



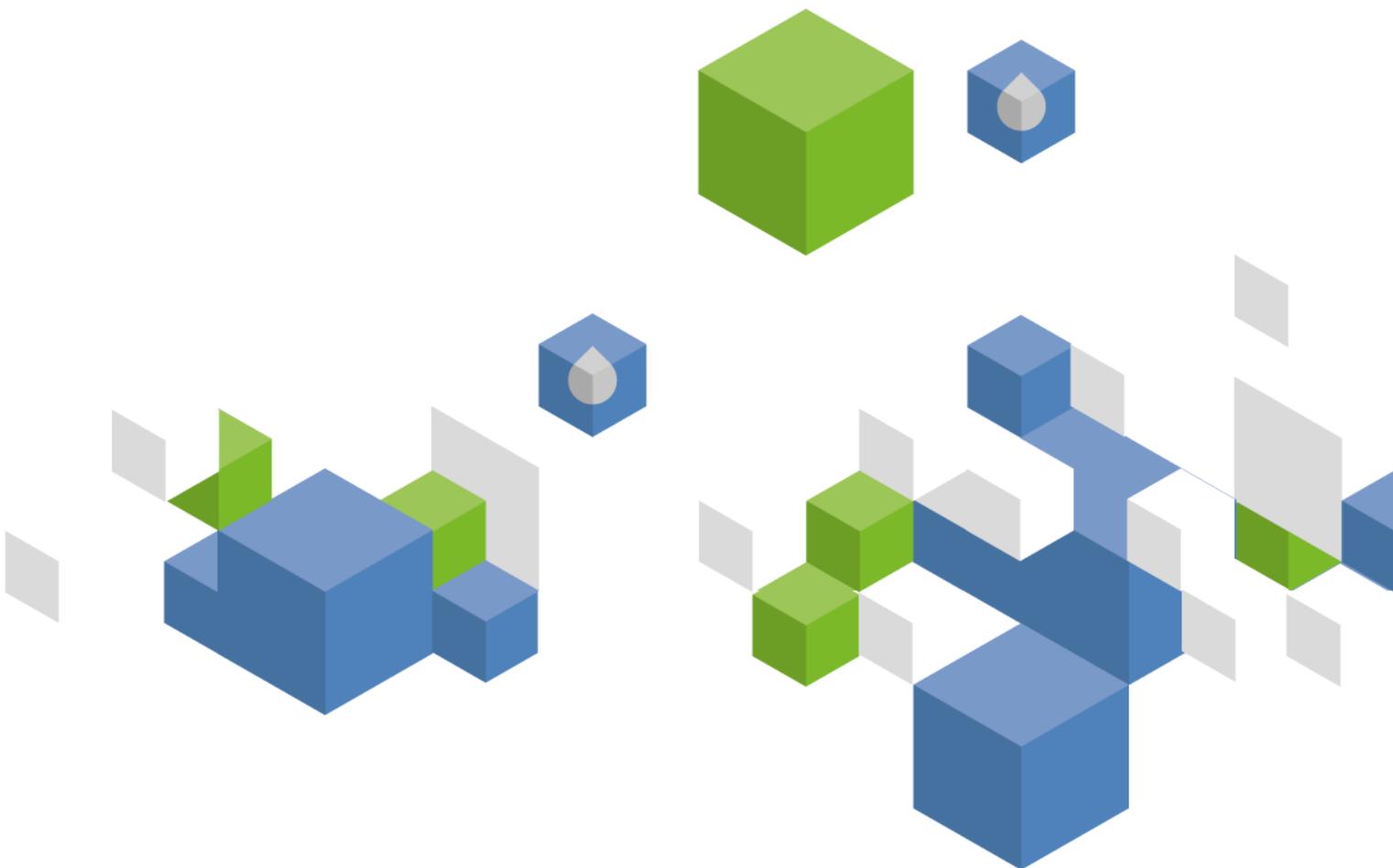
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Reports

# Country profile – Republic of Korea

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# Republic of Korea

## GEOGRAPHY, CLIMATE AND POPULATION

### Geography

The Republic of Korea is located in the semi-tropical area along the east coast of the Asian landmass. It is bounded by the Yellow Sea in the west, the Democratic People's Republic of Korea in the north, the Sea of Japan in the east, and is separated from Japan by the Korea Strait to the southeast and south. For administrative purposes, the country is divided into nine provinces and seven metropolitan cities. The capital is Seoul.

The country has a total land area of 99 900 km<sup>2</sup> and some 65 percent is mountainous, especially along the east coast with the highest point Halla-san at 1 950 m above sea level. The other main mountains are the Taebaek range, which cross the country from north to south with their highest point at Mount Sorak (1 708 m), and the Sobaek range running from the southwest to the northeast, of which the highest point is Chiri mountain (1 915 m). The plains are mainly located along the west and south coasts.

The cultivable area is relatively small and is largely spread along the southwest coast. Most of it has already been reclaimed and is intensively cultivated. In 2009, the total cultivated area was about 1 796 000 ha, of which 1 595 000 ha consisted of annual crops and 201 000 ha of permanent crops (Table 1).

TABLE 1  
Basic statistics and population

Physical areas			
Area of the country	2009	9 990 000	ha
Cultivated area (arable land and area under permanent crops)	2009	1 796 000	ha
• as % of the total area of the country	2009	18	%
• arable land (annual crops + temp fallow + temp meadows)	2009	1 595 000	ha
• area under permanent crops	2009	201 000	ha
Population			
Total population	2009	47 964 000	inhabitants
• of which rural	2009	17	%
Population density	2009	480	inhabitants/km <sup>2</sup>
Economically active population	2009	24 243 000	inhabitants
• as % of total population	2009	51	%
• female	2009	41	%
• male	2009	59	%
Population economically active in agriculture	2009	1 350 000	inhabitants
• as % of total economically active population	2009	6	%
• female	2009	44	%
• male	2009	56	%
Economy and development			
Gross Domestic Product (GDP) (current US\$)	2009	832 512	million US\$/yr
• value added in agriculture (% of GDP)	2009	2.6	%
• GDP per capita	2009	17 357	US\$/yr
Human Development Index (highest = 1)	2010	0.877	
Access to improved drinking water sources			
Total population	2008	98	%
Urban population	2008	100	%
Rural population	2008	88	%

FIGURE 1  
Map of Republic of Korea



REPUBLIC OF KOREA

FAO - AQUASTAT, 2011

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## Climate

The country's climate is determined by its latitude and geography, and there are four distinct seasons: spring, summer, autumn and winter. Winter is bitterly cold and is influenced primarily by cold Siberian fronts. Summer is hot and humid owing to the maritime Pacific high. The transitional seasons, spring and autumn are sunny and generally dry. Wind and precipitation are largely affected by the surrounding Pacific Ocean in the south and the Eurasian landmass in the north.

The mean annual rainfall is 1 274 mm, of which about 70 percent is concentrated during the summer months from June to September. The rainfall is evenly distributed over the country, with 1 300 mm in Seoul in the north, 1 100 mm in Taegu in the centre, and 1 400 mm in Pusan in the south. Typhoons accompanied by heavy rainfall during summer or early autumn often cause severe crop damage, as do the droughts before the beginning of the summer monsoon.

The mean monthly temperature varies from below freezing in winter to over 25°C in summer. Frost-free days extend from around the end of April until mid-October, varying from 175 days a year in the north to 220 days in the south. Double cropping is practiced in the south.

## Population

The total population in 2009 was about 48.0 million inhabitants, of which around 17 percent lived in rural areas (Table 1). With 480 inhabitants/km<sup>2</sup>, the Republic of Korea is amongst the countries with the highest population density. The capital, Seoul, has the highest population density, approaching 20 000 inhabitants/km<sup>2</sup> and the lowest density is in Cheju province with less than 284 inhabitants/km<sup>2</sup>. The annual demographic growth for the period 1999-2009 was around 0.5 percent.

In 2008, access to improved drinking water sources reached 98 percent (100 and 88 percent for the urban and rural population respectively).

## ECONOMY, AGRICULTURE AND FOOD SECURITY

The total population economically active in agriculture in 2009 is an estimated 1 350 000 inhabitants, amounting to 6 percent of the economically active population, of which 44 percent are women. Each farmer has on average 0.52 ha. Gross domestic product (GDP) was US\$ 832 512 million in 2009. Agriculture accounted for 2.6 percent of GDP, compared with 5.2 percent in 1999.

The absolute size of the area for rice cultivation has been decreasing continuously as such land has been diverted considerably to other purposes such as construction of public facilities, houses, factories and roads and growing of other crops. However, the ratio of the rice cultivation area to total arable land has been maintained at around 50 percent. There have been changes in the type of crop cultivated owing to changes in profitability as well as the impact from imported agricultural products.

Cultivation of grains, except rice, is decreasing as they have low profitability. On the contrary, the area of land used for growing vegetables and fruits and for greenhouse farming, which can yield more profit is increasing (MAF, 2005). Food crops grown in addition to rice are barley, soybeans, red bean, green bean, sweet potato, potato, maize, millet and sorghum. There is very little wheat cultivation because of the lack of competitiveness and therefore it is largely imported.

## WATER RESOURCES

Most of the rivers flow west and south through the plains. There are five main drainage systems, which altogether cover two-thirds of the territory:

- Han river basin in the northwest: average runoff 19.4 km<sup>3</sup>/year, drainage area 26 018 km<sup>2</sup>;

- Kum river basin in the west: average runoff 6.2 km<sup>3</sup>/year, drainage area 9 810 km<sup>2</sup>;
- Nakdong river basin in the south: average runoff 13.9 km<sup>3</sup>/year, drainage area 23 817 km<sup>2</sup>;
- Seomjin river basin in the south: average runoff 3.8 km<sup>3</sup>/year, drainage area 4 897 km<sup>2</sup>; and the
- Yeongsan river basin in the south: average runoff 2.6 km<sup>3</sup>/year, drainage area 3 371 km<sup>2</sup>.

The total annual volume of surface runoff produced internally is about 62.25 km<sup>3</sup>, while internal groundwater resources are approximately 13.3 km<sup>3</sup>. Since about 10.7 km<sup>3</sup> of groundwater resources comprise the base flow of the rivers, the total internal renewable water resources are an estimated 62.25+13.3-10.7 = 64.85 km<sup>3</sup>/year. Some transboundary rivers cross the border with the Democratic People's Republic of Korea. Compared with the annual discharge of the Han river in the Democratic People's Republic of Korea (19.4 km<sup>3</sup>/year with a catchment basin four times that of the basin flow into the Republic of Korea), the inflow to the Republic of Korea from the Democratic People's Republic of Korea is an estimated 4.85 km<sup>3</sup>/year. The total average surface water discharge in the Republic of Korea is, therefore, an estimated 67.1 km<sup>3</sup>/year, bringing the total renewable water resources to 69.7 km<sup>3</sup>/year (Table 2). Owing to the intensive nature of the rainfall and the steeper natural channel slopes, about 37 percent of the annual water resources are flood runoffs, concentrated in summer.

TABLE 2  
Water resources

Renewable freshwater resources			
Precipitation (long-term average)	-	1 274	mm/yr
	-	127 000	million m <sup>3</sup> /yr
Internal renewable water resources (long-term average)	-	64 900	million m <sup>3</sup> /yr
Total actual renewable water resources	-	69 700	million m <sup>3</sup> /yr
Dependency ratio	-	6.96	%
Total actual renewable water resources per inhabitant	2009	1 453	m <sup>3</sup> /yr
Total dam capacity	1994	16 200	million m <sup>3</sup>

During the last 60 years, a considerable effort has been made to regulate the course of rivers. Multipurpose river basin schemes have been developed for flood control, irrigation, community water supply and hydropower production. In 1997, there were 765 dams that were over 15 m high. There are more than 18 000 small irrigation reservoirs. Artificial lakes account for 93 percent of all lakes in the Republic of Korea. In 1994, the water storage for dams and reservoirs totals 16.2 km<sup>3</sup>.

In 1997, total hydropower electricity generation amounted to 5 404 GWh, representing 2.4 percent of the country's total electricity generation.

In 1996, total produced wastewater was an estimated 7 947 million m<sup>3</sup>. Only 4 180 million m<sup>3</sup> were treated.

## INTERNATIONAL WATER ISSUES

The Democratic People's Republic of Korea has built several dams on the Imjin river, a major waterway, including one a few kilometres north of the heavily armed border between the two states that have yet to sign a formal peace treaty to end the 1950-1953 Korean War. The river starts in the north and ends in the south to the northwest of Seoul. In 2009, the Republic of Korea made a complaint to the Democratic People's Republic of Korea about a sudden release of water into the Imjin river flowing across their border that left six people missing in the south. The Democratic People's Republic of Korea has failed to notify the Republic of Korea ahead of releasing water on several previous occasions, resulting in flood damage in the south (Reuters, 2009). So far, there is no cooperation between the two countries on flood control and the establishment of warning systems.

In 2005, the Republic of Korea constructed the Peace dam on the Bukhan river, the only dam in the world constructed with no reservoir. The aim of the dam is to prevent flooding coming from the Innam dam in the Democratic People's Republic of Korea.

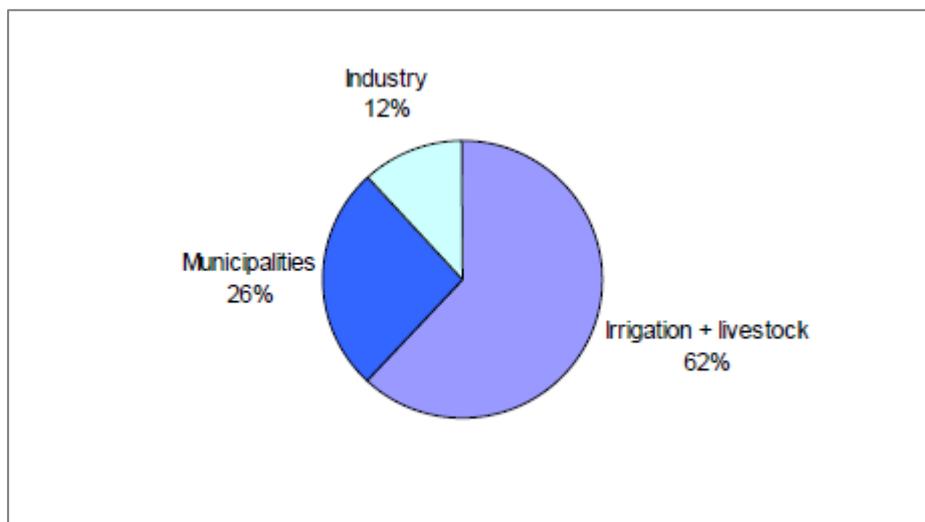
## WATER USE

In 2002, total water withdrawal was an estimated 25.47 km<sup>3</sup>, of which 15.8 km<sup>3</sup> (62 percent) for agriculture, 6.62 km<sup>3</sup> (26 percent) for municipalities and 3.05 km<sup>3</sup> (12 percent) for industries (Table 3 and Figure 2).

TABLE 3  
Water use

Water withdrawal			
Total water withdrawal	2002	25 470	million m <sup>3</sup> /yr
- irrigation + livestock	2002	15 800	million m <sup>3</sup> /yr
- municipalities	2002	6 620	million m <sup>3</sup> /yr
- industry	2002	3 050	million m <sup>3</sup> /yr
• per inhabitant	2002	549	m <sup>3</sup> /yr
Surface water and groundwater withdrawal	2002	25 470	million m <sup>3</sup> /yr
• as % of total actual renewable water resources	2002	36.5	%
Non-conventional sources of water			
Produced wastewater	1996	7 947	million m <sup>3</sup> /yr
Treated wastewater	1996	4 180	million m <sup>3</sup> /yr
Reused treated wastewater		-	million m <sup>3</sup> /yr
Desalinated water produced	2000	0.16	million m <sup>3</sup> /yr
Reused agricultural drainage water		-	million m <sup>3</sup> /yr

FIGURE 2  
Water withdrawal by sector  
Total 25.47 km<sup>3</sup> in 2002



Rapid industrialization and economic growth have changed the pattern of water demand. Municipal and industrial water withdrawal increased steadily from 10 and almost 0 percent respectively in 1975 to 26 and 11 percent respectively in 1994, while agricultural water withdrawal decreased from 90 to 63 percent in the same period.

In 2000, approximately 0.16 million m<sup>3</sup> of seawater was being desalinated at 16 stations to supply drinking water, mostly on island areas (ICID, 2002).

## IRRIGATION AND DRAINAGE

### Evolution of irrigation development

Irrigation development in Korea has a long history. Weirs (headworks) were built in the first century, and the first reservoirs were constructed at the end of the fourth century. Historical records show that in 1910 there were about 26 000 diversion weirs, ponds and dykes for irrigation water supply.

Irrigation development in the Republic of Korea can be divided into three stages:

- Stage I, before 1945, when numerous small-scale systems were constructed by mobilizing local technology;
- Stage II, 1946-1961, when existing systems damaged by the war were repaired;
- Stage III, since 1961, when large-scale comprehensive agricultural development projects have been implemented. During this stage, the Government invested large amounts from international loans for the development and rehabilitation of irrigation systems and for the improvement of technical, institutional and social aspects of irrigation.

In 1982, the estimation of water requirements for irrigation was adjusted to cover the ten-year drought frequency, and an inventory of existing irrigation systems throughout the country was prepared to identify rehabilitation requirements. As a result, many systems with insufficient capacities were categorized for rehabilitation.

In 2007, the irrigation potential area was taken as being the same as the total cultivated area, or 1 782 000 ha, since it is considered that all cultivable land is currently under cultivation. In 2002, total irrigated area was around 880 400 ha, a reduction compared to 1996, since some land has been diverted to other purposes such as construction of public facilities, houses and factories (Table 4).

Irrigation systems cover approximately half of the cultivated area. However, most of the cultivated areas are irrigated by virtually any means during the critical crop periods when threatened by drought. Typically, in high valleys where irrigation systems are not economically viable, farmers irrigate by pumping water from rivers, streams and reservoirs using small portable pumps or power tillers.

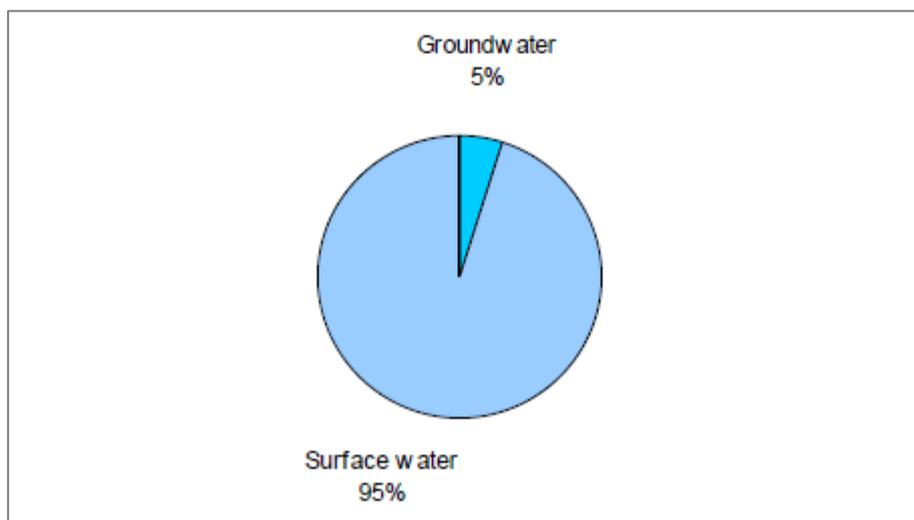
As fertile paddy fields can be more easily and economically developed on flat plains than hilly areas, more farmland and, consequently, the accompanying irrigation systems have been developed by reclaiming river plains and tidelands. This partly explains why surface drainage predominates. It is difficult to find a large and shallow river-swamp left idle. Irrigation development along the west coast is often implemented as part of tideland reclamation.

TABLE 4  
Irrigation and drainage

<b>Irrigation potential</b>	2007	1 782 000	ha
<b>Irrigation</b>			
1. Full control irrigation: equipped area	2002	880 400	ha
- surface irrigation	1996	888 800	ha
- sprinkler irrigation	1996	0	ha
- localized irrigation	1996	0	ha
• % of area irrigated from surface water	1996	94.9	%
• % of area irrigated from groundwater	1996	5.1	%
• % of area irrigated from mixed surface water and groundwater		-	%
• % of area irrigated from mixed non-conventional sources of water		-	%
• area equipped for full control irrigation actually irrigated		-	ha
- as % of full control area equipped		-	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)		-	ha
3. Spate irrigation		-	ha
<b>Total area equipped for irrigation (1+2+3)</b>	<b>2002</b>	<b>880 400</b>	<b>ha</b>
• as % of cultivated area	2002	47	%
• % of total area equipped for irrigation actually irrigated		-	%
• average increase per year over the last 12 years	1990-2002	- 0.92	%
• power irrigated area as % of total area equipped	1996	20	%
4. Non-equipped cultivated wetlands and inland valley bottoms		-	ha
5. Non-equipped flood recession cropping area		-	ha
<b>Total water-managed area (1+2+3+4+5)</b>	<b>2002</b>	<b>880 400</b>	<b>ha</b>
• as % of cultivated area	2002	47	%
<b>Full control irrigation schemes</b>			
	<b>Criteria</b>		
Small-scale schemes	< 50 ha	1996	362 230 ha
Medium-scale schemes		1996	369 630 ha
large-scale schemes	> 3 000 ha	1996	156 930 ha
Total number of households in irrigation			-
<b>Irrigated crops in full control irrigation schemes</b>			
Total irrigated grain production (wheat and barley)			- metric tons
• as % of total grain production			- %
<b>Harvested crops</b>			
Total harvested irrigated cropped area	2006	1 038 000	ha
• Annual crops: total	2006	991 000	ha
- Rice	2006	760 000	ha
- Maize	2006	3 000	ha
- Potatoes	2006	19 000	ha
- Sweet potatoes	2006	12 000	ha
- Vegetables	2006	137 000	ha
- Soybeans	2006	48 000	ha
- Other annual crops	2006	12 000	ha
• Permanent crops: total	2006	47 000	ha
- Citrus	2006	8 000	ha
- Fruit trees	2006	39 000	ha
Irrigated cropping intensity (on full control area)	2006	118	%
<b>Drainage - Environment</b>			
Total drained area	1996	1 039 000	ha
- part of the area equipped for irrigation drained		-	ha
- other drained area (non-irrigated)		-	ha
• drained area as % of cultivated area	1996	53	%
Flood-protected areas		-	ha
Area salinized by irrigation		-	ha
Population affected by water-related diseases		-	inhabitants

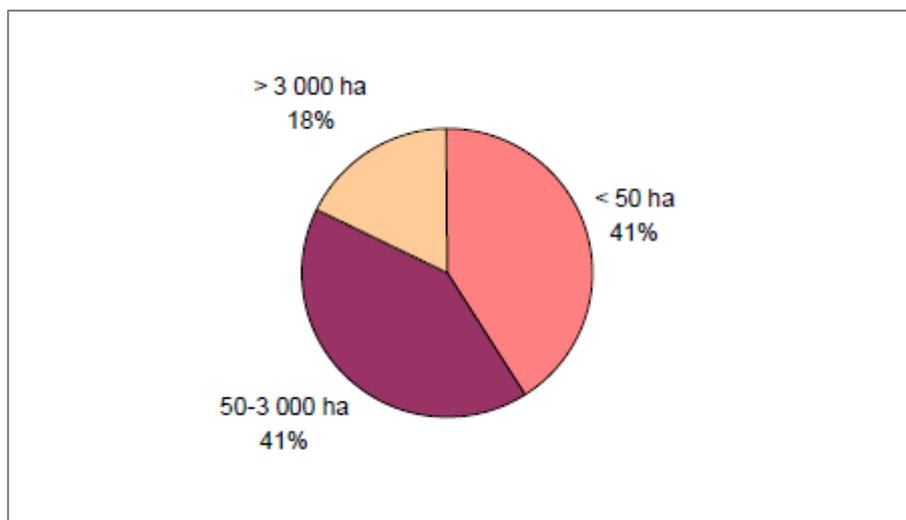
In 1996, out of a total irrigated area of 888 800 ha the area served by surface water was an estimated 843 500 ha (95 percent) of which 65 percent was fed by 18 000 reservoirs, 21 percent by 6 000 pumping stations, and 14 percent by 18 000 headworks. The area served by groundwater accounted for 45 300 ha (5 percent) (Figure 3).

**FIGURE 3**  
**Source of irrigation water on area equipped for full control irrigation**  
 Total 888 800 ha in 1996



In 1996, small schemes (< 50 ha) covered 41 percent of the total equipped area for irrigation, medium-size schemes (50–3 000 ha) 41 percent and large schemes (>3 000 ha) 18 percent (Figure 4). Using local government budgets, small systems are constructed by the cities or counties, and handed over to farmers' organizations for operation and maintenance (O&M). Medium-size systems are funded from the central government's budget, constructed by the provinces, and handed over for O&M to Farmland Improvement Associations (FLIAs). Large systems are financed by the central government, executed by the Rural Development Corporation (RDC), and then handed over to FLIAs for O&M. In any case, the full cost of construction is paid for by the Government. There are some privately developed and owned irrigation systems, but no data are available on their area.

**FIGURE 4**  
**Type of full control irrigation schemes**  
 Total 888 800 ha in 1996



#### Role of irrigation in agricultural production, the economy and society

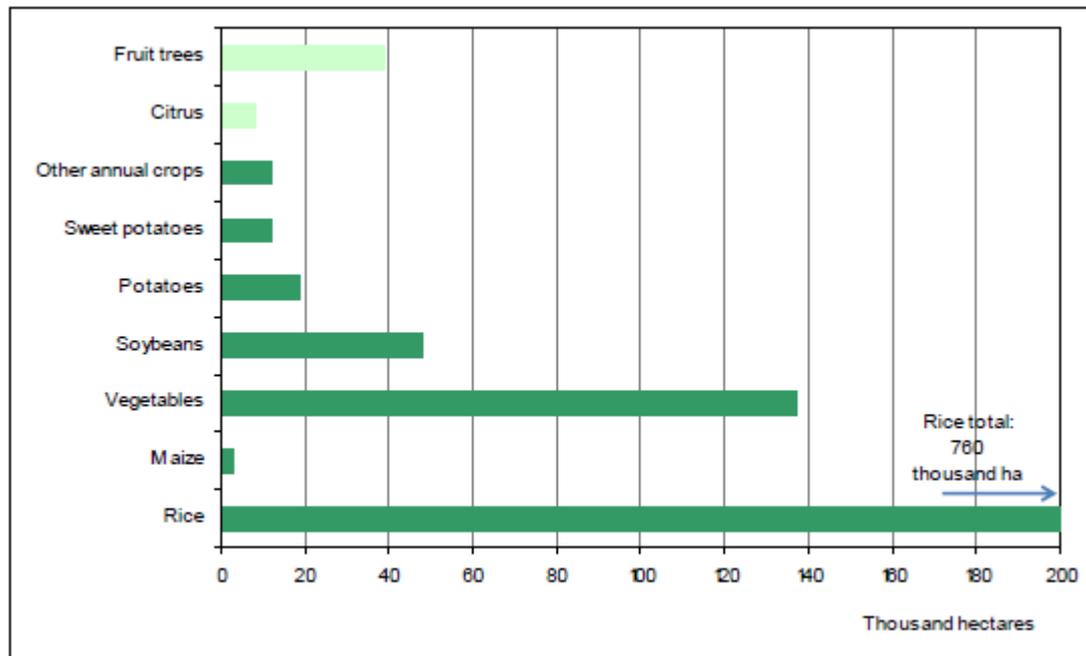
Total harvested irrigated cropped area in 2006 was around 1 038 000 ha. The major irrigated crops are paddy rice accounting for 73 percent of the total harvested area, followed by vegetables, which represent 13 percent, soybeans 5 percent and perennial crops 5 percent of which citrus accounts for 17 percent (Table 4 and Figure 5). Winter barley is mostly sown on paddy fields after the rice harvest in autumn,

and grown without irrigation during the winter with residual soil moisture until spring. Wheat and maize are seldom cultivated on irrigated paddy for economic reasons. The average yield of irrigated rice was 6.8 tonnes/ha for single cultivation in 1996. In that year, approximately 76 percent of all paddy was under irrigation.

FIGURE 5

**Irrigated crops on area equipped for full control irrigation**

Total harvested area 1 038 000 ha in 2006 (cropping intensity on equipped area: 118 %)



## WATER MANAGEMENT, POLICIES AND LEGISLATION RELATED TO WATER USE IN AGRICULTURE

### Institutions

The main institutions involved in water resources management and in irrigation and drainage include the Ministry for Food, Agriculture, Forestry and Fisheries (MFAFF), the Ministry of Environment (MOE), the Ministry of Land, Transport and Maritime Affairs (MLTM), the Rural Development Corporation (RDC), the Federation of Farmland Improvement Association (FFIA), the FLIAs and the WUAs.

The mandate of MFAFF is to provide consumers safe agro-food in a stable manner, strengthen agricultural competitiveness so that rural society can become a place for sustainable agriculture, enjoyable life and leisure. MFAFF, through the Rural Development Bureau (RDB), is responsible for policy, planning and financing of all rural infrastructure projects, and for the supervision of local government institutions, the RDC, the FFIA, the FLIAs and the WUAs.

The RDC is a semi-autonomous agency, which carries out the planning, study, design, and supervision of the rural infrastructure projects and oversees the execution of large-scale agricultural development projects, the O&M of the important facilities of large-scale agricultural development projects, and the provision of O&M training courses for FLIA staff as well as engineering and administrative training courses for its own staff.

The FFIA is a public corporation, which mainly carries out the planning, design, and supervision of the farmland improvement projects for farmland consolidation as well as providing guidance on the operational improvement of FLIAs. There are 105 FLIAs in the country, which are responsible for the O&M of public irrigation systems.

WUAs are organized by farmers for the O&M of small irrigation systems that are not included in FLIA systems. The small systems are constructed and/or rehabilitated by the Government through the cities or the counties before being transferred to WUAs.

The Korean National Committee on Irrigation and Drainage (KCID) is involved in irrigation and drainage issues.

In 1999, the Office of the Prime Minister set up a plan to establish a “national information system for water management” to improve information exchange on water-related issues and thus avoid double work and investment. This led to the creation in 2003 of the “Rural and agricultural water resources information system (RAWRIS)” by MIFAFF (in charge of agricultural water), MOE (in charge of water quality) and MLTM (in charge of water quantity).

### Water management

Even though the annual mean precipitation is more than 1 200 mm, the Republic of Korea often experiences drought because of the large variations in rainfall, making the management of water resources difficult (MAF, 2005).

The MIFAFF, within its environmentally-friendly agriculture promotion plan (1996-2010), reinforced water quality control and has implemented a water quality improvement programme for agricultural use.

Agricultural water withdrawal is generally decreasing, but peak irrigation water requirements are tending to increase because of the extensive use of rice-transplanting machines, which has led to a reduced duration of the spring transplanting period. As the remaining development options become increasingly expensive, emphasis is being placed on the efficient use of water resources and on the rehabilitation and upgrading of existing systems.

Urbanization and industrialization have caused water withdrawal in and near cities and industrial sites to increase more rapidly. Water quality is deteriorating rapidly in the natural channels and reservoirs.

### Finances

The cost of developing conveyance systems down to secondary canals was approximately US\$ 5 000/ha of irrigated area in 1989. Farmers still provide labour for the final land leveling of paddies to avoid possible dissatisfaction or disputes over quality control. In 1999, the cost of land acquisition was being paid for by the Government. Farmers paid more than 6 000 won (US\$ 7.72) per 0.1 ha of paddy as an annual fee.

### Policies and legislation

Rice policy reform is to abolish the government purchasing system, and to introduce a public stockholding system and direct income support mechanism.

### ENVIRONMENT AND HEALTH

The Ministry of Agriculture has been implementing an environmentally-friendly agriculture promotion plan in three stages over the 15 year-period 1996-2010, five years for each stage, in accordance with the policy for environmentally-friendly agriculture. The main purposes are: (i) to minimize pollutants coming from chemical fertilizers, agricultural chemicals, livestock and poultry waste; (ii) to maintain and improve agricultural resources including soil and water purity; (iii) to support farm household practicing environmentally-friendly agriculture to distribute products for sale (MAF, 2005).

Abnormal weather, in particular, causes direct damage to crops and yields. Being a peninsular surrounded by the sea, the Republic of Korea suffers from huge damage every year caused by typhoons. Typhoons usually hit the country from August to September when most crops, including rice, fruit and vegetables, fully ripen resulting in tremendous loss.

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