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Chiangmai, Thailand
13-16 November 2006

AGRICULTURE AND FERTILIZER SITUATION IN DEMOCRATIC REPUBLIC OF KOREA

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**All the papers and presentations prepared for the 2006
IFA Asia-Pacific Crossroads in Chiangmai are
compiled on a cd-rom released in December 2006.**

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Abstract

Agriculture, including forestry and fisheries, contributes about 30 percent of GDP for DPR Korea. The performance of this sector has been erratic with negative growth rates. Over the past several years, natural disasters such as droughts, floods, hail storms, and typhoons have affected agriculture, with consequent adverse impacts on food production. With the concerted efforts on the part of the government of the Democratic Republic of Korea, supported by 'humanitarian assistance', the food grain production has been showing an upward trend during the recent years. The double cropping programme, a joint UNDP/FAO ¹strategy, enabling the production of an extra crop of cereals, prior to main crops of rice and maize, has provided significant fillip to the food production programme. However, the cereal deficit and food insecurity concerns continue to be large. The fertility of most of the soils is low due to continuous cropping, inadequate fertilization and loss of nutrients through erosion on sloping lands. Cultivation of crops without fertilizers or at sub-optimal rates is leading to mining of soil nutrient reserves. Shortage of foreign exchange to buy the required feedstock and the raw materials has put constraints on domestic fertilizer production. Installed capacities have been affected by technological obsolescence, ageing plants, difficulties in the replacement of old equipment and the provision of spares. The annual requirement of fertilizers is estimated at around 700 000 t of nutrients. The supply and availability of fertilizers over the years have been significantly lower than the requirements. The domestic production of fertilizer having declined to a level of less than 10 percent of total requirement, there is an increasing reliance on fertilizer imports to ensure adequate availability. During the period following 1998, 'humanitarian assistance' helped to sustain the fertilizer availability and prevent further fall in fertilizer consumption. Humanitarian assistance, however, has not been sufficient to fill the overall gap. Consumption by 2010 is projected to be in the range of 280 – 300 thousand tonnes of nutrients. With little prospects of increase in domestic production, the major share of this quantity estimated at about 80 percent, has to come through imports.

¹ UNDP/FAO: United Nation Development Programme / Food and Agriculture Organization

Introductory

Total land area in DPR Korea amounts to 122 500 square kilometers, of which the total cultivated land area is estimated at 17-18 percent. Out of the total cultivated land, about 580 thousand hectares (ha) are used for rice, 496 thousand ha for maize, 123 thousand ha for wheat and barley, 187 thousand ha for potatoes, 200 thousand ha for vegetables and 300 thousand ha for permanent crops such as fruits and mulberries. Arable land in DPR Korea is extremely limited in scope due to the peculiar topography of the country, which has approximately 80 percent of its territory covered by mountains, and only 20 percent in flat land.

In order to increase total food production in the country, every possible piece of cultivable land including plots with extremely high slopes in the mountainous areas has been brought under production. However, cultivation of marginal lands has had unintended consequences of soil erosion and further reduction in overall land productivity. Reclamation of some 300 000 ha of tidal lands and another 200 000 ha by terracing of mountainous areas has been progressing, though at a slower pace, due to high costs involved. The ongoing land re-alignment exercise has resulted in significant increase in the paddy cultivation area during the recent past.

Average annual rainfall varies from 600-980 millimeters (mm) in the north and north-east (Jagang, Ryanggang, North and South Hamgyong Provinces) to 880-1300 mm in the centre, south-west and south-east (North and South Pyongan, Pyongyang, North and South Hwanghae, Kaesong and Kangwon Provinces). About 85 percent of all precipitation occurs during the spring-summer months, while 60 percent is distributed in June-September. Typhoons are a regular occurrence, the effects of which are usually felt at least once per growing season, usually in late summer or early autumn (FAO, 2004). Average temperatures in DPR Korea vary from -19°C in winter (Ryanggang in January, the coldest month) to 25°C in summer (South Hwanghae in August, the hottest month). The frost-free period ranges from 160 to 190 days, depending on altitude and latitude, and determines the length of the cropping season and choice of crops. Climatic conditions do not permit more than one crop per year in many areas, limiting the possibility of intra-annual rotation.

Agriculture, including forestry and fisheries, contributes about 30 percent of Gross Domestic Product. The Government has laid heavy stress on intensification of agriculture. The main features of the intensification strategy have been: i) irrigation -- the construction of artificial reservoirs and canals; ii) mechanization; iii) the intensive use of agro-chemicals; and iv) electrification. The performance of this sector has been erratic with negative growth rates.

A growing population, natural disasters and very limited agricultural land area act as limiting factors in relation to food supply. Over the past several years, natural disasters such as droughts, floods, tidal surges, hail storms, typhoons and extremely cold winters have affected agriculture with varying degree of severity, with consequent adverse impacts on food production. As a result, the production of rice and maize, the major food crops, fell sharply. In addition to losses to standing and stored crop, significant damages occurred to overall infrastructure of the country, including the irrigation network, transport and property. Consequently, the natural disasters have not only greatly affected the overall economic development of the country but also produced unprecedented food insecurity problems. The DPR Korea had experienced a severe economic decline since the early 1990s with unfavourable changes in trade with its traditional partners in the former USSR and Eastern Europe combined with major natural disasters affecting agricultural output in 1996, 1997 and 2000. With low foreign exchange reserves, the country faces serious obstacles to importing larger quantities of food grain commercially to meet a growing food shortage.

Out of the country's 12 provinces, the eight that generally account for about 90 percent of the nation's cereal and potato production include North Pyongan, South Pyongan, North Hwanghae, South Hwanghae, North Hamgyong, South Hamgyong, Ryanggang, and Kangwon.

Paddy is the most important crop in terms of both area cultivated and production. Paddy is grown mainly in the central, south-western and south-eastern parts of the country (the lowland parts of North and South Pyongan, North and South Hwanghae, Pyongyang and Kaesong, collectively known as the "Cereal Bowl" and the narrow east coastal strip comprising parts of Kangwon, and North and South Hamgyong provinces. Smaller areas are also cultivated in Jagang and Ryanggang provinces. Paddy is cultivated in the alluvial plains or on graded terraces equipped with irrigation control systems. In 2004, the area under paddy was reported as 583 390 ha.

Maize, which is mainly produced under rainfed conditions, is more universally distributed than paddy. Until 1998, the area under maize amounted to some 630 000 ha. Since then, however, the government has set lower maize planting targets in order to avoid expansion into lands with low potential. On such marginal lands, less moisture-demanding cereal crops and pulses have substituted maize, while on lands with higher potential, vegetables and main-season potato has entered into the crop rotations. For the year 2004, area under maize cultivation was reported as 495 026 ha. Maize transplanting, a method probably unique to DPR Korea, is adopted in most areas.

Potato cultivation has substantial potential for increasing the food supply. The Government has encouraged the potato crop both in the context of a double crop programme and as a main crop. Potatoes are grown as a spring (double) crop in the Cereal Bowl region, and as a summer crop in the cooler northern highlands (Jagang, Ryanggang), where a shorter growing season is experienced. As a double crop, potato is sown in March-April and harvested in June, while as a main crop it is sown in May-June and harvested in August-September. In response to the reduced productivity of the main cereals in the late 1990s, and in an attempt to boost carbohydrate production, the land under potato was increased in all the major agricultural areas. At present an area of about 277 000 ha is cropped with potatoes, up from about 48 000 ha in 1997-98. Cultivated areas under main and spring-season potato during 2005 were 89 000 ha and 188 000 ha respectively.

Double Cropping

The double cropping programme, was initiated in 1997 as a joint UNDP/FAO strategy to enhance the food grain production. The programme was designed to make optimum use of land that remains without a crop in autumn and early spring, after the main crops, rice and maize have been harvested, and before the main summer crops are planted. It permits the production of an extra crop of cereals by planting spring barley, winter wheat or potato crops prior to main crops of rice and maize. The western plains of the country, which include the regions below the 40-degree latitude, are the target areas of the double cropping programme.

The viability of the double cropping programme, is now well established and a substantial increase in the food grain availability has been achieved. The programme provides food during the lean period from June to September when food shortages are most acute. The double crops are not subject to flooding, which generally occurs in the case of the main summer crops during the months of July and August.

The initial stages of the double cropping programme had spring barley and then winter wheat as the double crops. Subsequently potatoes were also introduced as a double crop in spring, before the main summer cropping season. Winter wheat and spring barley are produced in all provinces except Ryanggang and North Hamgyong. They are the main cereals in the double-cropping programme. Winter wheat is the main winter cereal crop. Winter barley accounts for only a very small proportion of the total area under winter crops. Winter wheat is sown from the end of September to mid-October, immediately after the harvesting of the main-season crops.

Both winter wheat and spring barley are harvested in the second half of June. Spring barley is the main spring cereal crop. Spring wheat accounts for only a very small proportion of the total area under spring crops.

Cultivated areas under spring during 2004 were 98 180 ha. The average productivity is of the order of 10 t/ha. With good quality potato seed, free from virus and other diseases and the use of fertilizers, spring potato yields could attain 15 t/ha.

Efforts to increase the use of double cropping led to an expansion of the double-cropped area under winter wheat, spring barley and spring potato from 47 000 ha in 1997 to more than 290 000 ha in 2005, an increase of almost six fold (Table 1).

Table 1. Area and Production of Double Crops in DPR Korea

Year	Area (000 ha)	Production (000 t)
2001-02	192	441
2002-03	211	386
2003-04	201	431
2004-05	201	N.A.
2005-06	290	440

While the coverage under the double cropping has gone up from 47 000 ha in 1997 to 290 000 ha in 2005-06, its contribution towards food grain production has risen from 46 930 tonnes in 1996/97 to 440 000 tonnes in 2005-2006.

Constraints and Prospects of Double Cropping Programme

In addition to the natural constraints such as adverse weather and poor soils, double cropping suffers from a number of physical constraints such as a shortage of inputs, especially fertilizers, insufficient irrigation, inadequate mechanization and plant protection measures and a lack of varieties with short growing periods. In view of the short time available between the harvest of the first crop and the planting of the second crop, double cropping puts a heavy demand on labour and agricultural mechanization. A considerable proportion of the double-cropped area is in the rainfed zones. Irrigation is needed, but this depends on the power supply, which is a scarce resource. Barley is the preferred crop for spring in most situations. Spring barley often runs the risk of late maturity due to the short season and lack of short duration varieties, which may eventually lead to premature harvests or even ploughing in of the crop.

On most of the cooperative farms, a substantial area of additional land suitable for winter wheat/barley cropping is available and could be brought under winter cropping, provided that the needed resources such as tractors, tractor tyres and spare parts for the existing tractors, fuel, fertilizer, pesticide and labour are made available as required.

Other Crops

Other crops produced in DPR Korea include summer wheat and barley, sorghum, millet, soybean, buckwheat, vegetables (mainly cabbage, spinach, radish, cucumber, eggplant and tomato) and fruit (mainly pears, peaches, apricots, apples and persimmons). Many farms also have sizeable mulberry plantations. The short agricultural growing season limits crop rotations and favours cereal mono-culture. Summer wheat is grown in the higher-altitude parts of Jagang, Ryanggang, and North and South Hamgyong, where the growing season is relatively short.

Irrigation

Land area under irrigation is 70 percent of the cultivated area (Table 2). Substantial investment has been made in irrigation development, particularly in reservoir canal and pumping systems to serve the paddy areas. Recently constructed Kechan-Taesong Lake canal funded by the OPEC has led to improved gravity irrigation facilities in the main Cereal Bowl of the country.

Table 2. Irrigation Pattern of Major Cereal Crops

Irrigation Pattern	Paddy		Maize	
	000 ha	%	000 ha	%
Fully irrigated	320	56	155	31
Partially irrigated	150	26	115	23
Poorly irrigated	102	18	226	46
Total	572	100	496	100

Source: MOA, DPR Korea, 2001

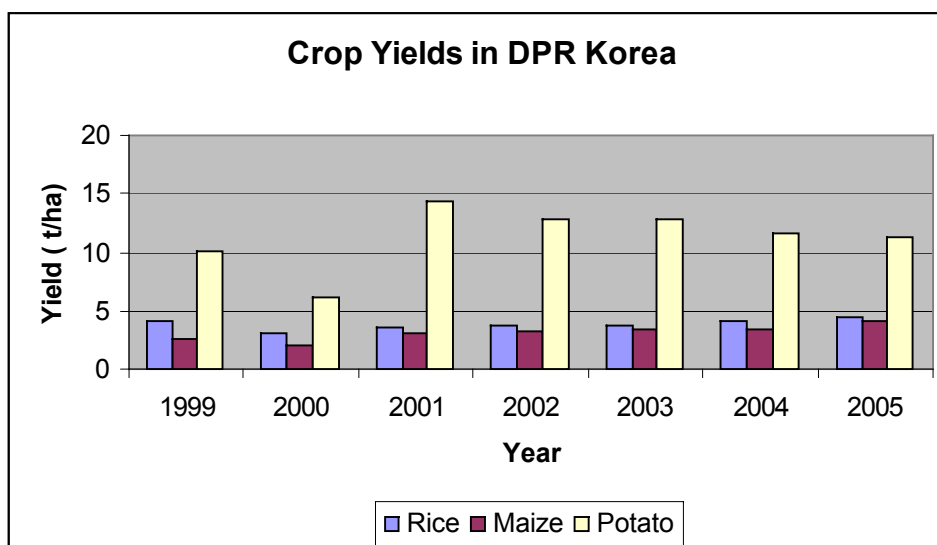
The proportion of gravity-fed irrigation systems continues to increase gradually as a result of the new waterways completed in recent years. These include the 148-km Pyong Nam, the 154-km Lake Taesong-Kaechun waterway in North and South Pyongan and the Pakma-Cholsam waterway, also in North Pyongan. However, most systems still depend on electrically powered pumping stations. Some farms depend for their irrigation on series of ten or more pumping-stations and are consequently very vulnerable to water shortages.

The Unpa county reservoir, with a designed capacity of 500 million m³ is the major source of water supply for the provinces of North and South Hwanghae. Even when adequate water supplies were available, shortage of fuel and of spare parts for the pumps often limit its use on the farms.

Crop Production and Food Gap

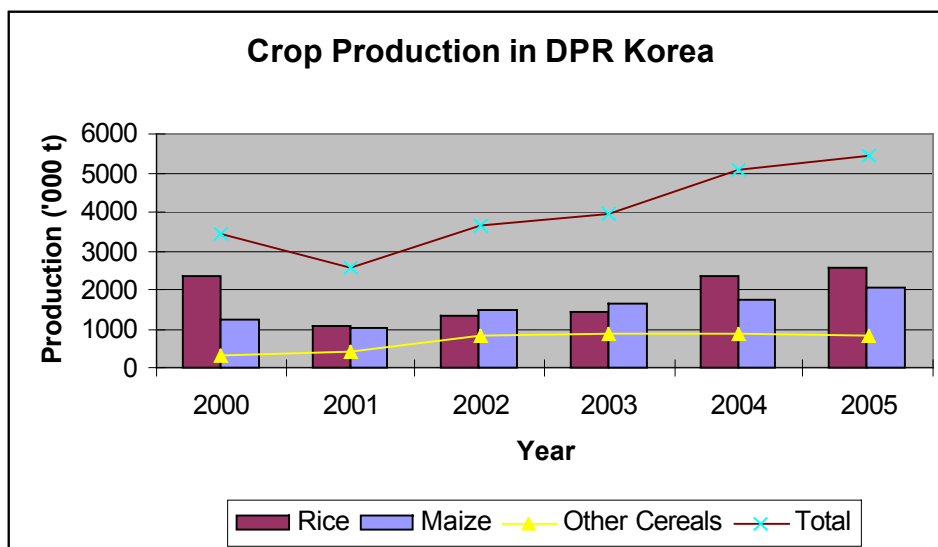
High yields of the order of 8 tonnes of rice and 6 tonnes of maize per ha were reported until the early 1990s in DPR Korea. Yields started to fall in the absence of the essential inputs such as fertilizers. The main summer crops are rice and maize. Whereas the average yields of rice and maize could be raised to the level of 6.5 t/ha with the support of adequate agricultural inputs, the average yields are of the order of 4.4 t/ha and 4.2 t/ha for rice and maize respectively (Table 3). Crop yield trends during the period 1999 – 2005 are depicted in Figure 1.

Figure 1. Crop Yields during the Period 1999 – 2005 in DPR Korea



Under optimum climatic and crop management conditions, yields up to 4 t/ha can be achieved for wheat and barley. The low yields are attributable mainly to the weather conditions and the insufficient use of inputs, mainly fertilizers. The present yields of potatoes are around 11 tonnes per ha and could be raised to 20 tonnes per ha with the support of adequate agricultural inputs and improved agricultural, soil and crop management practices. In controlled experimental plots, yields up to 40 tonnes per ha have been obtained.

Figure 2. Food Grain Production during 2000 - 2005 in DPR Korea



With the concerted efforts on the part of the government supported by the 'humanitarian assistance', the food grain production has been showing an upward trend following the national calamities during the late nineties. The food grain production has gone up from 2 574 000 tonnes in year 2001 to 5 451 000 t in 2005 – an increase of more than two fold (Figure 2).

Contribution of various crops to total food grain production is given in Table 3.

Table 3. Crop Production in DPR Korea - 2005

Crop	Area (000 ha)	Yield (tonnes/ha)	Production (000 tonnes)
Paddy Rice	583	4.42	2581
Maize	495	4.16	2062
Potato ¹	277	1.73	480
Wheat and Barley	135	2.06	280
Other Crops ²	26	1.82	47
Total	1517		5451

¹ Potatoes in cereal equivalent with 25% conversion rate.

² Other crops include Soybean, Millet, Sorghum and Sweet Potato

Share of various provinces in national food grain production is provided in Table 4. Out of the annual total food grain production of 5 451 000 t, the main crops contribute 5 011 000 t. Food grain production through the double cropping constitutes 8 percent of the total production.

The provinces that account for major share of the crop production include North Pyongan, South Pyongan, North Hwanghae, South Hwanghae, South Hamgyong, and North Hamgyong.

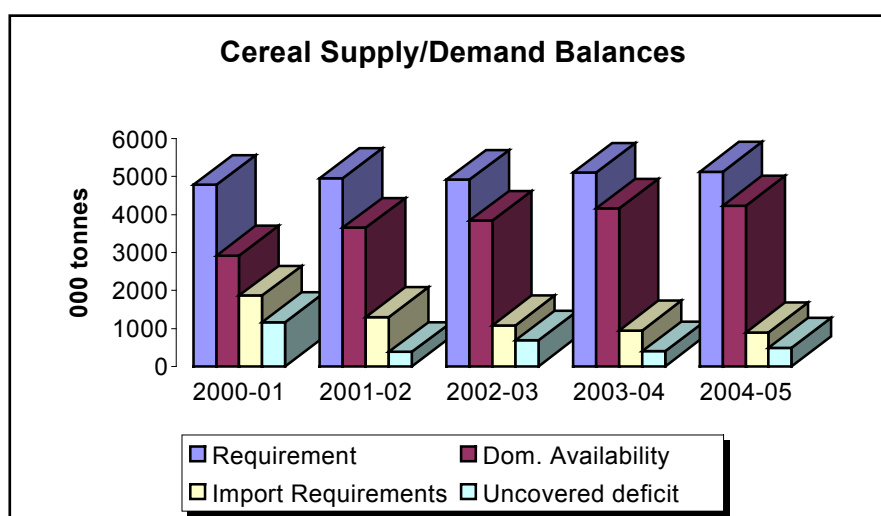
Table 4. Area and Crop Production DPR Korea 2005 - Province Wise

Crop	Area (000ha)	Production (Main crops) (000 t)	Production (Double Cropping) (000 t)	Total Production (000 t)
Pyongyang	47	185	12	197
South Pyongan	234	857	92	949
North Pyongan	247	887	88	975
Jagang	52	189	4	193
South Hwanghae	298	1098	104	1202
North Hwanghae	159	559	50	609
Kangwon	91	281	26	307
South Hamgyong	145	483	43	526
North Hamgyong	91	313	8	321
Ryanggang	50	115	11	126
Kaesong	14	44	2	46
Total	1428	5011	440	5451

The food gap in the last 10 years has ranged from under one million tonnes to over two million tonnes. The cereal deficit in 2004/05 marketing year (November/October) was estimated at 897 000 tonnes. With commercial imports estimated at 100 000 tonnes, and anticipated concessional imports at 300 000 tonnes from the Republic of Korea, there remained a cereal deficit of 497 000 tonnes, of which, 170 000 tonnes were either pledged or on hand at the time of the FAO/WFP Crop Assessment Mission in early October 2004. The cereal deficit for 2005-06 was estimated at 900 000 t. There were expectations of relatively good crop production in 2006; however, the floods during July would have adverse impact. It is obvious that the situation of large cereal deficit and food insecurity is likely to continue. For the year 2006–07, forecasts place the cereal deficit in the range of 720 000 – 830 000 t.

Following steady recovery in agricultural production during the recent past, the Government of DPR Korea requested the United Nations to end all the humanitarian aid with effect from 31st December 2005. However, months after, following heavy floods during July 2006, DPR Korea has approached the republic of Korea for food aid.

Figure 3. Cereal Supply/Demand Balances in DPR Korea



Major Strategic Options

Additional food production requires an increase in the productivity of the existing arable area. Intensive production requires, among other factors, an adequate availability of agricultural inputs such as fertilizers and agro-chemicals, seeds, irrigation and agricultural machinery. Mechanization on the farms perhaps represents the biggest challenge and biggest potential in DPR Korea. The obsolete and decaying farm machinery need rehabilitation or systematic replacement. Mechanization constraints severely affect further expansion of double cropping, which is highly dependent on tractor power.

In view of the vast challenges and constraints affecting the agriculture sector, major strategic options aimed at achieving sustainable food security by improving agricultural production systems based on modern scientific technology, resource base improvement and conservation of the environment include measures such as:

- Development of agricultural mechanization;
- Reconstruction of flood-affected land areas and irrigation network;
- Reclamation of tidal areas;
- Terracing in mountain areas suitable for maize production;
- Crop variety improvement, and efficient soil and crop management;
- Development of salt-tolerant or resistant rice lines;
- Expansion of the coverage under double cropping;
- Improvement of plant nutrient management and increased fertilizer use efficiency on rice, maize and vegetable crops;
- Improved pesticide management and crop protection through biological control;
- Improvement of crop rotation systems with legumes to maximize soil productivity; and
- Development of modern technologies and methodology for production of effective and quality bio-fertilizers.

Soil Fertility

Soil fertility levels vary widely across the country. The fertility of most of the soils is low due to loss of nutrients through erosion on sloping lands and long periods of cultivation. Sloping lands with shallow soils, on which most of the maize is grown, are especially low in organic matter and nutrients. Very short fallow periods, high plant densities and limited crop rotations have inevitably led to declining soil fertility. Soils are mostly acidic in reaction and are deficient in organic matter. Much needed lime application to improve fertility of acidic soils is severely constrained by lack of transport facilities and fuel availability. Most of the arable land is deficient in the major nutrients and low in micronutrients. Nitrogen deficiency is the most common.

Despite the gradual increase in fertilizer use in the recent past, soils in the DPR Korea are being heavily mined of nutrients with more nutrients being drawn from the soil than replaced. This is resulting not only in lower yields but also is reducing the efficiency of farm investments and inputs. To tackle the problem of depleting soil nutrient reserves and for maintenance of soil fertility, augmentation of nutrient supply is imperative. DPR Korea, thus, remains heavily dependent upon mineral fertilizers for its food production programme, which must either be manufactured within the country at substantial energy and raw material cost or alternatively imported.

Soil test based fertilizer recommendations have been in vogue in DPR Korea, in the pre-1990s. Soil samples used to be drawn and analyzed every three years on a large scale. Subsequent to calamities since the mid-nineties, soil analysis has a six-year cycle. Due to lack of resources, soil testing programme suffers from outdated equipment; shortage of chemicals, glassware, and technical staff acquainted with latest techniques; prevalence of old methodology and, inadequate research base. This has affected the efficiency of soil test programme and even sometimes the validity of the soil test results.

Micronutrients assume greater importance in the context of double cropping programme. However, micronutrient analysis facilities in general are not available. A model soil test laboratory in South Pyongan with the support of FAO funding has been recently set up. Similar soil testing facilities, in each of the provinces of South Pyongan, North Hwanghae, South Hwanghae, South Hamgyong and Kangwon are needed.

A comprehensive soil fertility management program involving the use of lime, fertilizer, farmyard manure, green manure crops and rotations with leguminous crops is the obvious need for enhancing the soil productivity.

Fertilizer Production, Demand and Supplies

Fertilizer Production and Raw Materials

Domestic fertilizer nitrogen and phosphate requirements were met previously by the national fertilizer industry. However, the shortage of foreign exchange to buy the required feedstock and the raw materials has put constraints on domestic fertilizer production. Installed capacities have been affected also by technological obsolescence, ageing plants, difficulties in the replacement of old equipment and the provision of spares.

Nitrogenous fertilizers are produced at three major units, located at Hungnam, Namhueng and Undok County. Urea, ammonium nitrate and ammonium sulphate are the three main types of fertilizer produced by these units. Urea plants located at Namhueng and Hungnam use naphtha and coal as feedstock. Ammonium nitrate production at Hungnam is based on water electrolysis. The July 7 Complex at Undok county uses fuel oil as feedstock (IFAD, 1997; FAO 2000; FAO 2001). The production capacity of the units is given in Table 5. Domestic fertilizer production during the past few years is given in Table 6. The capacity utilization of these plants is low.

Table 5. Nitrogen Fertilizer Production Units and their Capacity

Production Unit	Product	Capacity ('000 t)	
		Product	Nutrient (N)
Hungnam	Urea	170	78
	Ammonium Nitrate	180	61
	Ammonium Sulphate	170	35
Namhueng	Urea	360	161
	Ammonium Sulphate	4	0.8
July 7 Chemical Complex, Undok	Ammonium Nitrate	80	27

Single superphosphate (SSP) is produced domestically. Low-grade rock phosphate reserves are mined at several locations. Sulphuric acid requirements are met through imports. Some quantities are also available through fractionation of crude naphtha at the refineries.

Table 6. Domestic Production of Fertilizers

Year	1999	2000	2001	2002	2003	2004	2005
Production N only (000 t)	63.0	37.5	N.A.	18.0	32.0	56.5	56.0

DPR Korea has not been able to develop its domestic resources of potassium and has remained dependent on imports to meet the national requirements for potassic fertilizers. The Sariwon Potassium Fertilizer Complex, with an annual capacity of 3 million tonnes of potassium feldspar, as and when completed is expected to meet the potassium fertilizer needs.

No documented reserves of natural gas and crude petroleum exist. The country relies entirely on imports of crude petroleum to meet the raw material requirements of its fertilizer plants located at Namhueng and Undok county. Leave apart the technological obsolescence and other bottlenecks relating to production; DPR Korea fertilizer plants energy requirements may be past 50 GJ/t N to produce ammonia. The conversion of ammonia to urea requires an additional 25 GJ/t N. With one barrel of oil representing approximately 6 GJ of energy, and one tonne of nitrogen in urea requiring 75 GJ to produce, these fertilizer plants annual requirements for oil imports to run at capacity is estimated as 2.36 million barrels of oil. The opening of onshore and offshore oil and gas exploration to foreign companies in 2004 has the implicit objective of discovering hydrocarbons in the Tachon Rajin area and offshore west coast.

As far as Hungnam coal based fertilizer plant is concerned, its raw material requirements can be met indigenously as there are substantial reserves of coal, estimated at 1.8 Gt. The major coal resources are located in Anju, Kangdon, and the Sunchon areas of South Pyongan province; the Paegam area of Ryanggang province (Ryanggang-Do); and the Saebjol area of North Hamgyong province .

Abundant resources of limestone exist to meet the acid soil reclamation needs. Limestone resources are estimated to be 60 billion metric tonnes (Gt). Gypsum, however, is mostly imported from overseas.

Humanitarian Assistance / Fertilizer Imports

During 2004, about 72 percent (165 810 tonnes) of the total fertilizer nutrient consumption was provided as 'humanitarian assistance' by the Republic of Korea (137 220 tonnes), the European Union (21 362 tonnes), FAO and various NGOs. Following the Government's request for 'cessation' of humanitarian assistance, more particularly food aid, there were no further donations by the EU and international agencies in 2005. However, the Republic of Korea donated about 300 000 tonnes of fertilizer material during 2005. Till now, 150 000 tonnes fertilizer material have been donated by the Republic of Korea for the current year (2006). There is an additional demand of 300 000 tonnes to be delivered during the later part of 2006. The Republic of Korea's fertilizer aid programme has been kept in abeyance since July 2006. However, the food aid has been resumed following heavy losses caused by the recent floods in DPR Korea.

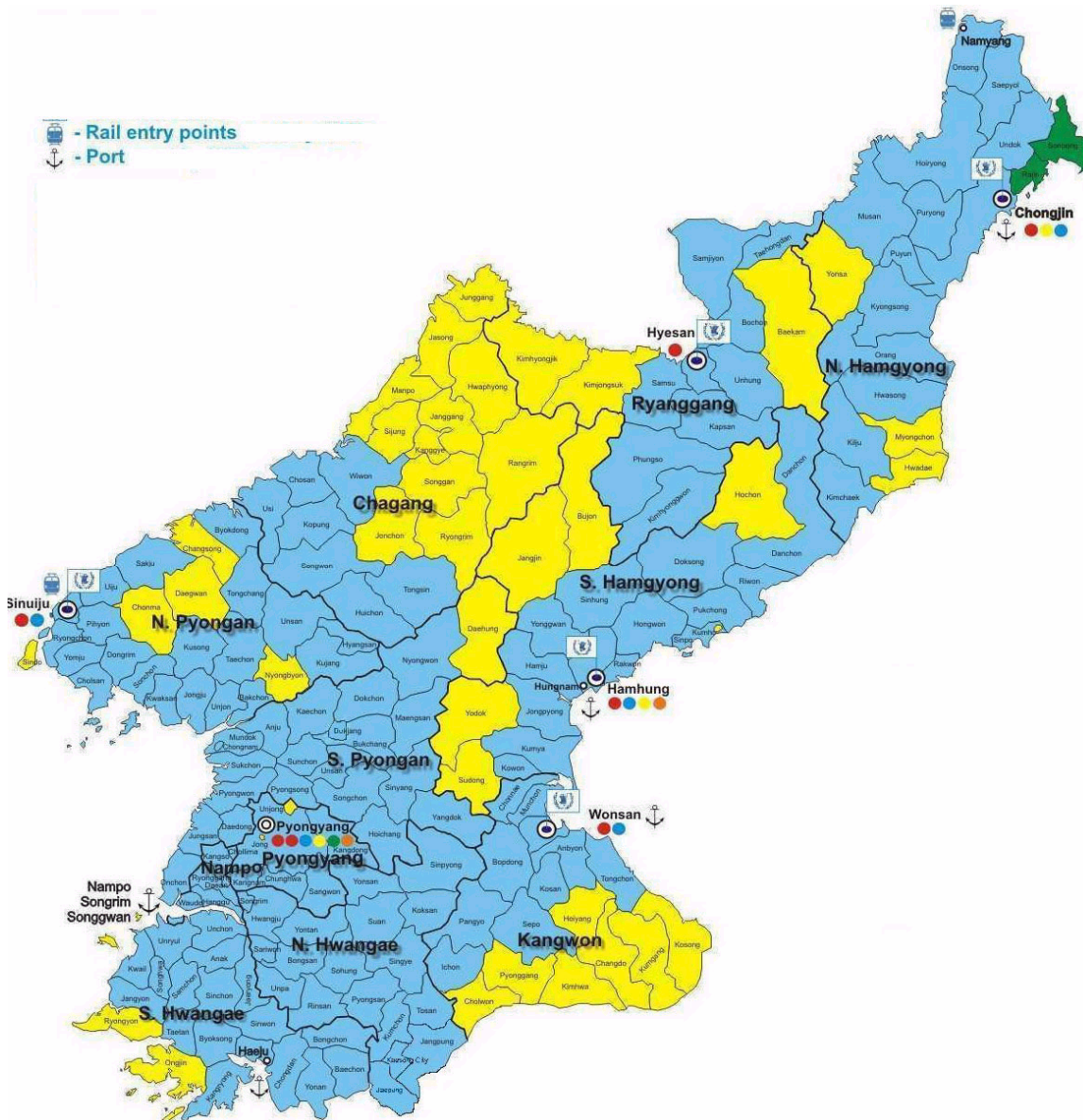
The imported fertilizer products mainly consist of urea, di-ammonium phosphate, muriate of potash and NPK complexes of various grades. DPR Korea's major trading companies are state-owned. Korea Non-ferrous Metals Export & Import Corporation is a major trading company concerned with imports of chemical products including fertilizers.

Logistics

The domestic production points (Namhueng, Hungnam and Undok) are well connected by rail to the main consumption destinations. North Korea's major ports for handling trade consignments include Chongjin, Nampo, Hungnam, Najin, Haeju, Sonbong, Wonsan and Songnim. The three major operating domestic railroad networks are: the Kaesong-Sariwon-Pyongyang-Siniju line running along the west coast; the Wonsan-Hungnam-Chongjin-Najin line along the east coast; and the Pyongyang-Wonsan Line, which links the eastern and western points on the Korean Peninsula.

The fertilizer shipments need to be planned for arrival at the designated ports at least a month in advance of the sowing season (beginning May for summer crops and beginning September for winter crops) in order to ensure timely application to the crops. The fertilizer supplies from the production points and ports are carried by rail to the nearest railway station of the identified cooperative farms in accordance with the distribution plan finalized earlier on the basis of requirements worked out taking into account the cropped area, fertilizer dosage and overall allocation taking into account scarcity situation.

Figure 4. Ports and Railway Entry Points for Import Consignments



The cooperative farms arrange for the transportation of the allocated quantity of fertilizers from the railway station to their farms through their own trucks/tractors. The Ministry of Agriculture supervises the transportation of the fertilizer consignment through the rail and provides necessary intimation relating to the arrivals of the consignment to the concerned cooperative farms. Each of the cooperative farms has its own warehouse to keep the fertilizers in proper condition till the time of their application.

Fertilizer Distribution / Allocation Strategy

The policy of the DPR Korea government regarding fertilizer distribution is based on two main principles. It should be equitably distributed, and, within the constraints of availability, it should be allocated according to each area's production potential.

The main crops, rice and maize, have an advantage over double crops in terms of yield, response to inputs and dietary preference. Returns from fertilizer use are higher with main crops compared with double crops. The late planting of main crops in double cropped areas can commonly result in a yield reduction of up to one t/ha at the same fertilization level. But despite the fact that the economic returns from fertilizer use on the main crops are higher in comparison to the returns from double crops, the double crops improve food security through additional food grain availability and also ensure supplies during the lean period.

Of the three double crops i.e. winter wheat, spring barley and spring potatoes, winter wheat is considered the most reliable, since it has sufficient time to become established and is better able to deal with harsh winter and drought situations. It normally matures on time. There is also a dietary preference for wheat. Winter wheat yields are normally higher than those of spring barley. Although the productivity of potatoes is higher, it is a relatively new dietary innovation and it is also subject to weather uncertainties (drought) and low yields due to early harvest.

There is scope for some rationalization of the overall strategy of input allocation. The experience gained so far suggests the following preferential sequence for the application of nutrient resources: Main crop rice>Main crop maize>Main crop potato>Winter wheat>Spring barley>Spring potato (FAO, 2001).

In view of the limited availability of fertilizers, their application might be focused on those provinces and areas that ensure best returns in terms of crop yields per unit of nutrient applied.

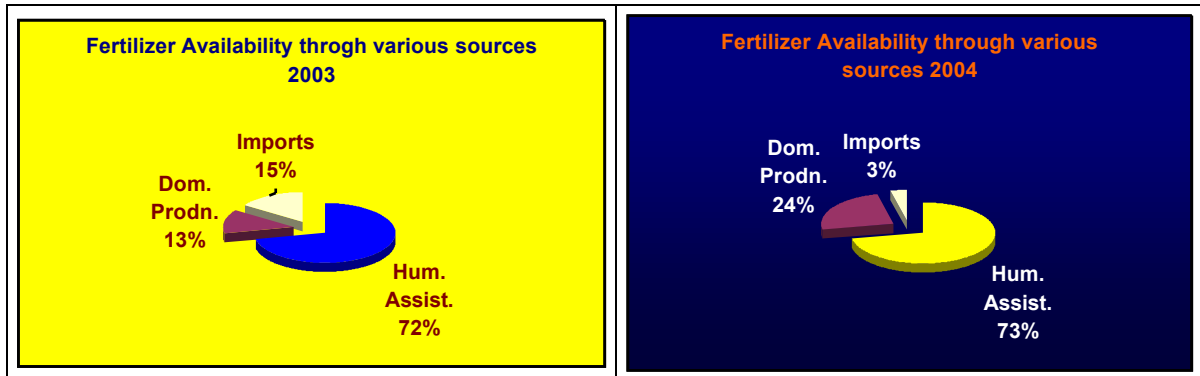
Fertilizer Requirements, Availability and Consumption

The annual requirement of fertilizers in DPR Korea is estimated at around 700 000 t of nutrients to maintain adequate levels of crop production. In the light of increased cultivation in (i) coastal areas previously flooded and where considerable areas have been reclaimed, and (ii) sloping lands, where at least 1 million 'new' hectares have been encroached in the past 5 years: this figure could probably be re-adjusted upwards. However, the availability of fertilizers over the years has been significantly lower than the requirements and has been continuously falling since 1989 reaching it's lowest in 1998. The domestic production of fertilizer having declined to a level of less than 10 percent of total requirement, there is an increasing reliance on fertilizer imports to ensure adequate availability. Fertilizer imports, however, suffer on account of shortage of foreign exchange reserves. During the period following 1998, humanitarian assistance has helped to sustain the fertilizer availability and prevent further fall in fertilizer consumption.

Although availability through humanitarian assistance has helped to improve the availability scenario, it has not been sufficient to fill the overall gap.

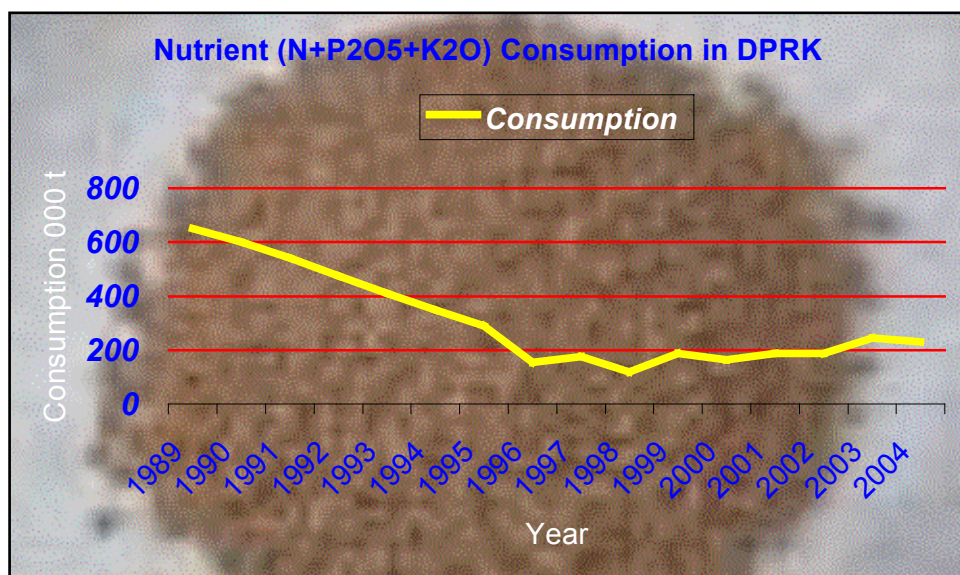
Availability of fertilizers from various sources for application in agriculture during the years 2003 and 2004 is depicted in Figure 5.

Figure 5. Availability of Fertilizers from Various Sources in DPR Korea



According to the Ministry of Agriculture, 230 173 nutrient tonnes of fertilizers were used in DPR Korea during 2004, compared with 244 512 nutrient tonnes in the previous year - a 6 percent reduction (Figure 6). About 166 000 tonnes was received as humanitarian assistance from the Republic of Korea, European Union, international agencies and NGOs. Domestic production amounted to 56 524 nutrient tonnes, a 75 percent increase on last year. This was reflected in a substantial reduction in commercial imports (8 161 tonnes as opposed to 37 706 tonnes last year). Of the total used, 67 percent was nitrogen, mostly in the form of urea; 16 percent was phosphorus; and 17 percent was potassium.

Figure 6. Consumption of Mineral Fertilizers in DPR Korea



Low domestic production of fertilizers and imports limited by scarce foreign exchange have restricted the availability and consumption of mineral fertilizers. Consumption has fallen considerably compared with the pre-1990 years.

Mineral fertilizer nutrient consumption from 1997 to 2004 is given in Table 7.

Table 7. Fertilizer Consumption in DPR Korea, 1997-2004
(nutrients in thousand tonnes)

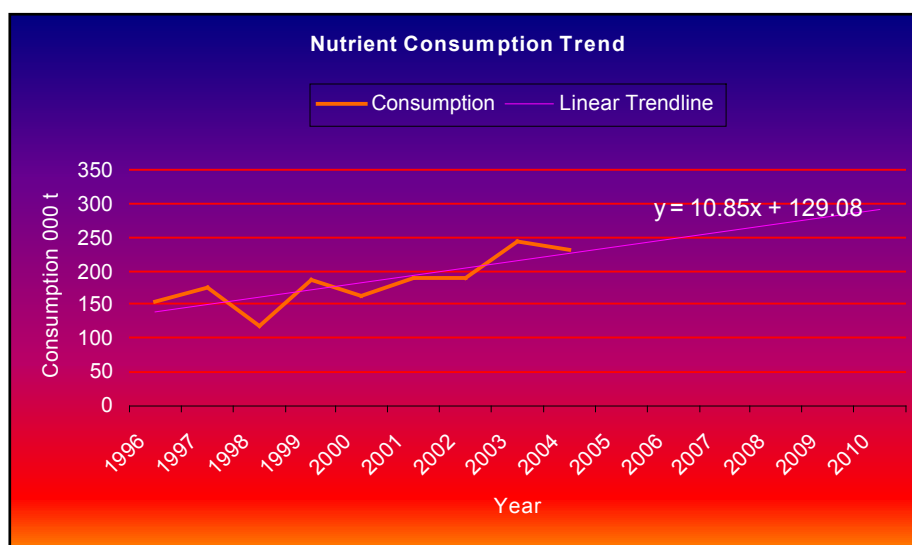
Year	Nitrogen	Phosphorus	Potassium	Total
1997	127.68	24.60	22.80	175.08
1998	92.82	18.15	7.20	118.17
1999	133.98	24.90	28.00	186.88
2000	110.88	19.94	32.28	163.10
2001	132.2	26.6	30.7	189.50
2002	135.36	23.29	30.45	189.10
2003	166.43	37.87	40.19	244.49
2004	153.51	37.43	39.24	230.18
2005				

Fertilizer consumption has revealed improvement during the past years – having risen from 118 thousand tonnes in 1998 to 230 thousand tonnes in 2004.

Figure 7 presents the growth trend and projections based on linear growth.

Consumption by 2010 is projected to be in the range of 280 – 300 thousand tonnes. With little prospects of increase in domestic production, the major share, say about 80 percent, has to come from outside sources.

Figure 7. Nutrient Consumption Trend in DPR Korea and Growth Projections



Fertilizer Consumption Pattern – Province Wise

Fertilizer consumption in the various provinces is shown in Table 8.

North Pyongan, South Hwanghae, South Pyongan, North Hwanghae, South Hamgyong and Kangwon are the major fertilizer consuming provinces.

Table 8. Use of Fertilizer in DPR Korea by Province, 2004

Province	Nutrients (000 t)		
	N	P ₂ O ₅	K ₂ O
Pyongyang	5.10	1.47	1.50
South Pyongan	27.86	6.60	6.56
North Pyongan	28.07	6.51	7.14
Jagang	5.95	1.42	1.44
South Hwanghae	35.35	8.42	8.56
North Hwanghae	16.38	4.03	4.28
Kangwon	8.07	2.30	2.33
South Hamgyong	13.22	3.55	3.58
North Hamgyong	7.77	1.85	2.47
Rygang	4.74	1.05	1.15
Kaesong	1.00	0.23	0.23
TOTAL	153.51	37.43	39.24

Fertilizer Usage Crop Wise

In view of the poor nutrient status of the soils of DPR Korea and the scarcity of fertilizers and other nutrient resources, it is important that the available fertilizers should be used as efficiently as possible. Rates of fertilizer application based on soil tests represent one of the most appropriate tools for ensuring higher levels of fertilizer use efficiency. However, due to various bottlenecks with the soil testing programme, mostly general fertilizer recommendations are in use. General recommendations for various crops are provided in Table 9. Nurseries for the main crops are heavily fertilized. Recommendations for fertilizer use for the rice and maize crops for the Eastern and Western Zone are provided in Annexes I and II.

Table 9. Mineral Fertilizer Use Recommendations in General for Crops*

Crop	Nutrient use (kg/ha)		
	N	P ₂ O ₅	K ₂ O
Rice	164	26	26
Maize	164	26	26
Potato	103	34	34
Winter Wheat/Barley	95	26	26
Spring Barley	89	20	20
Spring Potato	66	34	34

*Source: FAO, 2003 a

Average consumption of fertilizers for the two major crops of DPR Korea viz. rice and maize is provided in Table 10. Average fertilizer consumption by both the crops is well below the recommended rates for obtaining high yields.

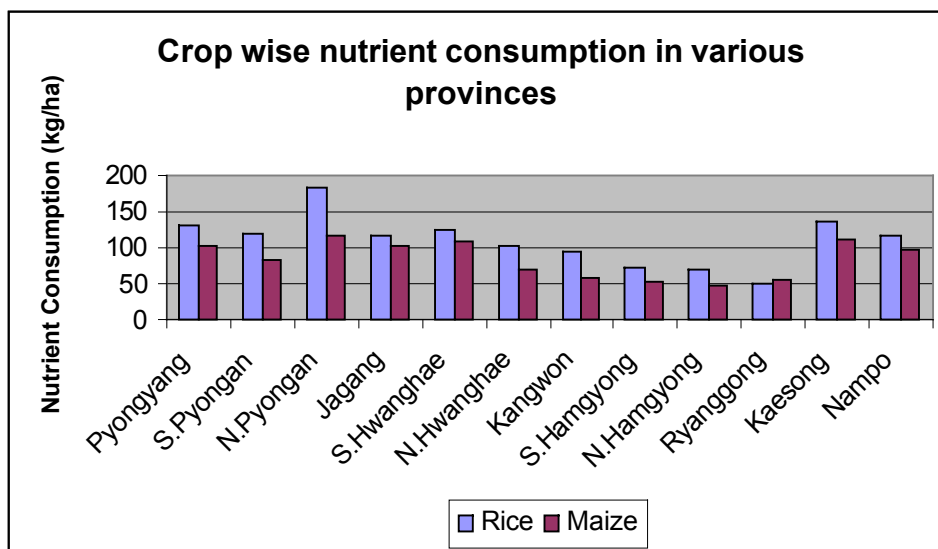
Table 10. Nutrient Consumption for the Main Crops*

Crop/Nutrient	(nutrients in kg/ha)			
	N	P ₂ O ₅	K ₂ O	Total
Rice	87.8	14.8	20.0	122.6
Maize	59.6	13.3	18.0	90.9

*Source: MOA, DPR Korea, 2001

Figure 8 gives the province wise nutrient consumption (N+P₂O₅+K₂O) pattern for the main crops. Nutrient wise break up is provided in Annex III.

Figure 8. Province Wise Nutrient Consumption Pattern for the Main Crops



Good Agricultural Practices with Relevance to Nutrient Management

With large cultivation areas under undulating and sloping terrain, leading to soil erosion and thereby loss of soil fertility, soil conservation assumes considerable importance. While significant measures relating to soil conservation and control of soil erosion are in place, lack of machinery and equipment coupled with fuel shortage act as a bottleneck.

Soils are mostly acidic in reaction and are deficient in organic matter. Much needed lime application to improve fertility of acidic soils is severely constrained by lack of transport facilities and fuel availability.

High yielding crop varieties have been introduced on a large scale. However, the exploitation of their full yield potential is hampered due to low soil fertility and lack of fertilizer input. Scope exists for further improvement of nutrient use efficiency especially under rice cultivation with the adoption of improved technologies (FAO, 2003 b). Lack of agro-chemicals to control pests and diseases is another major bottleneck.

Alternating a cereal-cereal rotation with a cereal-legume rotation at regular intervals could be beneficial from the viewpoint of soil fertility maintenance and breaking regular cycles of pests and diseases. Inter-cropping with leguminous crops might usefully be promoted. Crop rotations involving legume crops are being developed. The Swiss Agency for Development and Cooperation (SDC) is giving assistance to explore crop diversification opportunities through field trials and demonstrations. Cropping patterns with green manure crops such as spring oats (Chinese variety: Jin Yan Za), common vetch (Chinese variety: Jian She Wandu) and red clover are being developed as a component of the Project for Sustainable Agriculture, in Miru Hills, North Hwanghae.

With the soil testing programme suffering from outdated equipment; shortage of chemicals and glassware, mostly the blanket fertilizer recommendations are in use. However, due care is observed in making efficient use of fertilizers through split application of nitrogenous fertilizers and band application of phosphatic and potassic fertilizers.

Though under the present state of agriculture, soil nutrient mining is a foregone conclusion, soil nutrient balance assessment based on appropriate methodologies suited to various agro-soil-climatic conditions and the region specific nutrient flows, need to be carried out in order to have an appropriate measure of the resulting impact of current agricultural practices on soil productivity (FAO, 2003 c; Roy and Misra, 2005).

In order to tide over the tight situation relating to fertilizer availability, considerable emphasis on the use of organic fertilizers has been placed. Each of the cooperative farms devotes substantial energy and resources for production of organic fertilizer such as compost, based on utilization of animal, crop and human wastes. Nevertheless the need for adoption of more efficient and quick organic residue recycling methodologies is imperative (FAO, 2003 d). Besides, other alternatives such as ash are also used as a source of potash. Limited availability of biomass and the dwindled population of livestock have acted as constraints on production of organic fertilizers.

EM (Effective Micro-organisms), a bio-fertilizer, is practiced for various crops. Usually, EM is more effective for vegetable crops. Its efficacy is sometimes not very well established for cereal crops.

Looking to the scarcity of plant nutrient resources, the development of an Integrated Plant Nutrition System (IPNS) approach is called for. This approach takes a holistic view of the management of soil fertility and plant nutrition for a targeted yield, based not only on cropping and farming systems but also on systems adapted to distinct geographical areas (Roy et. al, 2002). Appropriate combinations of various types of plant nutrients in different situations need to be designed to ensure balanced plant nutrition, high yields, sustainable soil fertility and reduced nutrient losses.

Acknowledgements

The author is thankful to the FAO and IFAD for providing visit opportunities to DPR Korea through various assignments. Thanks are also due to the Government of DPR Korea, UNDP, WFP, OCHA, SDC, EU and various NGO representations in Pyongyang for valuable information on the subject.

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ANNEXES

Annex I. Nursery Fertilizer Use Recommendations for Rice

Fertilizer	Recommendation (per unit nursery area)*	
	Western Area	Eastern Area
Humus Soil	7.5-9 Mt	8.4-9.6 Mt
Urea	46-55 kg	51-59 kg
Single Super Phosphate (16%)	150-180 kg	168-192 kg
Muriate of Potash (50%)	15-18 kg	16.8-19.2 kg

*Eastern Region 280-320 Pyongs ((0.09-0.11 ha); Western Region 250-300 Pyongs (0.08-0.10 ha)

Annex II. Nursery Fertilizer Use Recommendations for Maize

Fertilizer	Recommendation (per unit nursery area)*	
	Western Area	Eastern Area
Humus Soil	10-12 Mt	15 Mt
Urea	13-15 kg	18 kg
Single Super phosphate (16%)	210-240 kg	300 kg
Muriate of Potash (50%)	4-5 kg	6 kg

*Eastern Region 100 Pyongs ((0.033 ha); Western Region 70-80 Pyongs (0.023-0.026 ha)

Annex III. Plant Nutrient Consumption pattern for Rice and Maize – Province wise* (kg/ha)

Province	Rice			Maize		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
Pyongyang	92.0	16.6	23.0	74.9	10.6	18.0
S.Pyongan	79.6	17.7	22.0	55.2	12.4	16.0
N.Pyongan	126.2	20.8	35.5	75.6	15.7	25.5
Jagang	92.6	12.7	11.0	72.0	17.7	13.5
S.Hwanghae	85.3	18.9	19.9	63.8	19.2	25.0
N.Hwanghae	68.9	13.5	19.9	39.9	12.4	16.0
Kangwon	88.2	3.0	2.5	57.9	1.5	-
S.Hamgyong	65.7	2.5	3.0	40.5	4.2	7.5
N.Hamgyong	63.8	1.8	3.5	44.7	1.6	0.5
Ryanggong	50.2	-	-	56.0	-	-
Kaesong	77.5	19.8	38.5	63.4	19.9	28.0
Nampo	79.8	18.7	17.5	57.7	18.7	21.0
Average	87.8	14.8	20.0	59.6	13.3	18.0

*Source: MOA, DPR Korea, 2001