land in North Korea as much as possible. This may serve as a motivation for the land owners living in North Korea that land purchase may be a source of income. Also, the newly developed agricultural zone is expected to eventually be owned or renovated by South Korean conglomerates. This would bring about a wealth transfer from South to North Korea, which could cause a hardly acceptable result morally or from the perspective of North Koreans. Therefore, plans or policies for land reform should be considered as a prerequisite for unification.

The figures and statistics of the North Korean fisheries and fishing capacity presented here are regarded as more or less correct. However, the difference is that this study overlooks the factor of China. China and North Korea have agreed to several fishery treaties, and North Korea is guaranteeing China access to its fisheries industry. Most of the fishery agreements are in the form of long-term leases and are approved by the International Maritime Act. Under this situation, it is necessary to ask what would happen if South Korea unilaterally canceled or changed the fisheries agreements after unification? How would China react, and what kind of action would China take to protect its fishing rights in North Korean waters, which play an important role in China's fishery supply? This and similar scenarios must be considered and prepared for before any action is taken toward unification.

The relative food production and processing systems of North and South Korea are well understood. The idea based on the comparison of the two systems is that South Korea will assist North Korea for the short term after unification and develop food security for the long term. In terms of food security, South Korea has self-sufficiency in rice only. In this regard, should South Korea legitimize unification with a poor country? The potential damage to food and political security after unification must also be considered.

In conclusion, first, as mentioned above, I am skeptical of Korean unification. Along with more than a 60-year gap between North and South Koreans, other political and economic factors are likely to hamper the possibility of unification. Second, I have doubts about South Korea's political and economic will and effort to achieve food security. Unfortunately, the responsibility of food security management may be compromised by having to yield to China's influence in future challenges, and political will is believed to be the most important, based on years of discussions with North Korean defectors.



09 Policy Recommendations

In preparation for unification, it is necessary to establish an overall Korean food policy. Currently, there are no such food policies to prepare for Korean unification. In response to the emergency food shortages which might occur in the early stages of unification and in several potential situations afterwards, it is necessary to create detailed scenarios and come up with the specific measures for each. In addition, to minimize the food procurement costs after unification, the South must seek measures to address the North Korean food issue before unification. Korean unification should become an opportunity to resolve South Korea's issue of high dependency on foreign food and excessive consumption, and North Korea's issue of food shortage and death by starvation.

9.1. Prepare for Food Shortages in the Early Stages of Unification

Assuming unification will be achieved in 2015, the grain production of both Koreas at the point of unification is estimated to be 12.73 million tons, with grain demand at 29.02 million tons, leaving 16.23 million tons of grain in shortage. Even after considering the

South Korean import volume of grain annually as 15 million tons, more than 1 million tons of additional grains would have to be imported after unification. For 10 years after unification the dietary life of the North Koreans is expected to improve, along with a surge in food demand. Agricultural productivity would also go up, such that North-South Korean grain production would grow to an estimated 13.18 million tons; but with demand reaching 31.87 million tons, the shortage would come to approximately 17.24 million tons. Without innovative food production increase polices, Korea would have to import more than 2 million tons of additional grain annually even after 10 years of unification.

9.2. Maintain Rice Production and Self-sufficiency in Rice

The production of the staple food, rice, should be increased to reach full self-sufficiency. To that end, South Korea must maintain its current rice production system and preserve its paddies. North Korea should establish a self-production system for rice primarily by focusing on raising rice productivity. The total rice production goal of post-unification Korea can be set at 7.249 million tons by maintaining the South Korean rice yield of 5.10 tons/ha and increasing rice cultivation areas to 955,000 ha to produce 4.775 million tons of rice. North Korea should increase rice productivity to 4.34 tons/ha (85% of the South Korean level) in order to produce 2.474 million tons.

9.3. Increase Soybean Production and Achieve Self-sufficiency in Soybeans for Food Use

The Koreas must increase self-sufficiency in soybeans for food use. To secure the cultivation areas for self-sufficiency in food-use soybeans, it is necessary to convert 300,000 ha out of 503,000 ha of maize cultivation areas in North Korea to soybean production and to convert 300,000 ha of terraced farm fields into forest. The North must set a soybean production goal of more than 625,000 tons, increase the current soybean cultivation area of 161,000 ha to 460,000 ha, and enhance the soybean productivity from 1.16 tons/ha to 1.65 tons/ha. High-yield varieties of soybean for making soybean paste, tofu, and soybean sprouts must be developed, and labor-saving mechanization, scaled-up production technology, and improvements in irrigation facilities must be achieved for reliable soybean production.

9.4. Rationalize Animal Husbandry and Increase Self-sufficiency in Rough Feed

Self-sufficiency in rough feed is required in order to reduce dependency on concentrated fodder from overseas. As South Korea is almost entirely dependent on foreign grains for feed, its self-sufficiency in grain is only 26%. Even rough feed for livestock is imported. The solution is to turn part of the maize fields in North Korea into quality feed crop production, including maize, and establish an economic and eco-friendly grazing system by creating pasture land in the northern mountainous areas.

9.5. Vitalize Offshore Fisheries by Developing Marine Resources and Modernizing Marine Technology

North Korea is pushing ahead with exporting fishery products to earn foreign money. While North Korea exports 120,000 tons of fishery products annually out of 260,000 tons of average catch (2003-2005), South Korea imports 850,000 tons of fishery products. As staple fish, including pollack, are moving northward under global warming, the unification of Korea will contribute to securing marine resources and expanding the amount of available fishing area. Since fishery products as a food resource account for 20% of the total supply of protein in the Korean diet, the development of marine resources and modernization of marine technology must be promoted, especially from a food security point of view. In-depth research into how to adjust fishing agreements reached between North and South Korea and neighboring countries must be conducted before unification.

9.6. Establish a Regional Specialization Plan to Connect Agro-fisheries to the Processing Industry

A plan must be established to develop the food processing industry in ports and production areas in North Korea in a similar way to the South Korean processing complex in terms of transport harbors for sugar, wheat, and maize and an ongoing food cluster plan for agricultural product processing. Detailed research is required on the current status and development potential of the food industry in ports such as Nampo, Sinhuiju, Najin-Sonbong, and Heungnam. A close monitoring of processing factories in North Korea such as grain processing factories and food service facilities is needed, and research on production technology, distribution and sales, and the method of applying business know-how is required in advance in order to prepare for implementing a plan to establish infrastructure such as supply and demand of electricity, workforce, and technical training, with the aim of invigorating the North Korean food industry.

9.7. Secure Food through North-South Cooperation Projects before Unification

It is necessary to establish special agricultural zones, special fishery zones, and special food industry zones patterned after the Kaesong Industrial Complex. Special zones for North-South cooperation in agriculture, fisheries, and the food processing industry will alleviate the food issues of a unified Korea. They will contribute to addressing North Korean food problems before unification and serve as food bases from which to prepare for unification. The special agro-fishery zones will transfer agricultural and fishing technology to North Korea and gradually improve yield, easing the shock of a potential sudden food crisis after unification. In addition, the cooperation projects will allow South Korea to evaluate the potential of the agro-fisheries industry of North Korea and reasonably establish plans for necessary goods and financial resources toward establishing production infrastructure.

9.8. Take Unification as an Opportunity to Improve the Food and Nutritional Status of Koreans

Korean unification should serve as an opportunity for Koreans to become one nation again and to become a role model country to the world before considering political issues. To that end, many current problems in society should be improved before unification. Unification must play a role in relieving the pervasive degenerative diseases resulting from excessive consumption in the South and in providing enough food and the proper amount of nutrition to citizens on the verge of starvation in the North. It is necessary to suggest a reasonable and optimal food and nutrition model for Koreans by analyzing and evaluating each surplus and deficiency issue in North and South Korea. According to the data in this report, it is desirable to set the optimal food intake of Koreans to the level of intake in the 1980s in South Korea. Under this standard, it is desirable that the South Koreans increase rice consumption 2 times, reduce animal food consumption to half the current level, and reduce food intake by 25%, to 1 kg per person per day.

About the Authors

About the Authors

Lee, Cherl-Ho

BS in Food Science, Department of Agricultural Chemistry, Korea University
PhD, The Royal Veterinary and Agricultural University, Denmark
Postdoctoral Research Associate, The Massachusetts Institute of Technology, USA
Professor, Department of Food Technology, Korea University
Fellow, The Korean Academy of Science and Technology
Fellow, Institute of Food Technologists (IFT), USA
Emeritus Professor, Korea University
Chairman, Korea Food Security Research Foundation

Moon, Huhn-Pal

BS and MS in Crop Science, Seoul National University
PhD in Genetics, University of California, Davis, USA
Vice Administrator, Rural Development Administration
Director General, National Institute of Crop Science, RDA
President, Korean Breeding Society; President, SABRAO
President, Korean Society of North Korean Agriculture Research
President, Northern Agricultural Research Institute, Inc.
Chief Executive, Korean Seed Forum, Inc.
Fellow, The Korean Academy of Science and Technology

Kim, Yong-Taek

BS and MS in Agricultural Economy, Seoul National University, Korea
PhD in Agricultural Economy, Michigan State University, USA
Principal Researcher, Korea Rural Economy Institute
President, Korean Agricultural Economic Association
Director, Agricultural Research & Development Promotion Center

About the Authors

Kim, Se-Kwon

MS in Food Science and Technology, National Fisheries University of Pusan
PhD in Marine Biochemistry and Marine Biotechnology, University of Pusan
Professor, Department of Chemistry, Pukyong National University
President, Korean Society for Chitin and Chitosan
President, Korean Society of Marine Biotechnology
Fellow, The Korean Academy of Science and Technology
Director, Marine Bioprocess Research Center

Park, Tae-Kyun

BA and MA, College of Veterinary Medicine, Seoul National University, Korea
PhD in Veterinary Public Health, Seoul National University, Korea
Reporter, *The Kyunghyang Shinmun*
Researcher, Georgia University, USA
Chief Editor, *The Joongang Daily*

Kwon, Ik Boo

BA, Busan National University, Korea
MA, Yonsei University, Korea
PhD, Kwangwoon National University, Korea
Director, Lotte Group Central R&D
CEO, Lotte Group Central R&D, Korea
Deliberation Committee on Food Additives/Hygiene, Korea FDA
Chairperson, ILSI Korea BOT., Industry Representative of ILSI

Editor's Note

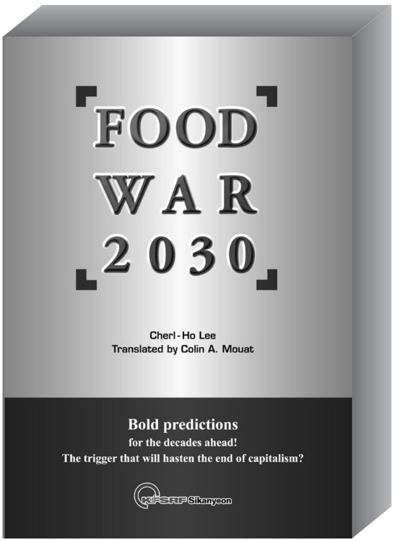
Diana Evans

As a lover of Korean poetry and art, I have been offered a glimpse into a very different field with Cherl-Ho Lee's work on food security on the Korean peninsula. I have often heard personal opinions on whether or not people hope for unification of the two Koreas, but Lee's work offers a practical guide to preparations that the governments of North and South Korea would do well to undertake in advance of such an event. It is instructive to consider Lee's researched, point-by-point suggestions for each of the different food production industries in the Koreas which, if implemented, would help avoid the kind of economic hardships experienced by East and West Germany upon their sudden and unexpected unification.

While editing Lee's book, which initially was translated by non-native English speakers, I encountered cultural differences of language with which I am familiar, having lived in Korea and being a native of the US, such as the order of the words north and south when written together. The perspective of South Koreans is to see North Korea from their vantage point, thus resulting in the linguistic usage of the phrase "south and north," whereas English-speaking North Americans see the rest of our continent as south of us, and so we say "north and south." There is one part of the text with which I struggled, that of regression analysis and its accompanying mathematical equations and jargon; I credit my husband, who is an economist, for rendering that segment of text appropriately in English.

March 2015

FOOD WAR 2030



Cherl-Ho Lee
Translated by Colin A. Mouat
241 pages | US $ 20
ISBN 978-89-967826-4-3

- hastening the collapse of capitalism.

For the past half-century, the history of the world has been a desperate attempt to satisfy the wants of the haves in the name of globalization, free trade, and economic development. Based on the theory of comparative advantage, Western capitalism has sought to subordinate the countries of the world into a division of labor, and the developing countries that neglected their own food production prior to WTO trade liberalization now face a situation of crisis amid fluctuating grain prices. "Food" is a byword for the momentous changes that will be shaking the world in the very near future. The food war has been a long time coming, and it is already under way. Based on the insights and knowledge gleaned from more than four decades of research in food science, the author presents a picture of the future that now awaits our world.

contents

KFSRF Sikanyeon

109A Life Science Bld.(East), Korea University, 145 Anamro, Sungbukku, Seoul, 136-713 Republic of Korea
T. +82-2-929-2751, F. +82-2-927-5201, E-mail. foodsecurity@foodsecurity.or.kr