REPUBLIC OF KOREA

EXECUTIVE SUMMARY

The agricultural water and farmland are two essential resources that should be conserved to ensure the sustainable agriculture and the sound rural society. The natural and socio-economic environments in Korea urgently require the conservation of agricultural and rural water in its quantity and quality.

The annual amount of total water consumption is estimated as 23.8% (30.1 billion m^3) out of the total amount of annual water resources (126.7 billion m^3) in Korea. Of this amount, 50%(14.9 billion m^3) out of total consumption is used for agricultural production. Pollutants from point sources such as municipal sewage, industrial wastes and livestock wastes and from non-point sources such as fertilizers and pesticides applied over the agricultural system have deteriorated the quality of agricultural water. Its organic pollutant and highly concentrated nitrate and phosphorus known as the cause material for lake and reservoir eutrophication characterize contamination of agricultural water.

Four most significant national issues for the development and management of the water for food and rural development are identified as follows:

The most significant issue is the development of agricultural and rural water resources under the spirit of environmentally sound and sustainable development. The construction of medium size multipurpose dams and irrigation reservoirs is recommended for supplying the increased water use. Enhancing existing reservoirs is advisable because of its fruitful merits. Linked operation of

dams in a basin or transfer of water between different watershed areas is also the apparent method within some degree of limitations.

The second is water saving by a good water management and reasonable maintenance. The water saving is the most environmentally protective and sustainable conservation method for the sake of its advantages as well as its effectiveness on reducing the new construction needs to meet the increased water demand. The effective use of reservoir storage, water saving irrigation, construction of concrete ditch, and water management by Telecontrol/Telemetering (TC/TM) system are the relevant methods fall into this category.

The third is protection of water from pollution. Watershed management is essential. Pollutant sources should be regulated by prohibiting the discharge of themselves. Fundamental environmental protection facilities must be broadened and enhanced. Water quality monitoring system should also be strengthened. Ground water should be conserved.

The fourth is the rearrangement of water management organizations and water laws. Many kinds of water laws must be unified and clarified. Two independent organizations for the agricultural and rural water development and for the management and maintenance of developed water, respectively, should be merged into one agency for more effective operation in the forthcoming 21st century.

1. OVERVIEW OF NATIONAL POLICIES AND DEVELOPMENT PLANS

Korea is now being recognized as one of the most successful Asian countries in overcoming the recent economic peril. A strong and consistent policy mixed with fiscal and monetary policy instruments has been focused on increasing the efficiency of the whole economy and stabilizing the foreign exchange market.

This recent economic situation has been the most severe crisis since 1960s, which was caused mainly by unfavorable domestic business environments including weakness of the financial market structure, fundamental weakness of the economic structure, and partly by the worldwide economic recession and lack of information on foreign financial markets.

The agricultural sector was not excepted from the peril to the whole economy. The economic crisis led to a decrease in farm incomes because of high production costs, leading in turn, to an increase in farm debts for the individual farm household.

The new Government, launched in February 1998, has taken a series of countermeasures to overcome the economic crisis and thereby to revitalize the national economy.

It is foreseen that within the agricultural sector in Korea in the 21st century the market will be open, and its competitiveness will be significantly developed. The government's agricultural policy would shift to a free open market system under the WTO system. As the world market for agricultural products is foreseen to be unstable due to the increasing world population and global climatic changes, there will be greater concern about food security for all. This was also noted at the World Food Summit held in November 1996. Internally, besides supplying agricultural products, non-trade concerns about agriculture and rural communities, such as food security, environmental protection and balanced regional development, which will not reflect in the market price, are expected to increase. As a result common interest in the economic and social safety nets would be widely expanded. A stable supply of agricultural products of high quality will be necessary due to the changes in consumer preferences in food products. Significant changes in the agricultural marketing system are also expected as technology develops in many areas. Nation- and region-specific farming will be accelerated in accordance with the development of world agricultural market system. A harmonious policy for the unification of South and North Korean agricultural sectors, which would contribute to a future unified Korea, should be considered. These situations require continuous investment in the agricultural sector, but

inefficient management of agricultural funds in the past becomes one of the problems, and therefore increasing investment efficiency and reforming the relevant organizations are strongly suggested.

Korea has a relatively high annual rainfall at 1.3 times the world average. However, the average amount of rainfall per capita per annum is about one-ninth of the world average because of the high population density; this is the main reason for a possible water shortage. Large seasonal variations in rainfall frequently result in floods in the summer rainy season and drought in spring and winter. Korea also has difficulty in managing water resources because the amount of rainfall varies from region to region due to the varied geographical characteristics. A stable water supply for rice production is very important because rice is a staple food. Water resource development for agricultural needs therefore has priority among public investment plans.

Changes in farming patterns such as direct seeding for paddy rice and agricultural mechanization have led to increased demands for peak irrigation water. Value-adding efforts through crop diversification and high quality production have also increased needs for irrigation water. Moreover, urbanization and industrialization of rural areas are additional sources of residential and industrial water demands. Water contamination caused by residential, industrial, and livestock spills will make the water shortage problems worse in the 21st century. Water distribution will be a critical issue among the users, of which the portion of agricultural users will decrease from its current majority.

2. PRESENT STATUS OF WATER

Korea has 1,274mm of average annual precipitation, which is estimated at 126.7 billion m^3 of water in volume. Out of 126.7 billion m^3 of water, 69.7 billion m^3 discharges to rivers and streams showing a 55% runoff rate and 57 billion m^3 evaporates or infiltrates as a direct loss. Total available surface and ground water is estimated at 47.2 billion m^3 which includes 23.0 billion m^3 of river flows during the non-flood season, 10.8 billion m^3 of stored water in multipurpose dams and agricultural reservoirs and 13.4 billion m^3 of ground water.

Water demand has been steadily increasing for the last several decades due to the increase in population, irrigation area and industries, as well as the rapid expansion of urban areas. The water demand in 1994 amounted to about 30.1 billion m^3 which comprises 6.2 billion m^3 of municipal use, 2.6 billion m^3 of industrial use, 14.9 billion m^3 of agricultural use and 6.4 billion m^3 of instream flow augmentation. Half of the total water demand came from agricultural use.

The usable water potential is estimated at 83.1billion m^3. The water potential consists of 69.7 billion m^3 of river discharge and 13.4 billion m^3 of ground water.

Of the 69.7 billion m^3 of surface water potential, about 27.5 billion m^3 (17.2 billion m^3 of river flows and 10.3 billion m^3 of reservoir storage) is being used and the remaining 42.2 billion m^3 is assumed to be the potential to be developed. Excluding 3.4 billion m^3 of developed ground water (1997), of the 13.4 billion m^3 of total available ground water, 10 billion m^3 becomes potentially developable ground water. Therefore, the amount of water potential to be developed totals 53 billion m^3, which are 42.2 billion m^3 of surface water and 10.8 billion m^3 of ground water.

According to the long-term plans for water resources development, approximately 5.1 billion m^3 of surface water is scheduled to be developed by the end of 2011. The plan includes the construction of 28 multipurpose dams with a storage capacity of 4.3 billion m^3 and many agricultural dams with a total storage capacity of 0.8 billion m^3. A great number of small-scale

ground water development projects will be executed by various sectors. However, water resources development has become more difficult in recent years due to an increase in construction and compensation costs, limited appropriate dam sites, and strong opposition from the inhabitants and environmental concerns.

About 18,000 agricultural dams together have 3.0 billion m^3 of effective storage capacity and irrigate about 506 thousand ha of rice paddies. Most agricultural reservoirs have small storage capacities with less than one million m^3 and only 377 reservoirs have more than one million m^3 of effective storage capacity. The 35 existing large dams for hydro-electric power generation, municipal or industrial water supply and flood control have a total storage capacity of 13.5 billion m^3 and effective storage of 9.3 billion m^3. Seventeen large dams having a total storage capacity of 3.9 billion m^3 are currently under construction.

Since approximately two-thirds of river water flows during the three months of the flood season, much of flood discharge flows directly into sea. Therefore, only 46.7 billion m^3 from 69.7 billion m^3 of river discharge can be considered available. River discharges show considerable variation from season to season. River's discharge remains low during dry season from October to June and runs high during the wet season from July to September.

A total of 14.9 billion m^3 of water for agricultural purpose is withdrawn from reservoirs (9.4 billion m^3), pumping stations (2.7 billion m^3), headworks (1.9 billion m^3), tube-wells and other sources (0.9 billion m^3). Most agricultural water is used for paddy rice and about 500 million m^3 of water is applied for upland crops. The water for non-agricultural use amounted to 15.2 billion m^3 which includes 6.2 billion m^3 for municipal use (41%), 2.6 billion m^3 for industrial use (17%) and 6.4 billion m^3 for instream flow augmentation (42%).

In Korea, basin management to continue safe water supply mainly depends on the construction of multipurpose dams and agricultural dams as well as reforestation. The government is preparing an integrated basin management plan including water quantity and quality control in order to maintain a stable supply of clean and fresh water.

Used for domestic, industrial, agricultural and other purposes, total 3.4 billion m^3 of ground water was mined from about 946 thousand wells in 1997. The ground water use consists of 1.6 billion m^3 (47.2%) for domestic use, 1.5 billion m^3 (43.9%) for agricultural use, 200 million m^3 (6.6%) for industrial use and 79 million m^3 (2.3%) for other uses. Domestic and agricultural uses of ground water cover about 91% of the total use. The use of ground water has sharply increased in recent years. Especially in coastal areas where main river systems do not pass nearby, ground water has become a major water source.

Water pollution has accelerated since the 1970s and water quality improvement has become a major task in the 1990s. In order to monitor water quality, 1,698 water quality measuring stations are operated throughout the country: rivers (530), reservoirs (153), domestic water sources (589), agricultural water sources (300), and others (126).

Ground water table drawdown and ground water contamination occurred in some areas and many small wells have been abandoned in urban areas.

Water pollution is caused mainly by domestic, industrial and livestock wastes. A total of 398 wastewater treatment plants treat about 10 million m^3 of waste discharge and many other plants are under construction or are planned.

Damages to crops by high salinity of irrigation water do not occur because irrigation water generally does not contain excessive salts and more than 1,000 mm of yearly precipitation flushes salts in soils.

Efficiency of agricultural water use is reported to be 80~85% for rice irrigation and 60~85% for upland crop irrigation. The measure of efficiency in rice irrigation includes only seepage loss through canals while operational losses are not properly counted. Therefore, actual rice irrigation efficiency seems to be considerably lower than 80%.

Wastewater recycling is in an initial stage in Korea.

Approximately 160 thousand m^3 of seawater is desalinized at 16 stations for supplying drinking water, mostly on island areas.

The total volume of annual wastewater is estimated at 8.0 billion m^3. About 45% (3.6 billion m^3) is treated and the remaining 55% (4.4 billion m^3) is discharged to rivers or reservoirs or seeps into ground water. The untreated wastewater is assumed to be the main source of water quality degradation.

3. PRESENT STATUS OF FOOD

The Republic of Korea had 99,373 km^2 of national land in 1977, which included 64,413 km^2 (64.8%) of forest, 19,235 km^2 (19.4%) of cultivated land, 2,822 km^2 (2.8%) of rivers and 12,903km^2 of other types (13%). The average amount of cultivated land per capita was 0.042 ha and the average farm household had 1.336 ha including 0.808 ha of rice paddy and 0.528 ha of upland. The mountainous forest areas cover about two-thirds of the national land. The cultivated land is mainly composed of 7,607 km^2 of uplands and 11,628 km^2 of paddy fields. The uplands comprised 473 km^2 of orchards and 511 km^2 of pastures. The cultivated land and forest have been shown to bear a sharp decreasing trend since the 1980s by being converted into roads, houses, industrial sites and other purposes.

The cultivated land is utilized to grow food crops (1,314 thousand ha), vegetables (285 thousand ha), oil and cash crops (108 thousand ha), orchards (174 thousand ha), green house crops (92 thousand ha), some permanent crops (25 thousand ha), and other products (98 thousand ha).

A total of 2,096 thousand ha of yearly land use indicates a 107.8% land use rate by growing two or three crops on some parts of the cultivated land. The cultivated areas for food crops cover rice (1,052 thousand ha), barley and wheat (70 thousand ha), miscellaneous grains (30 thousand ha), pulses (122 thousand ha) and potatoes (40 thousand ha).

The climatic conditions in Korea allow one harvest of most crops except some vegetables and food crops. The agricultural productivity of major crops is relatively high with high inputs of fertilizers and chemicals, applying advanced farming skills, intensive extension and farm mechanization. The yields of paddy rice, barley, wheat, potato, maize and pulse in 1997 recorded 6,950kg, 3,820kg, 4,040kg, 5,000kg, 4,110kg and 1,570kg per ha, respectively.

The yield of rice in Korea is the highest among all the food crops and indicates a high level in the world as well. Chinese cabbage is the most widely grown among the vegetables and yields 65,210kg per ha each season. Apples are one of the major fruits and harvests are 16,300kg per ha.

The production of major crops in 1997 were 5,449,561 tons of rice; 195,495 tons barley and wheat, 218,369 tons of potatoes, 97,402 tons of miscellaneous grains, 181,738 tons of pulses, 588,686 tons of vegetables, 2,451,653 tons of fruits and 33,393 tons of cash crops.

Rice, a staple food in Korea, was grown in more than half of the total cultivated land. In southern part of Korea barley and wheat were grown as second crops in rice paddies after harvesting the rice in November until the early 1980s. However, imported barley and wheat have replaced domestic products and nowadays only a small number of farmers grow these for their family's consumption.

Cattle, chickens and pigs are major meat products in Korea. The numbers of native beef cattle, pigs and chickens had sharply increased during the five years from 1992 to 1997.

The numbers of livestock and poultry farms were sharply reduced during the same period. The reduction of livestock and poultry farms means an increase of the number of cattle, pigs or chickens raised in a single house. The raw feed for livestock and poultry are grains, bran, vegetable protein, animal protein, inorganic substances, etc.

Chemical fertilizers have been overused and it has caused harm to soil and waters through residues. Agrochemicals were mainly used for rice, fruits and vegetables. However, overuse of agrochemicals has caused problems for human health, ecosystems, water quality, etc. Therefore, the government plans to reduce the use of chemical fertilizers and agrochemicals by promoting natural, organic fertilizer use.

A number of households have adopted environmentally favorable farming and the number is increasing continuously

A large portion of farm work, which was previously done by laborer or cows, has been replaced by agricultural machinery such as the power tiller, farm tractor, rice transplanter and combine.

Most of the rice farming work from nursing to harvesting has been mechanized and the rate of mechanization with the exception of drying rice has reached 98%.

There are four major agricultural cooperatives in Korea. The government plans to merge these cooperatives into a single cooperative.

Average nutrient consumption per capita per day is of the order of 2,957kcal, which is provided by combined intake of cereals, starchy roots, pulses etc.

A total national cereal production of 5,081,000 tons compared to 18,673,000 tons of domestic consumption in 1996 showed a self-sufficiency rate of only 27,2%. The self-sufficiency rates of rice (89.9%) and barley (73.5%) were relatively high, self-sufficiency rates of wheat (0.4%) and maize (0.8%) were extremely low. Low national production and dependence on imported wheat and maize caused an overall low self-sufficiency rate for cereals. A large portion of imported wheat and maize were used for livestock and poultry feed so that the self-sufficiency rate of cereal excluding animal feed reached 52.4%.

The self-sufficiency rates of pulses (11.7%) and oil crops (42.1%) were relatively low. But the self-sufficiency rates of starchy roots (99.6%), fruits (92.6%), vegetables (98.7%), eggs (100%), fish and shellfish (95.1%), and seaweed (126.7%) were high.

4. PRESENT STATUS OF RURAL DEVELOPMENT

As a result of concentrated efforts in agricultural water resource development by Korean government, 882,000 ha of the rice production area was converted into irrigated paddy fields by 1997, which accounts for 76% of total rice production area. However, about 50% of the irrigated paddy fields are still subject to possible damage from the drought with 10-year frequency because of poor irrigation facilities. Besides these problems, 10,000 reservoir (55% of the 18,000 existing reservoirs) do not function well due to this deterioration.

Major physiographic constraints are large mountainous areas, which are prone to erosion due to steep slopes and high intensity rainfall. These conditions limit development in the mountain area. Similarly the absolute shortage of flat plain area has led to the conversion of farming areas into industrial and urban areas. The recent development of industry as well as urbanization due to the increase of population is the major causes of the reduction in farmland.

The population as of 1997 is about 46 million, with a growth rate of 0.98%, population density of 463 persons per km^2, birth rate of 1.6 per female and death rate of 5.4(male 6, female 4.7) per 1,000 persons. The male-female ratio is 101.5%.

The farm population consists of 4.47 million (male 2.15 million: female 2.32 million) which is 9.7% of total population.

The human development index of Korea is 0.89 based on the average life span of 71.5, the literacy rate of 97.9% and the percentage of school attendance at 82%.

The Korean national economy has been steadily developed since the 1960s. The Gross Domestic Product (GDP) was US$ 480.2 billion in 1996, and dropped to US$ 437.4 billion in 1997. Gross National Product (GNP) per capita decreased from US$ 10,543 in 1996 to US$ 9,511 in 1997. The economic growth rate was 8.7% in 1995, 6.9% in 1996, and 4.9% in 1997. The gross saving ratio in 1997 was 34.6%: 24.3% in the private sector and 10.3% in the government sector.

Export volume increased sharply from US $ 1.0 billion in 1970 to US $ 63.0 billion in 1990, and it reached US $ 136.2 billion in 1997.

Household energy has been changed from coal to oil and gas during the last decade. For cooking, imported natural gas and propane gas are major energy sources. For heating, natural gas is used in the city areas and oil in the rural areas.

An autonomous system in local government was adopted in 1990, whereby local governments have increased power in administration and financing. Local governors and local assembly members are selected by direct election by the people.

5. FUTURE SCENARIOS AND AIMS

Water demand increases continuously, requiring that development is sustained in respect in water quantity as well as water quality. The national goal is to attain self-sufficiency in staple food production, and this requires irrigation water development and preservation of farmland.

Also, rural development for farm production as well as rural living conditions is necessary to achieve equitable regional living standards and to prevent a concentration of the population into the urban areas.

Considering the increase in water demand, water resources development is seriously needed. However, most of proper dam sites have been developed, and planning for new dams is difficult because of national conservation supported by environmentalists as well as because of high development costs.

Water consumption for agriculture utilizes 50% of totals the available water resources. Therefore, water saving farming needs to be developed to reduce water use in the agriculture sector and divert more water to other sectors

The on-going government plan for rural water development, which started in 1994, will be finalized in 2004. The plan aims to increase the ratio of irrigated paddy fields to the total, from

76% in 1997 to 88% in 2004. For this purpose, a total of 14,420 billion won (US$ 11.5 billion) will be invested.

The government expects that rural water development will also be achieved after 2004, and that most of the paddy fields, except those in mountainous areas, will be provided with irrigation facilities, attaining 94% irrigation in paddy fields.

Agricultural water resource development in the 21st century should aim at (1) transition of single purpose development for agricultural use into the multipurpose development, (2) site-specific and systemized water resource development, (3) developing harmonized systems of existing and newly-built facilities, (4) developing efficient water management systems, (5) expanding systems for repairing and improving the existing facilities to increase safety and use efficiency, (6) developing technology and systems for scientific and efficient water management structure(such as Telecontrol/Telemetring, or TC/TM), preparing for a decrease in the farm population and aging in rural areas, and (7)water resource development related to rural village development and agricultural infrastructure projects.

Inter-basin water resources development along the major rivers will be further studied in the future to cope with the problems of national water shortage.

For the efficient use of water and savings in management labors, automation of water management has been studied, and some pilot schemes are being executed. The automation will be expanded in response to the need for water savings and higher labor costs.

Also, the communication network, Agri-Net, will be established to give and exchange information between concerned agencies and farmers. The Agri-Net will become a useful tool for training farmers, the dissemination of new technology and the marketing of agricultural products.

A programme of farmland consolidation, on-farm development provision of irrigation and drainage canals and farm roads, and on-farm drainage improvement works has been implemented in large percentage of area and will be continued.

Operation and maintenance of irrigation systems and water management have been performed by Farmland Improvement Associations (FIA), autonomous irrigation organization with a 90-year history.

In the year 2000, a government corporation will merge all Farmland Improvement Associations, ending the 90-year history of these autonomous farmers' organizations. This change causes about after a decade in which the FIAs have lost most of their independent sources of income and seen a reduction in water charges while dependence on government subsidies has increased. While this shift in structure will produce changes, encouraging participator management will be an important issue to resolve in the future.

From the beginning of the installation of modern irrigation systems around 1910,

The irrigation association has acted as an owner of irrigation projects although under government guidance and supervision. Therefore turning over the system to the government was not necessary.

There is no private water resource and irrigation development except a number of tideland reclamation areas that were developed by private companies. All the investment costs and a part of operational and maintenance costs have been borne by the government budget since 1988.

Historically, community water rights have been recognized, and as such, water was owned by the community and not by individual farmer. Water was a social good in these days, even if self-help works were needed. After establishing Irrigation Associations from the 1910s to the 1950s,

farmers have had to pay water charges and part of the construction costs, changing the concept to be more closely tied to the economy.

Since the last decade, the concept of water had changed again from economic back to social, as a result of on the increase of subsidies.

Water charges had been based on operational and maintenance costs along with long-term loans for part of the initial construction costs. Since 1988 under the policy changes farmers have started to pay certain fixed amounts depending on the area irrigated (5kg paddy per 10a). Any shortage in operational and maintenance costs is subsidized through the government budget. As a result, farmers and the operating organization have little interest in water pricing.

The Republic of Korea shares several rivers and watersheds with North Korea. Some experts propose joint study and development for the basins, but politically it has been difficult to proceed.

6. CHALLENGES FOR THE FUTURE

Investment in water for food and rural development has increased remarkably in Korea, where the total investment since 1945 has amounted to US$17.5 billion. The corresponding increase in irrigated areas for example, was 0.188 to 0.882 million ha. Although there is evidence that investment in irrigation has declined in recent years, irrigation development will continue to receive a high priority due to limited land and water availability for further expansion.

As regards the agriculture and rural development policy, Korea has become a newly industrialized country, which means that agriculture is no longer the most important economic sector. However, increased food production and self-sufficiency in food are still important agricultural policy objectives. Even though the irrigated agricultural area has substantially increased, there remains a high proportion of farmland (usually over 50% on the basis of a 10-year drought recurrence interval) which is non-irrigated or rainfed.

The main policy objectives for water for food and rural development in Korea are (1) to establish an agricultural production structure that ensure a stable supply of staple foods and paddy rice and (2) to create a better rural living environment with coexistence among the primary, secondary, and tertiary industries in rural areas.

Several national visions for rural agriculture have been identified as follows.

1. To strengthen the development of the agricultural production infrastructure, particularly that of paddy rice for stable self-sufficiency in staple foods. This will include: the development of water resources for agricultural and rural use as a provision against drought, drainage improvement projects, the completion of un-finished large scale farmland reclamation projects for ensuring high quality farmland.
2. To establish agriculture’s production base early on to make mechanized farming possible. This will include an agricultural road improvement project, a farmland consolidation project and the development of upland production base.
3. To scale up the investment for the efficient management of water resources and related structures and facilities. This will also include the reorganization of agencies in charge of development and management of agricultural and rural water as well as rehabilitation and modernization of hydraulic structures and facilities.
4. To shift the development method for the preservation and conservation of national land and the environment. Disaster prevention and the conservation of farmland are also important from the viewpoint of national land conservation.

5. To pursue rural development where the primary, secondary, and tertiary industries coexist in rural areas. This will include the village sewage projects and integrated rural development projects.
6. To strengthen international cooperation and to study the North Korean agricultural production infrastructure as a provision for reunification.

Self-sufficiency in staple foods will be achieved through to the stable agricultural production. Living conditions in rural areas together with production infrastructures will improve as well for the creation of attractive living environments. In the 21st century, rural areas in Korea will be brought into the complex society where urban and rural populations are mixed and where areas function as a supporting background to large metropolitan areas.

Rainfall is one of the constraints to water resources development. Seasonal distribution of rainfall is concentrated in summer season (about two thirds of the yearly rainfall), causing flood damage along the rivers and in low land. And water shortage is common in the spring and winter season. Because of such hydrological conditions, reservoirs are a major source of water and supply irrigation water to 58% of all irrigated paddy fields. Unfortunately there are almost no more appropriate sites for reservoirs, and this is one of the constraints in water resources development.

Water pollution is also serious. Population increases, urbanization, industrialization and higher living standard have brought water quality problems.

Until 1988 and 1989, part of the farmers' contribution to the investment costs was made in the form of long-term loans and their yearly repayment. Upon political consideration, farmers were exempted from sharing investment costs and part of the operation and maintenance (O & M) costs. So, all the investment costs and part of the O & M costs were borne by the Government budget. This new policy limited the availability of funds for water resources development. More interest was bestowed on social and political costs than economic costs.

In Korea, the public have the impression that there is enough water, because they experience floods very often. When there is long drought, the government and the public realize the importance of water. Spring droughts are especially important to overcome by national efforts to transplant rice in its due season. In recent history, investment in water resources development has been heaviest just after drought years.

Water management in the irrigation sector has been done by Farmland Improvement Associations. Irregular rainfall requires irrigation at one time and drainage at other times. This makes good water management and saving water very difficult.

Public awareness of water development was very high about two decades ago. New irrigation systems were welcomed by farmers and local communities, because irrigated farming resulted in great increase in yield. Also, agriculture was a major industry then, which many people depended on.

Recently public awareness of the environment has increased and has lessened the public support for water resources development. Now, several reservoir sites are planned, but are caught in disputes between the government and environmentalists. Governmental efforts to persuade and guide the public are urgently very needed in order to meet future demands for water.

Korea has no international boundaries on land except with North Korea. However, the air masses which bring cloud, and rain also can bring pollution. A large amount of weather comes from the west and so air pollution in China can affect the quality of rainwater in Korea. Acid rain is found all over the Korean territory indicating that cooperation between Korea and China would be

indispensable. Mitigating air pollution in China would positively effect the Korean water resources.

Table 1. Agriculture in the national economy

Class	Units	1970	1980	1990	1996	1997(P)
GNP						
-Total	Bn.won	2,771	38,148	179,539	389,913	420,987
-Agriculture	Bn.won	646	4,773	13,262	21,094	20,661
(% of total)	(%)	(23.3)	(12.5)	(7.4)	(5.4)	(4.9)
Employment						
-Total	Thousands	9,617	13,683	18,085	20,764	21,048
-Agriculture	Thousands	4,756	4,429	3,100	2,298	2,215
(% of total)	(%)	(49.5)	(32.4)	(17.1)	(11.1)	

Source: Major Agricultural Indicators. MAF, MOFE, Korea. 1998

Table 2. Storage Capacity of Dams

(Unit: billion m^3/yr)

Classification	Total	Multi-purpose	Hydro-power Generation	Municipal & Industrial water supply	Flood Control	Agricultural Reservoir
Number of Dams	435	10	10	15	6	395
Total Storage Capacity	15.2	11.1	1.9	0.5	0.7	1.0
Effective Storage Capacity	10.8	7.6	1.4	0.4	0.5	1.0

* Agricultural Reservoirs are above 20 m of dam height

Table 3. Runoff Discharge of Rivers

(Unit: billion m^3/yr)

Total Water Resources	Losses	Average River Discharge	Major River	Small River	Other	Runoff Rate
126.7	57.0	69.7	45.9	19.5	4.3	55%

Table 4. Statues of Water Use in different Users

(Unit: billion m^3/yr)

Total	Municipal Use	Industrial Use	Agricultural	Instream Flow Augmentation
30.1	6.2	2.6	14.9	6.4

Table 5. Agricultural Water Use

(Unit: billion m^3/yr)

Total	Irrigated Paddy	Non-irrigated Paddy	Upland Irrigation	Remark
14.9	11.5	2.9	0.5	

Table 6. Ground Water Mining

(Unit: billion m^3/yr)

Total		Domestic Purpose		Industrial Purpose		Agricultural Purpose		Others	
No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
946,181	33.82	571,663	15.97	11,883	2.20	358,239	14.86	4,396	0.79
(100%)	(100%)	(60.4)	(47.2)	(1.3)	(6.6)	(37.9)	(43.9)	(0.4)	(2.3)

Table 7. Consumptive Use of Paddy Rice

(Unit: billion m^3/yr)

Paddy Area (1000ha)			Consumptive Use	Effective Rainfall	Net Duty Of Water	Gross Duty of Water
Total	Irrigated	Non-irrigated				
1163	882	281	19.01	7.69	11.32	13.32

Table 8. Number of Water Quality Measuring Stations

Class	Total	River	Reservoir	Domestic water sources	Agriculture water sources	Urban source	Industrial Waste Water
Number	1,540	530	153	582	149	52	74

Table 9. Agricultural land

Classification	Units	1970	1980	1990	1995	1996	1997(P)
Total land(A)	1000ha	9,848	9,899	9,927	9,927	9,931	9,931
Agricultural area(B)	1000ha	2,298	2,196	2,109	1,985	1,985	1,924
Ratio(B/A)	(%)	(23.3)	(22.2)	(21.2)	(20.0)	(19.6)	(19.4)
Paddy Fields	1000ha	1,273	1,307	1,345	1,206	1,176	1,163
(% of Agri. area)	(%)	(55.4)	(59.5)	(63.8)	(60.8)	(60.5)	(60.4)
Uplands	1000ha	1,025	889	764	779	759	76.1
(% of Agri. area)	(%)	(44.6)	(40.5)	(36.2)	(39.3)	(39.5)	(39.6)

Source: Major Agricultural Indicators. MAF, Korea, 1998

Table 10. Farm population and numbers

Classification	Units	1970	1980	1990	1996	1997(P)
Population						
-Total(A)	1,000	32,241	32,124	42,869	45,545	46,061
-Agriculture(B)	1,000	14,422	10,827	6,661	4,692	4,468
Share(B/A)	(%)	(44.7)	(28.4)	(15.5)	(10.3)	(9.7)
Farm numbers	1000	2,483	2,155	1,797	1,480	1,440
-Full-time farmers	(%)	67.7	76.2	59.6	56.5	58.7
-Part-time Farmers	(%)	32.3	23.8	40.5	43.5	41.3

Source: Major Agricultural Indicators. MAF, Korea, 1998

Table 11. Cropping pattern by area and production value

Area : 1000ha, Values: Billion-Won

Classification	Total	Rice	Barley	Pulses	Potatoes	Vegetables	Fruits	Others
Area	2,097	1,052	70	122	41	364	176	272
(%)	(100.0)	(50.2)	(3.3)	(5.8)	(1.9)	(17.3)	(8.4)	(13.0)
Production	28,129	8,163	294	354	540	6,356	2,524	9,448
Value	(100%)	(30.6)	(1.0)	(1.3)	(1.9)	(22.6)	(9.0)	(33.6)

Source : Major Agricultural Indicators. MAF, Korea, 1998

Table 12. Self-Sufficiency Rate of Each Food Group (1996)

(Unit: 1,000 M/T)

Products	Production	Domestic Consumption	Self-sufficiency Rate(%)
1. Cereals	5,081	18,673	27.2
Rice	4,695	5,225	89.9
Barley	288	392	73.5
Wheat	11	2,882	0.4
Maize	74	8,996	0.8