

Assessing the Food Situation in North Korea*

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Introduction

Increased severity of food shortages in North Korea in recent years has been unmistakable. Perhaps the most revealing incident to those familiar with the region was North Korea's willingness to accept food aid from South Korea after similar offers in the past had been routinely ignored. Under an inter-Korean accord on emergency rice aid reached in Beijing on June 21, 1995, South Korea made a rice loan of 150,000 tons to North Korea to alleviate food shortages, on highly concessional terms. Such large-scale food assistance from South Korea was unprecedented. The Japanese food agency also supplied 427,000 tons of emergency rice to North Korea, as of December 1996. Further grain shipments to North Korea from South Korea, the United States and other nations, and international organizations have been pledged. In the spring of 1997, the head of the World Food Program of the United Nations traveled to North Korea and urged further assistance.

While international attention to North Korea's food situation is relatively recent, food shortages in North Korea are not new. A variety of evidence suggests that North Korea has had a precarious food situation for several years. Many factors seem to have contributed to reduced food supply in North Korea. The disintegration of Eastern Europe and the former Soviet Union disrupted the supplies of agricultural inputs such as fuel, mechanical parts, and chemicals. Further, the cold front that affected the Korean peninsula in the early 1990s damaged crops, and wet weather caused pest problems. Food concerns reached a more serious stage when the floods in the summer of 1995 destroyed crops and cropland across the country. Additional agronomic problems in 1996 made it clear that North Korea's production concerns are now chronic. A lack of

established food import sources meant that declines in domestic production became domestic consumption shortages.

With increasing media attention, there have been efforts to assess the urgency of the immediate North Korean food situation.¹ Although there is now a general recognition of food shortages in North Korea, the extent and severity is difficult to assess, in part because the North Korean government makes little data available to independent analysts. As a result, little is known about North Korea's food production and consumption, even during the normal periods. In the absence of reliable official statistics, in this article we assess North Korea's grain consumption and production. We use a variety of indirect indicators, circumstantial evidence, and inferences. Normal consumption is estimated using information on typical daily rations and data on the population distribution across location and occupation. The estimate of normal production uses information on North Korea's crop areas and yield data from experiments conducted in South Korea to simulate North Korean conditions.

As in many less developed economies, food consumption in North Korea is directly related to the availability of grain, which is a main source of staple food. This article focuses on the consumption and production of rice and corn. These two types of grains represent a significant portion of staple food and grain production in North Korea. Planting and harvesting of these two grains in North Korea is tightly controlled by the government, and official grain rations consist of only these two types.²

An assessment of the food situation in North Korea is important for several reasons. First, for purely humanitarian reasons it is important to better understand the long-term nature of food problems in North Korea. Is the recent demand for aid expected to be a regular occurrence? Second, for the world grain trade, it is useful to know if North Korea is likely to become a regular customer through foreign aid or commercial sales. Finally, North Korea may be vulnerable to political instability or even military action prompted in part by food shortages. If such shortages are chronic, then without policy restructuring, North Korea may be the source of substantial security concerns for the region, and indeed for the world.

We do not attempt to measure the severity of the food shortages in 1995–97. Our purpose instead is to assess the longer-term food situation in North Korea. To do so, we estimate grain production and consumption for a "normal" year under current conditions of productivity and population. Our research provides an independent calculation that may be used to evaluate official figures. Our work may also provide a baseline on which the estimates of short-term impacts of fluctuations may be built.

The article proceeds as follows. First, we briefly summarize the institutional and historical background of agriculture in North Korea. Then, we estimate the normal consumption of food grain and feed grain

based on daily rations and per capita meat consumption projected from South Korean figures. The following section estimates the North Korean production of rice and corn. We use detailed information on crop areas, geographical conditions, and seed varieties. We then examine the food situation in North Korea within the context of its grain imports. The final section provides a summary and implications.

Background on North Korea's Economy and Agriculture

North Korea is a lower-middle-income country, with per capita income estimated between \$1,200 and \$2,000.³ Consistent with these income figures, farm households account for about 30% of the total population, down from about 75% in 1948.⁴ Among the countries with severe food shortages, North Korea has a relatively high income. Countries in Africa or South Asia with chronic food shortages generally have per capita incomes below \$1,000. Thus, even with considerable attention to agricultural production in the past, it seems clear that North Korea's food problems are due to policy choices by the government, not simply to a lack of national income.

One of the first acts of the North Korean government after being set up in 1946 was the Land Reform Act, which redistributed nearly 50% of total farmland from landowner classes to farmers.⁵ With the completion of land reform in 1953, the country's farm households were transformed into collective farms. The three stages of farmland collectivization were completed by 1958.⁶ The first was the labor cooperative stage, in which production tools were shared for member use; the second was the land cooperative stage, with the distribution of output based on the individual's share of private land ownership (quasi-socialist stage); and the final stage was the socialist cooperative stage that abolished all private ownership of land and tools. When the process was completed, each collective farm consisted of, on average, about 466 hectares of land with about 300 households.⁷ Even though the management system and size of collective farms have evolved over time, socialist farming constitutes the basic institutional structure of the agricultural sector in North Korea and it continues to the present day.

Of the total land area of 12 million hectares, about 14% of North Korea is arable land.⁸ Rice and corn continue to be the chief food grains produced and consumed in North Korea. Even though rice traditionally constitutes the major part of the diet, North Korea is less connected to rice cultivation than are neighboring South Korea or Japan because of both geography and weather. About 80% of the country is mountainous and, though North Korea is at the same latitude as the United States from New England to South Carolina, it is subject to more severe weather because it is exposed to cold winds from Siberia.⁹ As a result, the summer growing season is short and the possibility of cold snaps during the growing season is real.

Ensuring adequate food supply through the modernization of the rural sector has been one of the country's publicly stated policy goals since the early 1950s. Substantial investments were made in North Korean agriculture during the modernization period of the 1960s and 1970s. The government launched land expansion programs and initiated rural development plans that aimed to increase agricultural irrigation, chemicalization and mechanization, and electrification in rural areas.

Through the conversion of coastal areas and swamplands, total agricultural land grew about 16%, from 1.8 million hectares in 1946 to 2.1 million hectares in 1984; since then, it has leveled off.¹⁰ Irrigation and rural electrification projects were completed by the mid-1970s. Overall mechanization in agriculture also increased considerably. Fieldwork requiring intensive labor such as plowing, transplanting, and milling was fully mechanized by 1975. By 1976, the number of farm tractors had increased to eight times the level of 1963.¹¹ At the same time, North Korea increased fertilizer production by building new plants or rebuilding existing old facilities. From 1965 to 1980, fertilizer use increased from 337 kilograms to 1,000 kilograms per hectare.¹²

In the 1980s, investments in agriculture slowed, and the supplies of agricultural inputs were reduced.¹³ In particular, diminished trade and material support due to the disintegration of Eastern Europe and later the former Soviet Union affected the general economy and farm activities. The former Soviet Union was the major supplier of petroleum to North Korea, and the reduced imports of petroleum diminished the supplies of fuel and feedstock for petrochemical plants. Imported machinery parts were also lacking.¹⁴

Estimates of Grain Consumption

Grains are used for human food and animal feed. In our calculation of grain use in North Korea, estimates for food use are based on information on daily grain rations from the North Korean government; estimates for feed use are derived as the feed equivalent amounts from meat consumption.

Even though other grains are consumed in North Korea, this study considers only rice and corn.¹⁵ Food use includes both rice and corn, while feed use includes only corn. The total amount of rice and corn rationed is a reasonable estimate of normal grain consumption because rice and corn are the main staple sources, and all grain harvested is procured and distributed by government authorities.¹⁶

Rice and corn are rationed by the North Korean government according to a basic formula that varies by location and the recipient's age and occupation. Table 1 presents per capita daily rations as well as the proportions of rice and corn in rations for various population classes.¹⁷ In general, ration quantities are larger for adults, high-ranking government officials, and laborers with physically demanding work. Those in presti-

TABLE 1
RICE AND CORN PER CAPITA DAILY RATIIONS

OCCUPATION AND AGE GROUP	PER CAPITA DAILY RATION (grams)	RATIO OF RICE TO CORN	
		Pyongyang Area	Other Areas
High-ranking government officials	700	10:0	10:0
Regular laborers	600	6:4	3:7
Heavy-labor workers	800	6:4	3:7
Office workers	600	6:4	3:7
Special security	800	7:3	7:3
Military	700	6:4	3:7
College students	600	6:4	3:7
Secondary school students	500	6:4	3:7
Primary school students	400	6:4	3:7
Preschool students	300	6:4	3:7
Children under 3 years	100–200*	6:4	3:7
Aged and disabled	300	6:4	3:7

SOURCE.—Ministry of National Unification.

* For this category, the average value of 150 was used in the calculation of total rations in table 3.

gious groups, such as high-ranking government officials, the special security force, or Pyongyang (the capital city of North Korea) residents, receive higher proportions of rice in their rations.¹⁸

To arrive at the amount of total grain rations for the whole country, we used population data compiled by the Korea Development Institute (KDI).¹⁹ However, population data obtained from KDI were not complete for our purpose. For example, KDI data provided only the combined population for regular and heavy laborers, even though these two laborer classes receive different amounts of rations. Thus, where population data are incomplete, we assumed an equal distribution between population classes (numbers in brackets in table 2 are constructed under these assumptions), except for the military population. The entire military population was assumed to reside outside Pyongyang.

The amount of total daily grain rations is computed by multiplying per capita daily rations (table 1) by the matching population numbers (table 2) for each population class and summing rations over population classes. The conversion into annual figures yields annual direct food grain consumption of about 1.6 million metric tons of rice and 2.8 million metric tons of corn (table 3).

Additional grain in North Korea is consumed in the form of meat. Feed grain consumption is derived from meat consumption. Unfortunately, little is known about North Korean meat consumption. As an approximation, South Korean per capita meat consumption in 1960, 7 kilograms, is used as a best approximation for current average meat

TABLE 2
POPULATION DISTRIBUTION BY OCCUPATION AND RESIDENTIAL LOCATION

Occupation and Age Group	All Areas (in Thousands)	Pyongyang Area	Rest of Areas
High-ranking government officials*	4.8	...	...
Regular and heavy laborers†	9,810.9	1,595.9	8,214.9
Regular	...	[797.95]	[4,207.45]
Heavy work	...	[797.95]	[4,207.45]
Office workers	1,976.3	321.5	1,654.9
Military and special security forces‡	1,206.6	...	...
Military	[603.3]	...	[603.3]
Special security	[603.3]	...	...
College students	591.7	96.3	495.5
Secondary school students	2,182.5	355.0	1,827.4
Primary school students	2,397.5	390.0	2,007.5
Children under 6 years	1,270.6	206.7	1,063.9
Children under 3 years	1,866.0	303.5	1,562.4
Aged and disabled	104.9	17.1	87.8
Total	21,411.8		

SOURCE.—Korea Development Institute, 1991.

NOTE.—We constructed the numbers in brackets under assumptions on the population distribution.

* Original data do not contain population information separately on the two geographic areas.

† Original data do not contain population information separately on these two types of labor workers. We assumed a uniform distribution of regular and heavy laborers across locations.

‡ Information is available neither by area nor by occupation. We assume that the population is distributed equally between occupations, and that the military population is stationed outside Pyongyang (no assumptions on location are needed for special security forces because there is no discrimination in rations against residents of non-Pyongyang areas).

consumption in North Korea.²⁰ Applying 7 kilograms to North Korea's population of 21.4 million, we arrived at a total meat consumption of 149,800 metric tons. Using a conversion ratio of 3.9 kilograms of grain per kilogram of meat,²¹ we obtain 584,220 metric tons of feed grain that are required to produce 149,800 tons of meat.²²

In addition to annual food and feed consumption figures, table 3 presents data on other uses of grain, including seeds, processing, and losses during handling and storage. The amount of other uses was estimated as a constant proportion of food and feed consumption, with the proportions obtained from South Korean grain data for 1960 (see table 3). However, given that the portion of consumption that is supported by imports does not require grain reserved for seed use, we developed a range of total grain use, with and without other uses. The resulting total grain use ranges from 4,985 thousand tons (food and feed) to 5,720 thousand tons (food and feed plus other uses) depending on the role of imports.

TABLE 3
ESTIMATES OF ANNUAL RICE AND CORN REQUIREMENTS TO MEET SPECIFIC CONSUMPTION RATIOS

	FOOD* FOOD AND FEED†	FEED	OTHER USES		FOOD AND FEED PLUS OTHER USE‡
			Seed Plus Processing\$	Loss\$	
For the country (1,000 metric tons):					
Rice	1,590||	...	95	64	1,749
Corn	2,811#	584	497	79	3,395
Rice and corn	4,401	584	592	143	5,720
Per capita (kg):					
Rice	74.3	...	...	...	81.7
Corn	131.3	27.3	...	...	185.5
Rice and corn	205.6	27.3	...	...	267.3

SOURCE.—Based on data in tables 1 and 2.

* The quantity for food is the total amount of rations that is the sum of rations over all population classes. The total ration for each population class is calculated using data in tables 1 and 2 as the multiplication of the per capita daily ration, the ratio of rice in the ration, and the population for the region. For example, the quantity of rice for office workers is calculated as the sum of rationed amounts for Pyongyang and other area residents: $[600 \text{ g} \times (6/10) \times 1,976.3] + [600 \text{ g} \times (3/10) \times 321.5]$.

† The food and feed consumption provides the lower end of the consumption range.

‡ The food and feed plus other use provides the upper end of the consumption range.

§ The numbers for the seed plus processing and loss (weight loss or decay) categories were constructed based on the situation of South Korea in 1960: for rice, 6% for seed plus processing and 4% for disappearance; and for corn, 14.5% seed plus processing and 2.3% disappearance. These ratios are obtained from *Food Demand and Supply Statistics* (Seoul: Korean Rural Economic Institute, 1980).

|| The annual figure is based on the amount of daily rice rations for the whole population: 4,357,458 kg.

The annual figure is based on the amount of daily corn rations for the whole population: 7,702,067 kg.

TABLE 4
RICE AND CORN AREA BY REGION

REGION*	RICE			CORN		
	Paddy Land (Ha)	Rice Variety	Experimental Yield/Ha (Metric Tons)	Nonpaddy Land (Ha)	% of Corn Area	Corn Area (Ha)
1	8,309	Sunbong #9	3.21	116,152	50	58,076
2	22,826	Sunbong #9	3.21	125,531	68	85,343
3	10,554	Sunbong #9	3.21	46,513	72	33,489
4	11,620	Pyungbuk #3	5.25	51,399	58	39,578
5	79,124	Yeumju #4	4.78	211,904	77	141,976
6	25,446	Sunbong #9	3.21	79,783	69	55,002
7	21,544	Yeumju #4	4.72	62,389	69	43,285
8	74,215	Pyungyang #15	4.77	118,172	68	80,357
9	346,362	Pyungyang #15	4.77	188,157	60	112,894
Total	600,000	Weighted average	4.60	1,000,000	65	650,000

SOURCE.—MAFF and Ministry of National Unification.

* Region 1: Gehma highland area; Region 2: northern part of east coast area; Region 3: northern mountainous area; Region 4: northwestern mountainous area; Region 5: central part of the east coast; Region 6: central east mountainous region; Region 7: central inland mountainous region; Region 8: central west mountainous region; Region 9: west coast area.

North Korean Diet in Comparison with Other Countries

To have some indication of the adequacy of food consumption in North Korea, we examine per capita consumption compared with other countries. The adequacy of the staple diet depends on the extent of the consumption of supplementary food. However, with no knowledge of North Koreans' supplementary diet, the comparison with other countries in their staple food diets may give some insight into this issue. Most low-income countries' consumption of staple food (in terms of grain use) is less than North Korea's 205 kilograms per capita.²³ Among 63 countries that needed food aid in the past decade, North Korea would have been the second largest staple food consuming country on a per capita basis (just below Niger). Among Asian countries, Afghanistan consumes a similar amount of grain, 202 kilograms per capita.

Poor countries vary in the share of grain in the overall diet, depending on the country's dietary culture. For example, on a caloric basis, the grain share ranges from Zaire's 17% (with per capita grain consumption of 33 kilograms) to Bangladesh's 83% (with per capita grain consumption of 164 kilograms). This indicates that a country's dietary culture may be an important component in its dietary formation, and a low quantity of per capita grain consumption in a low-income country may not necessarily reflect a deficiency of food. To gain insight into North Korea's dietary culture, we use the South Korean data and investigate

the dietary pattern of the late 1960s because the per capita grain consumption of the north (shown in table 3) is quite similar to that of the south in the late 1960s.²⁴ During this period, the grain share in South Koreans' diet was 87% on average on a caloric basis.²⁵ A grain share of 87% would place North Korea as the highest grain share among the 63 countries that needed food aid in 1995, followed by Bangladesh's 83% (at per capita consumption of 164 kilograms) and Nepal's 80% (at per capita consumption of 190 kilograms).²⁶

It is important to keep in mind that North Koreans' staple food examined in our comparison was based on the food rations designed by the government. That is, these rations are what the North Korean government considers normal. The food rations may be subject to changes depending on North Korea's economic and grain reserve situations.²⁷ In this regard, our study could be viewed as providing a baseline and does not reflect the current situation distressed by the recent years of floods.

Estimates of Production

Cropland in North Korea is grouped into nine agricultural regions based on terrain and weather patterns. Table 4 presents rice and corn areas in each region. Rice and corn account for almost 80% of total cropland in North Korea. Based on these areas, we estimate rice and corn production for the country as a whole.

Rice Production

Rice is the preferred staple grain in North Korea, but North Korea's mountainous terrain and climate are not well suited for rice production. The North Korean government devoted considerable effort to developing rice varieties that are adapted to the country's climate. This resulted in a number of rice varieties that are now widely cultivated, and we obtained information from the Ministry of Agriculture, Forestry, and Fisheries of South Korea (MAFF) on the rice variety that is most widely planted in each region (for planted area by region, see table 4).

For each variety, MAFF established yield data from 3-year experiments. Our estimates of North Korean output are based on the 3-year average yield from the MAFF's experimental data. These experimental yields are presented in table 5.²⁸ However, as it is likely that experimental plots receive more attention and expertise in farming practices than those provided by an average farmer, experimental yields tend to be higher than the yields on average farms. To correct the likely overstatement in experimental rice yield, we allowed two adjustments based on past experience in South Korea. We use yield adjustments of -7.5% and -29% from the experimental yields to represent North Korean yields.²⁹ The total rice production figures consistent with the 7.5% and 29% scenarios are presented in table 5.

TABLE 5
RICE AND CORN PRODUCTION ESTIMATES BASED ON ADJUSTMENTS FOR FARM VS. EXPERIMENTAL YIELDS
AND INSTITUTIONAL INEFFICIENCY (1,000 Metric Tons)

BASE AND ADJUSTMENTS	GRAIN PRODUCTION				
	Rice		Corn		Total
	Low	High	Low	High	
Base production*					6,154
Adjustment for:					
Farm vs. experimental yields†	1,961 (-29%)	2,555 (-7.5%)	3,393	5,354 (-29%)	5,948 (-7.5%)
Institutional inefficiency‡	1,635 (-16.6%)	2,131 (-16.6%)	2,830 (-16.6%)	4,465 (-16.6%)	4,961 (-16.6%)

SOURCE.—Based on table 4.

* Base production is (experimental yields × rice planted area) for rice and (5.22 MT × corn planted area) for corn.

† As explained in the text, the adjustments for rice to convert experimental yield to farm yield use two reduction scenarios, 29% (low production) and 7.5% (high production).

‡ As explained in the text, yield loss due to institutional inefficiency is estimated to be 16.6%.

Corn Production

Corn land accounts for about 65% of North Korea's nonpaddy cropland. The north's terrain, rainfall, and climate provide good conditions for corn production, with relatively high yields of corn compared with other crop production. North Korea's hybrid corn varieties also contribute to a relatively high corn yield.

To reflect North Korea's high corn yield, in our estimation we used the average of two yields: South Korea's 3-year average (1991–93) corn yield, 4,140 kilograms per hectare, and a Chinese 3-year average, 6,300 kilograms per hectare, from the yields in the Jilin province—the region located to the north of North Korea that is known for high corn yield in China. Applying the average of these two values, 5,220 kilograms per hectare, to the corn areas in North Korea, we obtained total corn production of 3,393,000 metric tons (table 5).

To arrive at the final production figures, we make corrections on our production figures in table 5 for institutional inefficiency. The adjustment for institutional inefficiency applies to both corn and rice production.

Accounting for Institutional Inefficiency

Studies analyzing prereform and postreform Chinese agriculture indicate that substantial productivity loss exists with collective farming systems compared with market-oriented systems.³⁰ North Korea's collective farming system probably suffers from similar productivity loss due to insufficient incentives for farmers. Our estimates for rice and corn production in the previous section are based on the yields of South Korea and postreform China. To adjust our production estimates to take account of productivity loss due to the collective farming system, we adopted the output loss figure from J. Lin's Chinese study.

Lin analyzed the effects of the structural change brought by the inception of the "household responsibility system" on the productivity of Chinese agriculture. The household responsibility system began to replace the collective farming system in 1978 and was completed in 1983. Under this reform, collectively owned land was assigned to individual households with contracts of up to 15 years, and individual households were rewarded according to their output. Lin's study shows that agricultural output increased 42.23% between 1978 and 1984—20% due to the system change and 22% due to other changes, such as increases in input use.³¹ The 20% growth based on 1978 output implies that assigning 1984 output with index 100 yields output index 83.4 for 1978. This implies that 16.6% of output was lost under the collective system (1978 index) compared with the market-oriented system (1984 index). Using -16.6% as an adjustment for a similar institutional inefficiency, our final production estimates are presented in table 5. Based on our best estimates of area and farm yields for both rice and corn, North Korea's total rice and corn production ranges between 4,465,000 and 4,961,000 metric tons.

TABLE 6
ESTIMATES OF GRAIN DEFICITS BASED ON ALTERNATIVE CONSUMPTION AND
PRODUCTION ESTIMATES (1,000 Metric Tons)

GRAIN	CONSUMPTION*		PRODUCTION		GRAIN DEFICIT† (Consumption Minus Production)	
	f&f (Low)	f&f+o (High)	Low	High	Low	High
	Rice	1,590	1,749	1,635	2,131	-541	114
Corn	3,395	3,971	2,830	2,830	565	1,141
Total	4,985	5,720	4,465	4,961	24	1,255

SOURCE.—Based on tables 3 and 4.

* The range for grain consumption is defined by food and feed (f&f) and food and feed plus other use (f&f+o).

† The range of grain deficit is defined by the low deficit that is the low consumption minus high production and the high deficit that is the high consumption minus low production. For example, -541 is calculated as 1,590 minus 2,131.

Food Shortages and Food Trade

Comparing our figures for consumption (table 3) to those for production (table 5), we may derive a range of estimates for the grain shortfall for each grain and in total (table 6). Consumption and production estimates indicate that North Korea's grain production in a normal year falls short of the total domestic grain rations by between 24,000 and 1,255,000 metric tons. Using the midpoints of our production and consumption estimation, 4,713,000 and 5,353,000 metric tons, the midpoint shortfall is 640,000 tons, which represents about 12% of midpoint grain consumption.³²

North Korea was a net grain importer of around 200 thousand tons until the mid-1980s (table 7). During this period, North Korea's grain imports consisted mostly of wheat, and the trade was mostly with Australia and the former Soviet Union. From the late 1980s, grain imports increased sharply, exceeding 1.3 million metric tons in 1993. The share of corn in its grain imports rose with the import quantity. In 1992 and 1993, corn imports accounted for over 60% of total grain imports. With a surge in corn imports, China emerged as North Korea's leading import supplier, becoming the sole supplier of corn from 1989 to 1994. However, there had been no grain trade with the former Soviet Union since its disintegration.

Implications

Our estimates indicate that the food deficit in North Korea in a normal year could be sizable (our median estimate is 12% of normal consumption) unless imports or grain reserves are used to fill the grain deficit. Import data show that North Korean grain imports surged in the early

TABLE 7
NORTH KOREA: ESTIMATED GRAIN AND FLOUR IMPORTS (in Tons)

	1975	1980	1985	1990	1991	1992	1993	1994	1995	1996
Rice:										
China	...	...	...	...	...	16	12,503	28,549	2,396	34,000
Hong Kong	...	...	...	800	...	...	...	...	...	...
South Korea	...	...	...	5,000	...	...	...	...	150,000	...
Thailand	...	...	...	51,594	...	10,000	100,000	...	177,000	75,000
Vietnam	...	...	...	103,606	...	...	...	...	...	67,000
Other	...	...	...	...	...	...	...	...	...	38,950
Corn:										
China	...	...	...	264,609	216,790	586,577	876,218	209,478	9,000	139,474*
Yugoslavia	...	...	...	...	...	...	...	...	...	...
Thailand	1,501	500	5,000	...	...	...	...	...	...	...
United States	...	...	...	...	...	...	...	...	85,500	...
Barley:										
Australia	10,800	...	...	...	...	...	...	...	...	...
China	...	...	...	...	...	200	276	100	976	...
Hong Kong	...	...	...	...	515	...	...	...	...	...
Syria	...	...	...	...	...	...	...	...	20,000	...
Wheat:										
Australia	...	208,884	12,600	188,201	203,963	63,000	...	...	83,000	...
Canada	...	...	...	454,988	...	...	293,135	...	...	...
China	...	...	...	1,230†	1,230†	60,341†	37,374†	8,966	...	239,655†
Hong Kong	...	...	...	...	198†	102†	147†	69†	...	...
India	...	...	...	...	145,668	...	...	...	...	14,000
Turkey	...	...	...	...	...	180,235	...	...	...	...
European Union	...	40†	...	71,781	...	...	...	...	33,000†	...
Soviet Union	212,162	200,000	...	...	...	...	...	...	...	...
Yugoslavia	...	...	...	...	75,012	...	...	...	...	...
Other	...	...	...	...	...	...	...	100,000†	...	120,000
Total‡	224,463	409,440	19,958	524,640	1,259,893	923,650	1,349,610	401,299	893,707	968,723

SOURCE.—The data prior to 1993 are from *Asia and Pacific Rim*, U.S. Department of Agriculture, Economic Research Service, Report no. WRS-94-6 (Washington, D.C., 1994). The data for the period 1993–96 are provided by John Dyck at USDA, who is also responsible for the construction of the data prior to 1993.

* Includes 40,508 tons of corn flour that is equivalent to 68,774 tons of corn.

† Measured in wheat flour. Multiplying by the factor of 1.37 yields the wheat equivalent amount.

‡ Also includes the small amount of miscellaneous grains and flours.

1990s, up to a point roughly equal to our projection of the maximum normal year grain deficit. This indicates that even before the 1995 flood, North Korea was experiencing considerable food shortfalls.

North Korea's food shortages do not reflect solely agricultural problems or the inability to be self-sufficient in food. North Korea's 88% self-sufficiency ratio (using the median estimate) for grain consumption in a normal year is high compared with neighboring countries such as South Korea or Japan, which rely on foreign supplies for more than half of their grain consumption. The recent disastrous weather worsened North Korea's food situation, but the country's basic problem is one of economic policy, not agriculture per se. Even the food shortfalls could be easily overcome by increased imports of grain. However, with a lack of foreign exchange and a policy that limits grain imports, there are reports suggesting that North Korea is in the midst of famine.³³

The most immediate issue faced by North Korea is keeping its people fed. To deal with this situation, its agricultural policy may be directed to increasing productivity. However, in order to improve food production, adaptation of the economic system based on international experience would be particularly useful, as China has led the way with respect to on-farm reforms.³⁴ Even more important than productivity growth on farms, however, may be a restructured trade policy that recognizes North Korea's position as a natural food importer.

Notes

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1. See, e.g., Woon Keun Kim, "Food Crisis in North Korea," *East Asian Review* 8 (1996): 57-73. Kim's article focuses on the recent food crisis in North Korea. He estimates that North Korea will need 2-2.4 million tons of grain in 1997 (under the scenario of minimum food consumption) to save people from starvation.

2. Potatoes were once a major source of food. However, the government expanded the production of high-yield corn varieties, and potatoes are now much less important.

3. Various per capita income figures are available. World Bank, *The Human Development Report 1993* (Oxford: Oxford University Press, 1993), reports \$2,000 for the period of 1985-88, and *The Encyclopedia of the Third World* (ed. George Thomas Kurian [New York: Facts on File, 1992]) reports \$1,240 (estimated as of 1989 in current U.S. dollars). It is generally acknowledged that economic growth since 1990 has been stagnant at best.

4. *Asia and Pacific Rim*, U.S. Department of Agriculture, Economic Research Service, Report no. WRS-94-6 (Washington, D.C., October 1994); *The Economic Statistics of North Korea, 1946-85* (in Korean) (Seoul: Ministry of National Unification, 1987).

5. According to *The Economic Statistics of North Korea, 1946-85*, out of

983,954 hectares taken by the government, 981,390 were redistributed. The major part of data in this publication is based on various issues of North Korean publications by the North Korean Statistics Agency, such as *The Yearbook of Chosun Central* and *The Yearbook of United Chosun* (Pyongyang: North Korean Statistics Agency).

6. Collective farms consist of cooperative farms and state farms. The majority of collective farms are cooperative farms, accounting for about 90% of agricultural land. State farms are run as industrial enterprises and, on average, are larger and more mechanized than cooperative farms.

7. *The Economic Statistics of North Korea, 1946–85*.

8. *Asia and Pacific Rim*.

9. *Encyclopedia of the Third World*.

10. *The Economic Statistics of North Korea, 1986* (Seoul: Ministry of National Unification, 1987).

11. *The Economic Statistics of North Korea, 1946–85*.

12. Fertilizer use of 1,000 kilograms is measured in actual weight of the fertilizer.

13. For example, 10 fertilizer plants were constructed (including rebuilt plants) during the 1960s and 1970s, while in the 1980s only two fertilizer plants were initiated, but they were never completed. See Hy-Sang Lee, "Supply and Demand for Grains in North Korea," *Korea and World Affairs* 18 (Fall 1994): 509–52; and *Comprehensive Statistics on North Korea, 1983–93* (in Korean) (Seoul: Research Institute for North Korean Studies, 1994).

14. Woon Keun Kim, *Estimating North Korea's Grain Production* (in Korean) (Seoul: Korean Rural Economic Institute [M37], 1994); and Woon Keun Kim, Seokun Choi, and Hyungmo Kim, *Trade of Agricultural Goods and Regional Cooperation between North and South Korea* (in Korean), Report no. R309 (Seoul: Korean Rural Economic Institute, 1994).

15. Substantial imports of wheat (see table 7) indicate that wheat was used to supplement North Koreans' daily staple food. In this study, wheat is not included in staple grain consumption because of the wide yearly fluctuations of wheat imports.

16. In North Korea, some small plots of land are allowed to be cultivated noncollectively. Crops produced from this privately cultivated land can be made available for private use. However, this private use excludes production of grains.

17. *Economic Situations of North Korea* (in Korean) (Seoul: Eulyou Publishing Co., 1990); and *Social and Cultural Comparisons of the North and South* (in Korean) (Seoul: Ministry of National Unification, 1983).

18. In his recent publication, W. K. Kim reports more detailed ration information (see Kim, "Food Crisis in North Korea" [n. 1 above]). The updated information includes three more population categories than are reported in table 1. These three are farmers, athletes, and miners, and they are rationed with 800, 800, and 900 kilograms, respectively. Even though some details may vary, North Korea has maintained the general standard of daily rations of 700–800 kilograms for an adult and 300 kilograms for a child (see Lee; and Robert A. Scalapino and Chong-sik Lee, *Communism in Korea, Part 2: The Society* [Berkeley: University of California Press, 1972]). However, the ratio of rice to corn varies depending on the country's grain reserve situation. Currently, this ratio dropped as low as 1:9 in provinces remote from Pyongyang.

19. The Korea Development Institute constructed the population data based on the 1989 report to the United Nations by the North Korean Statistics Agency. This report was provided to receive aid from the United Nations population funds.

20. The choice of the year 1960 as our reference period, even though per capita income in North Korea is comparable to that of South Korea in the early 1970s, reflects the fact that meat consumption is relatively income elastic in a market economy, but in a planned economy, consumption of income-elastic goods is known to lag behind that in a market economy with comparable income. We recognize that the former Soviet Union provided excess meat consumption relative to market economies with similar incomes. However, this seems very unlikely in Asia, and there is a general impression in the popular media that meat consumption in North Korea is uncommon. We chose the year 1960 because it was the year before South Korea's economic development plans were initiated.

21. Although the feed conversion figure normally used in South Korea is 7.8, this study used the conservative figure of 3.9. Unlike South Korea, corn in North Korea is also used as a major food grain, and North Korea is deficient in food grains. North Korean meat producers probably substitute feedstuff that is not fit for human consumption for compound feeds, and this unaccounted portion of feed is likely to lower the quantity of grain per unit of meat. To reflect this situation, we chose to use the conversion rate, 3.9, that is half of the rate for South Korea. A similar conversion rate is used in Carter and Zhong's study of China in 1991 (see Colin A. Carter and Fu-Ning Zhong, "China's Past and Future Role in the Grain Trade," *Economic Development and Cultural Change* 39 [1991]: 791–814). Their study used a conversion rate of 4.0 to estimate the consumption of feedgrain to account for the fact that the backyard operation of livestock production is common in China, and farmers tend to feed scraps and other nongrain feedstuff to hogs. See also Jikun Huang, Scott Rozelle, and Mark Rosegrant, "China's Food Economy to the Twenty-First Century: Supply, Demand, and Trade," Food, Agriculture, and the Environment Discussion Paper no. 19 (International Food Policy Research Institute, Washington, D.C., 1997).

22. For more information, see the notes in table 3.

23. *Food Aid Needs Assessment*, U.S. Department of Agriculture, Economic Research Service, Report no. GFA-7 (Washington, D.C., 1995). This publication summarizes total and per capita grain consumption for 63 countries for the period 1985–95.

24. Per capita food grain consumption in South Korea increased through the 1960s, and then declined as the nonstaple supplemental diet increased. Some periodic per capita food grain consumption figures in South Korea are 189 kilograms in 1965, 219 kilograms in 1970, 207 kilograms in 1975, and 159 kilograms in 1993 (*Major Statistics on Agriculture, Forestry, and Fisheries 1994* [in Korean] [Seoul: Ministry of Agriculture, Forestry, and Fisheries, 1994]).

25. See *The 1992 Data Book for Food Demand* (Seoul: Korean Rural Economic Institute, 1993). Grains were the main source for calorie intake, providing 2,052 calories out of a total 2,355 calories, during 1962–69. Such a high grain consumption rate in the overall diet is not uncommon in some other Asian countries. For example, Carter and Zhong also report in their 1991 study that the average person in China obtains over 90% of their caloric intake from grain.

26. See *Food Aid Needs Assessment*. From this we may conjecture that the daily caloric intake per person in North Korea is much higher than it is in Bangladesh and slightly lower than in Nepal. (Unfortunately, the USDA/ERS publication reports only per capita food use and share of grain in diet without total caloric figures. Thus, this comparison assumes the same mix of grains and uses the figures on caloric shares and per capita consumption.)

27. According to recent reports, North Korea's food shortage has grown intensely worse, and food rations have been substantially reduced (Nicholas D. Kristof, "U.N. Says North Korea Will Face Famine as Early as This Summer,"

New York Times [May 14, 1996]; Paul Homes, "North Korea Faces Bigger Food Crisis from Floods," *Reuters* [September 9, 1996].

28. In an effort to study their productivity, MAFF commenced experiments on these varieties in 1991 in South Korean fields. To reproduce the cold environment of North Korea, the area near the demilitarized zone and the high mountainous region in the northeastern part of South Korea were chosen for the experimental sites.

29. To estimate how much a regular experimental yield may overstate the actual field yield, we obtained annual experimental records from the experimental station of the Rural Development and Promotion Agency of the MAFF, and also obtained MAFF's data on area yields in the region closest to the experimental site. Experimental yields were higher than actual field yields by 29% in the 1970s (an average of 1971–80) and 7.5% in the 1980s (an average of 1981–90).

30. See Justin Yifu Lin, "Rural Reforms and Agricultural Growth in China," *American Economic Review* 82 (1992): 34–51; and John McMillan, John Whalley, and Lijing Zhu, "The Impact of China's Economic Reforms on Agricultural Productivity Growth," *Journal of Political Economy* 97 (1989): 781–807.

31. This decomposition is based on Lin's study, which showed that 46.89% of total productivity growth is attributable to the household responsibility system, 45.79% to input increases, and 7.32% to other factors. See Lin.

32. Our uppermost estimate (1.3 million tons) is similar to the 1.47 million tons that was reported by Homes as the grain imports needed by North Korea in 1996.

33. Kristof.

34. Lin; McMillan et al.

