Causes and Lessons of the "North Korean Food Crisis"

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1. Purpose

The purpose of this paper is to draw attention to the fragility of modern industrial (chemical- and fossil fuel-based) agricultural systems. If the timely supply of commercial inputs is disrupted, especially when this results in a shortage of energy (fossil resource) inputs over an extended period of time, agricultural systems are liable to catastrophic collapse, resulting in food shortages. The recent experience of the Democratic People's Republic of Korea (DPRK, North Korea) is examined in order to focus attention on the relevant aspects of this problem.

2. Background Elements of the Problem: Economic Development and Energy in the DPRK

2.1 The Development of the DPRK Economy Following WWII

The division of the Korean Peninsula following the Second World War resulted in around 65% of the heavy industrial capability and infrastructure in the North, but the majority of the population in the largely agrarian South.(1)

Table 1: Approximate Populations of DPRK and ROK in 1950 and 1999

	1950	1999
DPRK	9,471,000	21,386,000
ROK	20,846,000	47,026,000

Source: International Data Base (IDB) of the US Census Bureau (http://www.census.gov/ftp/pub/ipc/www/idbsum.html)

[*Recent DPRK population estimates are controversial. The value here is quoted as given by the IDB, but was announced officially by the DPRK government for the end of August 1999 as 22,554,000 (FAO, 1999/11, Section 4.2)*]

Following the suspension of hostilities and the armistice of July 1953, the DPRK was able to achieve rapid growth in output, mainly by mobilization of its labor force and through use of its substantial mineral resources and hydropower. Prewar levels of output were attained by around 1955 or 1956, and are thought to have doubled in the following six or seven years.(2) This rapid growth, achieved with the assistance of the USSR, Warsaw Pact Europe, and the People's Republic of China (PRC), averaged 12% per annum, but was mainly focussed on heavy industry and mining rather than on agriculture and light manufacturing.(3)

The 1960s' Sino-Soviet split resulted in economic problems for the DPRK. The USSR suspended aid to the DPRK when Pyongyang decided to align itself with the PRC in the dispute. Further, the manpower of the DPRK's armed forces are believed to have increased from about 300,000 in the early 1960s to around one million by the late 1970s. This was achieved through large increases in the share of economic output devoted to military readiness, thus diverting resources from the development of the civilian economy.(4)

In the 1970s, the DPRK began to turn toward Western markets in search of alternative sources of goods and capital, and by 1975 had contracted as much as $1.2 billion in hard currency loans for purchases of capital goods and grain from OECD countries. However, due to inability to operate plant efficiently and to produce goods of export quality (and a downturn in global demand brought on by the oil shocks of the 1970s) the DPRK fell into arrears on its debts. By 1980, this international debt had swollen to $5 billion, nearly $2 billion of which was owed to communist creditors. Trade with the Western industrialized nations collapsed, and the DPRK's refusal to make good on its loans poisoned trade relations with the Western nations. During this period, as much as 30% of the DPRK national budget was being appropriated for rapid expansion of the armed forces.(5)

The death of Leonid Brezhnev in 1982 gave the DPRK an opportunity to mend its ties with the USSR, resulting in substantial economic and military aid to the DPRK in the late 1980s. USSR subsidies to the DPRK economy in the 1985-1990 period are estimated to have exceeded $4 billion, and its military transfers to the DPRK to be something over $5 billion. By 1987, military personnel in the DPRK may have numbered around 1.25 million.(6)

By 1989, the per capita gross domestic product (GDP) of the DPRK is reported to have reached US$1,250. Agriculture, the manufacturing industry, and the service industry accounted for approximately 27-30% of GDP each, the remaining estimated 10% of GDP coming from utilities and construction.(7) The collapse of the Warsaw Pact and the USSR between 1989 and 1991 brought the stagnating DPRK economy to the brink of collapse. Roughly 60% of the DPRK's trade was conducted with Warsaw Pact countries in the 1980s. The collapse of the Pact necessitated all trade to be settled in hard currency terms, thus forcing a collapse in the trade with the DPRK. It is estimated that total DPRK trade contracted by one-third to a half of its pre-1989 level.(8) It is also estimated that imports of arms from the USSR in the period 1988 to 1990 accounted for around 30% of the DPRK's total imports, and that between 1981 and 1989 the DPRK earned approximately $4 billion from the export of arms, approximately 30% of the DPRK's total exports in that period. The nominal dollar value of arms exports from the DPRK in 1996 is estimated to have been around $50 million.(9)

Further, freed from the necessity of having to compete with the USSR, and yet unwilling to take up the onerous responsibilities of the collapsed Soviet Union towards the DPRK, the PRC moved to distance itself from economic ties with its neighbor by, for example, announcing that commerce with the DPRK would be settled in hard currency from January 1, 1993 onwards, and by cutting its shipments of "friendship grain" from 800,000 tons in 1993 to 300,000 tons in 1994, thus precipitating the DPRK emergency appeal for food aid in the spring of 1995. This food problem, a shortage of approximately two million tons of grain, could have been resolved through $400 million to $500 million per year in grain imports, roughly $20 per person for the population of the DPRK.(10) But with DPRK exports of merchandise of less than $50 per capita ($912 million in 1996) and a trade deficit of over $1 billion (imports in 1996 $1.95 billion) that was not possible. External debt in 1996 amounted to approximately $12 billion. Eberstadt estimates that between 1970 and 1997 the DPRK's cumulative trade deficit with the outside world (measured in current dollars and at official exchange rates) stood at nearly $12.5 billion. This is quite surprising when we know that the DPRK's cumulative nominal exports over the same period appear to have totaled less than $30 billion.(11) Per capita GDP is thought to have been less than half in 1998 of the $1,250 figure given for 1989.(12)

In 1995 and 1996 the DPRK experienced serious flooding, and in 1997 was the victim of tidal waves and drought. This was the final shattering blow to an already teetering economy. By late 1995 the "North Korean famine" was becoming public knowledge all over the world, and by early 1999 it was being estimated that three million people had died prematurely because of the food crisis.(13) Caught in a downward spiral, with an annual $1 billion trade deficit, low foreign exchange reserves, virtually no means of obtaining credit, shortages of energy and raw materials, crumbling infrastructure, obsolete technology, and dilapidated machinery and equipment, the country whose highest leader equated opening up to the global economy with the infiltration of bourgeois ideas and culture was forced to become a mendicant state dependent on handouts from the "enemy".(14)

2.2 Energy Overview of the DPRK

The DPRK is heavily reliant upon indigenous sources of power, predominantly coal and hydropower, and has no known reserves of oil or natural gas. In 1997, coal accounted for more than 80% of primary energy consumption and hydropower more than 10%. Net imports of coal represented only about 3% percent of coal consumption. Hydroelectric power plants generated about 65% of North Korea's electricity and coal-fired thermal plants about 35% in 1997. However, with only 20% of the per capita electricity generation of Japan, the DPRK suffers from chronic supply shortages.(15)

Imported oil, limited to non-substitutable uses such as motor gasoline, diesel, and jet fuel, accounts for about 6% of primary energy consumption. Most of the oil is imported as crude and refined at domestic refineries. Under the October 1994 "Agreed Framework," the United States agreed to supply the DPRK with 500,000 metric tons (approximately 3.75 million barrels) of heavy fuel oil annually through the Korean Peninsula Energy Development Organization (KEDO) until the completion of the first light-water reactor power plant.(16)

Table 2: Energy Overview of the DPRK and Selected Countries

		DPRK	**Japan**	**PRC**	**USA**	**Canada**
1	Population (1000s)	21,234	126,281	1,255,698	274,028	30,563
2	Annual Per Capita Energy Consumption (GJ)	81.2	177.7	28.5	370.0	412.5
3	Annual Per Capita Electricity Generation (kWh)	*1,587*	7,887	874	**13,388**	18,025
4	Annual Per Capita Coal Consumption (m. ton)	*2.99*	1.00	0.95	**3.46**	2.00
5	Annual Per Capita Oil Consumption (bbl)	*1*	**15.9**	**1.25**	**26**	**22.7**
6	Annual Per Capita Electricity Generation (GJ)	*5.71*	28.4	3.15	**48.2**	64.9
7	Annual Per Capita Coal Consumption (GJ)	*81.6*	27.3	25.9	**94.5**	54.6
8	Annual Per Capita Oil Consumption (GJ)	*6.15*	**97.8**	**7.7**	**160**	**140**
9	Calculated Annual Per Capita Energy Consumption (GJ)	*93.46*	153.5	36.75	302.7	259.5
10	Energy Intensity (MJ/$1990)	*75.1*	7.0	41.25	14.66	18.5
11	Carbon Intensity (mm.tC/$1000 [1990$])	*1.7*	0.09	0.85	0.22	0.2
12	Per Capita Carbon Emissions (mm.tC/cap)	1.8	2.3	0.6	5.5	4.6
13	Gross Domestic Product (GDP) (G$)	*21.8*	**4400**	**1030**	**9000**	**621.9**

1998, except *1997* (italic) and **1999** (bold)

This table was compiled based on a suggestion by Pascal Bourguignon

Sources:

Population: DPRK: CIA Factbook, Others: United Nations, World Population Estimates and Projections 1998 Revision

Energy: http://www.eia.doe.gov/emeu/cabs/nkorea.html, http://www.eia.doe.gov/emeu/cabs/japan.html, http://www.eia.doe.gov/emeu/cabs/china.html, http://www.eia.doe.gov/emeu/cabs/usa.html, http://www.eia.doe.gov/emeu/cabs/canada.html

Energy values converted using the following conversion factors available from: http://www2.dti.gov.uk/epa/annexa.pdf
Electricity: 1 kWh = 0.0036 GJ
Coal (Avg) 1 m.ton = 27.3 GJ
Imported Crude Oil = 1181 liters/m.ton
Crude Oil = 45.7 GJ/m.ton
1 barrel crude oil = 159 litres
1 barrel crude oil = 0.1346 m.ton = 6.15 GJ

Note: Figures for per capita energy from lines 6, 7, and 8, added to make line 9 are not the same as the published figure given in line 2 for a variety of reasons. Firstly, not all energy sources are mentioned. Secondly, as electricity is produced from a variety of energy sources, countries using relatively more coal and oil to generate electricity are likely to show a larger total for line 9 (since if oil and coal is used to generate electricity, the energy consumed is double-counted). Conversely, countries that use relatively more nuclear, hydro-power and other renewable energy sources to generate electricity will tend to show a relatively smaller total in line 9.

Table 2 shows basic energy statistics for the DPRK and other selected countries. The image of the DPRK that is apparent from these figures is one of a country with an outdated industrial and energy use structure, low productivity, and inefficient in energy use (high energy intensity); unusually dependent on coal (high carbon intensity); and with relatively low levels of electricity and oil consumption. Statistics for natural gas imports are unavailable and this possibly means that natural gas is not currently imported into the DPRK.

3. The Collapse of Modern Agriculture in the DPRK

3.1 The Collapse of Motive Power: The Substitution of Human and Animal Labor for Machines and Commercial Energy

Agriculture in the DPRK has been organized as co-operative and state farms and has concentrated mainly on the production of rice and maize. Since the 1950s, modernization of agriculture has been carried out through the promotion of irrigation, electrification, chemicalization (fertilizers, pesticides, herbicides, and so on) and mechanization. The seventies and early eighties saw fruition of these efforts, irrigation reaching 70 percent or more of the cultivated land by 1970; a total of 75,000 tractors as well as transplanters, threshers, trucks and other farm machinery were provided; rural electrification covered all rural areas by about 1970; and fertilizers and other chemicals became available in large quantities.(17)

Since the early 1990s, resource constraints brought about by an ailing economy, as described above, made it difficult to continue to provide previous levels of inputs, making it impossible to maintain land and labor productivity given the high input-based agricultural system which had been built up. Much of the agricultural machinery and equipment was purchased in the 1950s and 1960s and is now obsolete and/or in a very poor state of repair due to the inability to purchase or manufacture sufficient spare parts. Fuel to operate the machinery for critical mechanized operations has also become exceedingly scarce. It is estimated that by the end of 1998 80% of the motorized capacity in the DPRK agricultural sector was inoperable.(18)

During field visits, the October 1998 FAO/WFP Mission saw a large proportion of tractors, transplanters, trucks and other farm machinery lying unused and unusable, as well as harvested paddy left in the fields in piles for three weeks or more, resulting in large post-harvest losses. Decreasing ability to carry out mechanized operations (including the pumping of water for irrigation), as well as lack of chemical inputs, was clearly contributing to reduced yields and increased harvesting and post-harvest losses.(19)

Energy has been a critical factor in the operation of the irrigation system of the DPRK. Water is pumped into the main canals and reservoirs, but scarcity of fuel has made it impossible to guarantee timely supplies of water to the irrigation system.. The condition of canals and pumping stations has also been severely affected by natural calamities, while the pumping stations and steel pipes used in the system have suffered from a lack of spare parts and poor maintenance. It has been the breakdown of the irrigation system due to lack of spare parts and fuel that has caused severe deterioration in rice production.(20)

In order to maintain agricultural production despite the declining availability of machinery and equipment, it has been increasingly necessary to perform operations by the use of manual labor and work animals.(21) In the late 1980s, it was thought that approximately 25% of the civilian workforce was engaged in agriculture, and by the mid-90s this appears to have risen to about 36%.(22) The June 1998 FAO/WFP Mission observed that large numbers of the non-agricultural population, including school children, assisting with land preparation, planting and weeding activities.(23) In October 1998, the Mission observed people carrying bundles of harvested paddy on their backs to threshing stations and school children collecting grains around the harvested crop bundles in the fields.(24) Nevertheless, it has proved impossible to perform all operations previously carried out by machinery simply by use of manual labor or work animals (e.g. plowing, pumping of water for irrigation, harvesting, threshing and so on). Thus the timely and effective scheduling of farm operations, particularly at peak times around harvesting and planting of double crops, has been severely affected, reducing productivity and increasing post-harvest losses.(25)

Work animals have been increasingly substituted in operations previously carried out using farm machinery, but this is still quite limited due to low numbers of animals available. This practice is also problematical since animal health is poor due to lack of feed, the provision of which could lead to competition with humans for the use of arable land.(26)

3.2 The Collapse of Soil Fertility: Mining the Soil

The DPRK has three fertilizer factories (at Namhung in the southwest and Hungnam and Aoji in the east/north east) capable of a total annual production of 400,000 metric tons of nitrogen nutrient. This would be sufficient for self-sufficiency if the plants were not obsolescent and poorly maintained, and if the shortage of raw materials (principally the main raw material, petroleum) could be overcome.(27)

Details of the DPRK's fertilizer factories are scanty, but a rough idea of the problem can be gained by a general view of the modern nitrogenous fertilizer manufacturing process. In the Haber-Bosch synthesis of ammonia, the first and crucial step in the procedure, the nitrogen needed is taken from the atmosphere, and the hydrogen is now overwhelmingly supplied from natural gas. Hydrogen was traditionally produced by hydrogenation of coal, which is still perhaps possible in the DPRK. Nevertheless, the energy cost of ammonia synthesis even in large modern plants averages over 40 GJ/tN, of which 60 percent is feedstock and 40 percent is process energy. It is unlikely that the DPRK fertilizer factories can produce ammonia for less than 50GJ/tN. Further, because ammonia requires special storage and application, most of it is converted to liquid or solid fertilizer (e.g. urea) for easy shipping and application.(28) The conversion of ammonia to urea requires an additional 25 GJ/tN. Since one barrel of oil represents approximately 6GJ of energy,(29) and one ton of nitrogen in urea requires 75 GJ (or more) to produce, to run the DPRK's fertilizer factories at capacity for a year would require:

$$\mathbf{(75 \div 6 = 12.5) \times 400{,}000 = 5{,}000{,}000}$$

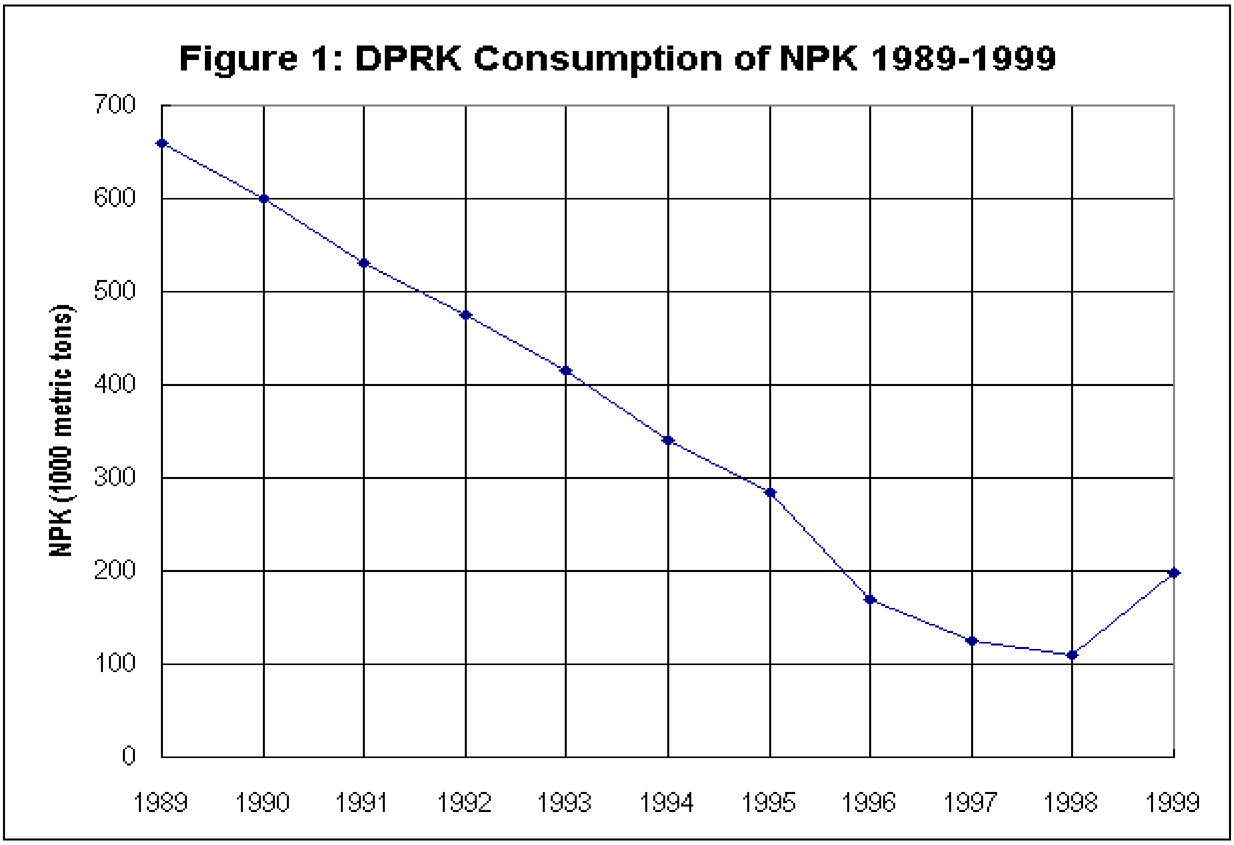
…or at least 5 million barrels of oil, roughly a quarter of the amount of oil imported annually into the DPRK in recent years.

Table 3: DPRK Fertilizer Availability 1999 (1000 metric tons)

	Nitrogen (N)	Phosphate (P)	Potassium (K)
Total Fertilizer	638	166	48
Total NPK equivalent	199		
N in Ammonium Sulfate equivalent (22-23 percent)	*143.4*		
P in Super-phosphate equivalent (18-22 percent)		*33.2*	
K in Potassium Chloride equivalent (47 percent)			*22.4*
Total NPK equivalent	**199**		

Source: FAO, 11/1999, Section 3.2

Accurate statistics of fertilizer manufacture and use are virtually nonexistent, but the availability of fertilizers has shown a steady decline in the 1990s. In terms of nutrient content, the availability in 1998 was only about 18 percent of the 1989 level, believed to be about 660,000 metric tons, thus about 119,000 metric tons.(30) Availability apparently rose in 1999, as can be seen in Table 3 and Figure 1.



Source: FAO, 11/1999, Section 2

This increase in 1999 is largely attributed to external fertilizer assistance, which contributed 58 percent of total fertilizer availability, 32 percent coming from domestic production and 10 percent from commercial imports. Along with the collapse of mechanization, the severe shortage of fertilizers has also contributed greatly to the decrease in agricultural productivity in the DPRK. It was estimated in 1998 that fertilizer availability for that year would allow applications of only around 200 kg/ha, roughly one third that recommended for optimum yields. Despite the increase in fertilizer availability in 1999, soils in the DPRK are being heavily mined of nutrients, as more nutrients are being extracted than replaced. It is estimated that the annual fertilizer requirement of the DPRK is around 700,000 metric tons (roughly the amount available in 1989) of NPK, the nutrients nitrogen, phosphorus and potassium.(31)

The modern system of intensive agriculture introduced in the DPRK between the 1950s and 1980s enabled the continuous production, including double-cropping, of cereals, but has resulted in soils highly depleted in natural nutrients. Rotational systems including fallowing or planting with leguminous crops have been abandoned, as has largely the practice of using organic fertilizers. These systems can, of course, be reintroduced and would be expected to raise yields as they help to revive soil fertility. These are, however, systemically complex, long-term measures which can only be reintroduced with careful consideration for the overall productive capacity of the DPRK's agriculture, the ability to import substantial quantities of food, existence and location of relatively large numbers of livestock, availability of surplus organic matter (e.g. not in competition with livestock feed or biofuel production!) and so on. For the time being the DPRK remains heavily reliant for its food supply upon chemical fertilizers, which must either be manufactured at considerable energy and raw material cost or imported.(32)

3.3 The Collapse of Cereal Production

The staple foods of the DPRK are rice and maize, and these crops are the main food grains produced in the country, accounting for about 1.2 million hectares of the country’s total arable land of about 2 million hectares. Rice is grown predominantly in the southern plains, while maize is grown generally on sloping ground. Rice is transplanted from mid-May to early June, harvested from late September to October, and is almost totally irrigated. Maize is largely rainfed, planting being carried out from mid-April to early May, harvesting coming between the end of August and mid-September. Irregular or poor rainfall will therefore affect maize more than rice. Whereas the 1997 drought devastated maize production, rice production has been adversely affected by breakdowns in the irrigation system, as mentioned above.(33) There has been a shift in recent years away from the cultivation of maize in favor of potatoes on low yielding and vulnerable (easily eroded or degraded) sloping land. This shift has been in the region of 110,000 hectares. Double-cropping of maize and potatoes has also been reported, the area planted being around 77,000 hectares.(34)

Statistics showing approximate cultivated land areas and food production derived from FAO reports follow. Table 4 shows land classification of arable land cultivated to paddy and maize in the DPRK in 1998 and gives a rough idea of total areas under these two main crops.

Table 4: Classification of Rice and Maize Areas Cultivated (1998)

Land type	**Rice**		**Maize**		**Total Area**
	Area (ha)	%	Area (ha)	%	
Good: Class I	188,000	32.4	202,000	32.1	390,000
Moderate: Class II	195,000	33.6	195,000	31.5	390,000
Poor: Class III	197,000	34	229,000	36.4	426,000
TOTAL	**580,000**	**100**	**626,000**	**100**	**1,206,000**

Source: FAO, 1998/11, Section 3.7.1

Notes:

Class I Lands: Flat and/or leveled, good soil, irrigated, farm machinery and equipment routinely used.

Class II Lands: Flat or undulated (gradient 0 to 10 degrees), irrigated or unirrigated, good to moderate soil, farm machinery and equipment often used.

Class III Lands: Sloped and hilly (flat for paddy), no irrigation except for paddy, unsatisfactory soil, farm machinery or equipment not normally used.

Table 5 shows estimated cereal production and availability for the 1999/2000 marketing year. Total arable land area available for food crops, approximately 1.4 million hectares, is shown.

Table 5: DPRK Cereal Area and Production, 1999/2000

Crop	Area (1000 ha)	Yield (m. tons/ha)	Production (1000 m. tons)	Total Cereal Area (1000 ha)
Rice (unhulled) [A]	580	4.04	2343	580
Maize [B]	496	2.49	1235	496
Potato (2000) [C]	180	10.07	1813	180
Wheat and Barley, double-cropped (1999-2000) [D]	123	1.96	241	123
Other cereals [E]	20	1	20	20
Rice in milled equivalent[1] [F]			1523	1399
Potato in cereal equivalent[2] [G]			453	
Total Production (cereal equivalent) [B+D+E+F+G]			3472	

[1] *Milling rate of 65 percent* [2] *Potato to cereal equivalent 25 percent (4:1)*

Source: FAO, 1999/11, Section 3.4

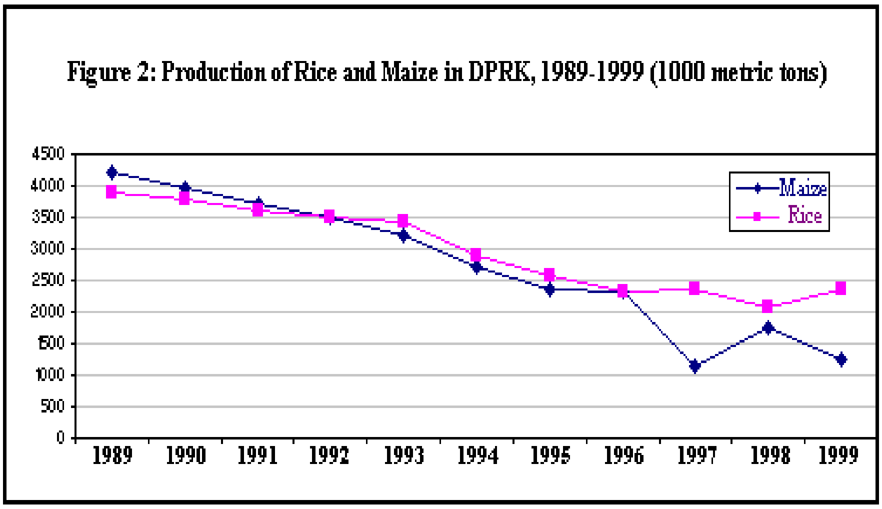
Table 6 gives approximate production figures for rice and maize for selected years between 1989 and 1999 (the figures in Table 6 correspond to those shown in Figure 2). It is clear from the table and the graph just how much staple grain production declined in the DPRK between 1989 and 1999. The graph also suggests that without the revival of substantial inputs of chemical fertilizer and the restoration of the former mechanical capacity of DPRK agriculture, food production in that country may have slipped to a new steady level of production at about 40% of that of the 1980s

Table 6: Production of maize and rice in DPRK, 1989-1999 (metric tons)

Year	Maize	Rice	Milled Rice	Total	Total Milled
1989*	4,200,000	3,900,000	2,535,000	8,100,000	6,735,000
1996*	2,350,000	2,350,000	1,527,500	4,700,000	3,877,500
1997*	1,200,000	2,400,000	1,560,000	3,600,000	2,760,000
1998	1,765,000	2,063,000	1,340,950	3,828,000	3,105,950
1999	1,235,000	2,343,000	1,522,950	3,578,000	2,757,950
99/89 %	29	60	60	44	41

** estimate* *milled rice conversion ratio=65%*

Source: FAO, 1999/11, Section 2



Source: FAO, 1999/11, Section 2

Table 7 gives an approximate overview of the food situation in the DPRK for the years 1997 to 2000.

Table 7: DPRK Cereal Balance for 1997/98-1999/2000 (metric tons)

Report Year	**June 1998**	**November 1998**	**June 1999**	**November 1999**
Marketing Year (November-October)	**1997-1998**	**1998-1999**	**1998-1999**	**1999-2000**
Total Availability	2,838,000	3,481,000	3,783,000	3,472,000
Production	2,838,000	3,481,000	3,400,000	3,472,000
Stock draw-down	0	0	383,000	0
Total Utilization	4,674,000	4,835,000	4,823,000	4,765,000
Food use	3,874,000	3,925,000	3,925,000	3,814,000
Feed use	300,000	300,000	300,000	300,000
Other uses, seed and losses	500,000	610,000	598,000	651,000
Import requirement	1,836,000	1,354,000	1,040,000	1,293,000
Commercial imports	500,000	300,000	300,000	300,000
Pledged and delivered food assistance	814,000	0	642,000	370,000
Uncovered import requirement	522,000	1,054,000	98,000	623,000

Sources: FAO, 1998/6, 1998/11, 1999/6, 1999/11

3.4 The Collapse of Food Security: Malnutrition

It is estimated above that grain production in the DPRK in 1999 was approximately 40% of what it was ten or more years previously. There are few detailed accounts of what this has meant exactly for the population of that country, but it is possible to get an approximate picture from the scanty evidence that exists. Former DPRK Korean Workers' Party secretary for international affairs and president of Kim Il Sung University Hwang Jang Yop, who defected to South Korea in February 1997, publicly estimated in March 1999 that the death toll in the DPRK food crisis had exceeded three million people. This figure was backed up by a DPRK public security ministry document obtained by the intelligence agency of South Korea.(35)

Many anecdotal indications of the severity of the food situation inside the DPRK have appeared in the mass media, the following being one example.

Scores of children dead in North Korea famine
U.S. lawmaker says 'gigantic' disaster in the making
April 8, 1997
PYONGYANG, North Korea (CNN)

Even North Korea's military is suffering, according to a "stunned" U.S. congressman who recently spent four days in the northern part of the peninsula.

Ohio Democrat Tony Hall said he saw soldiers whose uniforms hung off their bodies.

"Everyone is systematically starving together," he told reporters in Tokyo, adding that he saw "evidence of slow starvation on a massive scale."

Hall said the evidence included families eating grass, weeds and bark; orphans whose growth has been stunted by hunger and diarrhea; people going bald for lack of nutrients; and hospitals running short of medicine and fuel.

Source: CNN News: http://www.cnn.com/WORLD/9704/08/korea.food/index.html

The FAO/WFP Missions found that large-scale food shortages in the DPRK had resulted in chronic nutritional problems in the population at large, which may have "long term irreversible consequences." A nutrition survey carried out in the DPRK in September/October 1998 by the UNICEF, WFP and the EU, in partnership with the DPRK Government, focussed on children from 6 months to 7 years of age. The main findings were:

- ◊ Moderate and severe wasting, or acute malnutrition, affected approximately 16 percent of the children (one of the highest rates of wasting in the world) including about three percent with edema. Moderate and severe stunting, or chronic malnutrition, affected about 62 percent of all children surveyed, while the prevalence of moderate and severe underweight, or low weight for age, was approximately 61 percent.
- ◊ The prevalence of wasting peaks in the age range 12 to 35 months, before and after which it is less. On the other hand, stunting and underweight continue to rise through the fourth year and tend not to decline thereafter. The data also show that the prevalence of malnutrition tended to be higher among boys than girls and that the whole population of children seems to have been affected by the crisis.

As recovery from even moderate malnutrition can take several months, chronic nutritional deficiencies can have long-term and possibly even irreversible consequences. Malnutrition in childhood can lead to irreversible stunting, which means that a severely malnourished person will never reach the height normally expected in a given population. This can mean that the person will remain stunted for life even though a normal diet is restored at a later date.(36)

It is clear that a severe food crisis arising from shortages of energy and other commercial inputs can bring about a disastrous situation for the future health of a population within just a few short years.

4. Conclusion

The FAO Reports make several recommendations for agricultural rehabilitation in the DPRK. These can be summarized briefly as follows:

1. Recovery of chemical fertilizer production through rehabilitation of the DPRK fertilizer factories.
2. Rehabilitation and expansion of the irrigation system (pumps, pipes, drainage networks) and further emphasis on flood management.
3. Implementation of crop diversification should be carried out to reduce the emphasis on monocropping, enhance soil productivity in the long run and reduce risk of crop losses due to adverse weather conditions.
4. Research into effective crop rotation schemes including leguminous crops to promote soil fertility and productivity.
5. Research on seed improvement, and early and short-maturing and less chemical fertilizer dependent crop varieties.
6. Research and development of integrated crop and livestock systems.(37)

Recommendations 1. and 2. depend heavily on the ability of the DPRK to develop its economy in the future. Naturally, if the DPRK is capable of achieving that (by no means mean) feat, restoration of motive power in the countryside will also take place. Recommendations 3. to 6. suggest a strong emphasis on what now generally comes under the rubric of "organic farming". With a high population to arable land ratio, as in the DPRK, intensive cultivation and increased land productivity (higher yields) are the only way to increase food availability, if we assume that substantial food imports and population reduction are not realistic options. Further, high rates of application of chemical fertilizers and other agricultural chemicals, usually combined with mono-cultures of grains, may exacerbate soil degradation and erosion, ultimately resulting in lower yields despite high levels of commercial inputs. Finally, the answer must be to attempt the transition to intensive organic agriculture; low levels of use of commercial energy sources and chemicals, a tight recycling of nutrients in combination with other methods of maintaining soil fertility, such as rotational systems, diversification of crops and the development (return to!) integrated crop and livestock production systems. This has been attempted fairly successfully in Cuba in recent years.(38)

More generally, we can say the following concerning the **<u>cause</u>** of the DPRK food crisis:

Inability or unwillingness to participate in the global trading economy can cause difficulties in maintaining levels of commercial inputs necessary for continuous operation of a modern food producing agricultural system.

The experience of the DPRK, and perhaps Cuba, points to several **<u>closely interlinked lessons</u>** that need to be learned by countries which currently operate a modern industrialized agricultural system based on commercial chemical and energy inputs. Agriculture has now become simply one adjunct of the overall economic-industrial matrix of the human global social-economic entity. This matrix is a highly complex web of financial and industrial relationships backed up by fairly precisely timed operations, such as transport of raw materials, fuel, components, and so on. Adjuncts to the matrix are therefore sensitive to disruptions and other irregularities. Thus the modern agricultural system can very quickly get into deep trouble if we do not have the ability to:

1. fuel, maintain, repair, and replace agricultural and distribution-related machinery and infrastructure (trucks, tractors, transplanters, harvesters, irrigation pumps, fuel and chemical delivery systems, and so on)
2. fuel, maintain, repair, and replace factories and factory equipment for the manufacture of agricultural machinery and inputs, e.g. regularly replaced items such as spark plugs and filters, spare parts, fertilizers, herbicides, pesticides, plastic sheeting and so on.
3. ensure steady supplies of fuel, raw materials, and feedstocks for agricultural operations and inputs, such as petroleum, natural gas, coal, potassium and phosphorus minerals, and so on.

Again, the final answer is to convert to low-input, yet land and labor intensive, organic farming. Crucially, this would require perhaps a ten to twenty year transition period; something the DPRK has not had the luxury of.

As a final general statement, it can be said that once a country takes the decision to abandon traditional agriculture and switch to a modern agricultural system (a mechanized system making use of commercial chemicals and fuels), then in order to maintain food production levels it is essential to ensure that levels of fuel and other inputs are maintained, and that machinery and equipment is kept in good working order. Shortages of fossil resources (oil, natural gas and coal) can result in productivity collapses when soils are mined, and eventually destroyed, due to crop production without replacement of essential nutrients, and where agricultural machinery and equipment can no longer be kept operational because of lack of fuel and maintenance.

A transition to organic and/or traditional and sustainable forms of agriculture is not easily carried out in a short period of time (for instance due to lack of livestock and lack of sufficient numbers of farmers with the requisite knowledge and skills). Meanwhile the population must be fed; a population that has ballooned on food produced by the modern industrial agricultural system that has been built up thanks to fossil resources.(39) This is now the paradoxical complex of problems faced by almost all of the world, including the great food-producing areas of North America, Europe, South America and Oceania; how to maintain high agricultural productivity with decreasing amounts of the central element that has made that productivity possible, oil. The end of cheap and abundant oil and other fossil resources means the end of our current methods of food production and thus it possibly spells the end of advanced industrial society as we know it. The DPRK is an exceptional case only in that due to political miscalculation and mismanagement of its economy it has manifested these symptoms before fossil resource shortage becomes a serious concern for most of the world.

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(6) Eberstadt, 1999, p.36 and Australia, DFAT
(7) FAO, 1998/11, Section 2
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(9) Eberstadt, 1999, pp.105-106
(10) Eberstadt, 1995, p.666, Eberstadt 1999, p.100
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(14) Eberstadt, 1999, pp.14, 84
(15) US Energy Information Administration (http://www.eia.doe.gov/emeu/cabs/nkorea.html)
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(27) FAO, 1998/6, Section. 2.3
(28) Smil, 2000, p.50
(29) Hill, Robert, Phil O'Keefe and Colin Snape, p.179
(30) FAO 1998/11, Section 3.3, Radiopress, p.215. Radiopress quotes the UN Statistical Yearbook for Asia and the Pacific, 1996, and this figure of 660,000 metric tons is given as nitrogen nutrient. Although there appears to be a certain degree of confusion surrounding fertilizer statistics, the qualitative phenomena of fertilizer shortage and the resulting loss of agricultural productivity are sufficiently compelling for the purposes of this argument.
(31) FAO 1998/6, Section 2.3, 99/6, Section 2.2, 99/11, Section 3.2
(32) FAO 1999/6, Section 2.2
(33) FAO 1998/11, Section 3
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(36) FAO, 1999/6, Section 5
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Units

bbl	barrel (oil)
cap	capita, person
GJ	Giga Joule (10^9 Joules)
ha	hectare (10,000 m^2)
kg	kilogram
kWh	kilowatt hour
m	million (10^6)
MJ	Mega Joule (10^6 Joules)
m. ton	metric ton (tonne)
PJ	Peta Joule (10^{15} Joule)
tC	metric ton of Carbon
tN	metric ton of Nitrogen
$	US Dollar, unless stated

Notes:

- A Japanese language version of this paper was given at the annual convention of the *East Asian Area Studies Academic Association of Japan* on 22 July 2000. The Japanese language version of this paper may be accessed from: http://www.net-ibaraki.ne.jp/aboys/
- A Korean language version of this paper was published in the September-October 2001 issue of *Noksek Pyongron* (*Green Review*), pp. 71-84