

# Korea, Republic of

## 1. PHYSIOGRAPHY

The Republic of Korea is a peninsula located between the People's Republic of China and Japan. It lies between the latitudes 33° 6' N and 38° 31' N and has many islands along the west and south coastlines. The total territorial area of Korea is 99,373 km<sup>2</sup>, while 19,235 km<sup>2</sup> or 19.4 percent of the total area are arable. Forest area is 64,410 km<sup>2</sup> or 64.8 percent of the total area. Rivers, roads, residential area, industrial sites, or others occupy the rest.

Korea is a mountainous country and high mountains are located along the eastern part of the peninsula. Most plains and hilly areas are scattered in the western and southern parts of the country. Therefore, agriculture is mainly developed in the south-western part of the country. Major rivers flow into the Yellow Sea in the west and the South Sea in the south.

Divides of watersheds of the major rivers are in the eastern part of the peninsula. So major rivers flow long distance from east to west or from north to south through low valleys and plains and become good irrigation water sources. The eastern coast of the Korean Peninsula has steep slopes, simple shorelines and deep water depth. But there are many islands and irregular shorelines in the western and southern coasts. Tidal range of the western coast is very high and tidal flats are well developed. Many tidal land reclamation works were implemented in the past and a good potential for tidal land reclamation widely prevails.

## 2. CLIMATE AND RAINFALL

Korea lies within the temperate zone between the People's Republic of China and the Pacific Ocean. The climate is mainly dependent on the Pacific Ocean air masses during the summer months and on the continental air masses during the winter months. Korea has four distinct seasons. Summer is hot and humid, while winter is cold and dry. The climates of spring and autumn are moderate and dry. A long drought from winter to spring or a severe spring drought often threatens transplanting of rice which is carried out in May or June.

The monthly average temperature is higher than 20° C during the summer months from June to September and it falls below freezing point during the winter months from December to February. The highest monthly temperature occurs in August and the lowest in January. The highest temperature in Korea was recorded at 40° C in August and the lowest temperature -28.5° C in January. Temperature also varies with the location, showing high in the southern part and low in the northern part. The southeast wind prevails in summer and the northwest wind in winter.

Annual average precipitation is 1,274 mm and the annual precipitation varies greatly year by year ranging from 754 mm to 1,683 mm. More than two third of the annual precipitation occurs during the summer months from June to September.

Typhoons originating from the Pacific Ocean pass the peninsula mainly in August and September. Gusts and storms accompanied by typhoons sometimes cause severe damages to crops or other properties.

## 3. POPULATION AND SIZE OF HOLDINGS

The population of Korea was 24,952 thousand in 1960, 31,466 thousand in 1970, 37,436 thousand in 1980, 43,411 thousand in 1990, 44,551 thousand in 1995 and 45,991 thousand in 1997. Korea is one of the most populated countries showing the population density of 463 persons/km<sup>2</sup> in 1997.

The population engaged in agriculture in 1997 was 4,468 thousand persons or 9.7 percent of the total population. Due to the fast industrialization and rapid expansion of urban areas, the percentage of population in the agricultural sector has sharply decreased during last several decades.

The average size of farm holding has been steadily increased from 0.97 ha in 1977 to 1.366 ha in 1997 mainly due to decrease in farm households and with the Government's continuous efforts.

#### **4. LAND RESOURCES**

Korea has 99,373 km<sup>2</sup> of total land area in 1997 out of which the cultivated land covers 19,235 km<sup>2</sup>; paddy fields (11,629 km<sup>2</sup>) and upland (7,606 km<sup>2</sup>). The remaining 80,138 km<sup>2</sup> is occupied by mountainous areas (64,413 km<sup>2</sup>) and other uses (15,725 km<sup>2</sup>).

The soils of Korea have been generally divided into soil groups such as low humic gley, alluvial, red-yellow podzolic, regosols, lithosols, reddish brown lateritic, acid brown forest, planosols, saline alluvial, acid sulphate and organic soils. Most of the irrigation practices have taken place on the low humic gley and alluvial soils in the paddy field areas.

Humic gley and alluvial soils are spread in the coastal plains, flood plains, inland alluvial plains and local valleys. These soils are medium or fine textured and are poorly or imperfectly drained and have relatively high or medium productivity. They are found mainly on the western and southern coastal plains and in the lower Nakdong, Han, Yongsan and Keum river basins. Most of the lands are well suited to paddy rice and are intensively used for that crop.

Red-yellow podzolic soils, regosols and lithosols are formed on rolling areas, in middle or strongly dissected part, denuded areas of older paddy plains and hilly and mountainous lands underlain by residual materials such as granites, gneisses, andesites, porphyries, shales and conglomerates. Topography is rolling with some undulating and more steeply sloping areas. Dominant slopes range from 7 to 60 percent. Interfingering dendritic patterns of narrow valleys are found. These valleys are U-shaped and include nearly levelled or gently sloping land along the valley floor. These soils are distributed mostly on the western and southern parts of the country. The soils were originally under natural vegetations of pine trees, acacias, shrubs and grasses. Presently some of these soils are for production of upland crops, such as barley, wheat, millet, sweet potato, soy bean, corn, sesame, tobacco, red pepper and other vegetables. Where water is available for irrigation, paddy rice is principal crop. The high areas that cannot be irrigated are used for the production of general upland crop, forage crops and fruits.

#### **5. WATER RESOURCES**

##### **Surface water**

The average annual precipitation in Korea is 1,274 mm and it indicates 126.7 billion m<sup>3</sup> of water in volume. The average annual runoff is 69.7 billion m<sup>3</sup> (55 percent) and the annual volume lost by evaporation or others is about 57 billion m<sup>3</sup> (45 percent). More than two-third of the annual runoff occurs during the flood season from June to September and so that a great amount of the water becomes unusable. Total available surface and ground water is estimated at 47.2 billion m<sup>3</sup> which includes 23 billion m<sup>3</sup> of river flows during the non-flood season, 10.8 billion m<sup>3</sup> of stored water in multipurpose dams and agricultural reservoirs and 13.4 billion m<sup>3</sup> of ground water. Yearly water use amounts about 30.1 billion m<sup>3</sup>; 14.9 billion m<sup>3</sup> (50 percent) for irrigation, 2.6 billion m<sup>3</sup> (9 percent) for industrial water, 6.2 billion m<sup>3</sup> (20 percent) for municipal water and 6.4 billion m<sup>3</sup> (21 percent) for instream flow augmentation. Half of the total water use comes from agricultural use.

Out of 14.9 billion m<sup>3</sup> of irrigation water, 9.4 billion m<sup>3</sup> is supplied by about 18 thousand agricultural

reservoirs, 2.7 billion m<sup>3</sup> by pumping stations, 1.9 billion m<sup>3</sup> by headworks and 0.9 billion m<sup>3</sup> by tube-wells or others.

### **Ground water**

From considerations of geologic condition, the Korean Peninsula is comprised of crystalline sedimentary rocks and a few kinds of bed rocks such as granite and granite-gneisses, which occupy about 70 percent of total area of the country. And the remaining area 27,370 km<sup>2</sup> is covered with alluvial deposits.

Except some regions, the quantities of the ground-water storage in the bed rocks are not sufficient for irrigation. But relatively large quantities of the ground water are extractable from the basalt areas of CheJu-Island (total area of 1,280 km<sup>2</sup>), from limestone areas of Kangwon-Do, and from the tertiary strata of Pohang-Woolsan areas in the eastern part of the country.

In addition, alluvial deposits, such as coastal plains, flood plains of large streams, intermountain plains, plains between valleys, deltas, etc., may be classified as significant aquifers. But their thickness does not exceed several meters except the deposits in the lower part of the Han River and the Keum River.

Out of a total potential groundwater storage of 1,324 billion m<sup>3</sup>, the available amount of ground water is evaluated to be 16.8 billion m<sup>3</sup>. In Korea, groundwater is not a major source of irrigation water and it covers less than five percent of irrigated land. Groundwater often used for supplementary irrigation water during drought periods.

Irrigation facilities, including 3,853 infiltration galleries and 16,001 tube wells to irrigate 20,509 ha and 30,586 ha respectively, were installed by the end of 1997.

## **6. BRIEF HISTORY OF IRRIGATION AND DRAINAGE**

It was known that rice culture in the Korean Peninsula began in the fourth or third century B.C. Rice consumes much water in comparison with other crops and generally requires irrigation. Therefore, irrigation in Korea was mainly developed for rice culture and rice irrigation dated back to the first century A.D.

From the beginning, most irrigation water was obtained from rivers and streams by constructing small reservoirs, diversion weirs or feeder canals. The Pyokkol reservoir, the oldest one remained in Korea, was constructed in 330 A.D. The reservoir had a dam with four kilometer long and could irrigate about 10,000ha. Many irrigation and flood protection facilities such as small dams, diversion weirs, canals, river embankments, etc. were continuously constructed by the central governments, local governments or farmers for many centuries up to 20th century. However, most of them did not have enough storage capacity and were not strong and firm. Therefore, farmers experienced frequent drought damages and the facilities were easily damaged or destroyed by floods. According to the record, about 80 percent of paddy areas were rain-fed until the early 20th century and the remaining 20 percent were irrigated mainly from thousands of small reservoirs and diversion weirs.

The Irrigation Association Law was enacted in 1906 and the first irrigation association was established in 1908. Fifteen irrigation associations were established until 1919 and the area under their jurisdiction was about 40,000ha. The 15-year Irrigation Development Plan for about 427 thousand ha was established in 1920 and the plan was changed to the 12-year Plan for 350 thousand ha in 1926. Up to 1934, 196 irrigation associations were formed and managed 226 thousand ha. At the end of 1935, irrigated paddy fields recorded 760 thousand ha or 45 percent of a total 1,700 thousand ha.

In 1940, the Korean Union of Irrigation Associations was founded and the 6-year Irrigation Development Plan for 163 thousand ha was formulated. A total 829 thousand ha or 47 percent of the total paddy fields

was irrigated as of 1941. Later in 1942, the 6-year plan was expanded to the 12-year Plan for 577,000 ha and the Korean Land Development Corporation was set up for developing large-scale projects.

From 1945 to 1960, the Korean War following the liberation of the country hindered the development of irrigation. The first 5-year Economic Development Plan from 1962 covered agricultural land development of about 230 thousand ha including new irrigation development of 102 thousand ha.

In 1965, the Agricultural Water Resources Development Plan for all-weather-farming was prepared for the new irrigation area of 386 thousand ha. This plan included many small-scale irrigation projects and several large-scale comprehensive agricultural development projects such as the Keumgang-Pyongtaek project. The large-scale projects consisted of various components such as irrigation, drainage, land consolidation, land reclamation, river improvement, etc..

Severe droughts in 1967 and 1968 led to ground-water development and nation-wide construction of tube-wells, dug-wells and infiltration galleries were carried out in the period 1969-1970.

The Keumgang-Pyongtaek comprehensive agricultural development projects (30,567 ha), the first large-scale irrigation project, were commenced in 1971. Many large-scale projects, such as the Yongsangang stage I (34,500 ha), Sapkyocheon (24,574 ha), Imjin (7,185 ha), Mihocheon stage I (11,554 ha), Namgang (5,754 ha), Changyeong (2,269 ha), Nonsan (9,938 ha), Daeho (7,700 ha) and others followed in 1970s and 1980s.

Active implementation of several hundred small-scale and more than 10 large-scale irrigation projects doubled irrigated paddy area from 534 thousand ha in 1965 to 1,104 thousand ha in 1977. Rice paddy area has continuously expanded for a long period and it reached to 1,358 thousand ha in 1988. Rapid expansion of urban areas, industrial sites and roads resulted in sharp reduction in rice paddy area and the total paddy area dropped to about 1,163 thousand in 1997.

## **7. IRRIGATION AND DRAINAGE METHODS USED**

The installation of irrigation and drainage facilities has been confined to paddy fields ever since its initiation. However, with the rapid development of national industry, the requirements of upland irrigation have been recently recognized and upland irrigation area is expanding year by year.

In paddy field irrigation, general practice is to retain water in the paddy fields throughout the growing period. The retention of water in the paddy fields has some advantages in rice growing and irrigation water management. The retention depths of water vary according to growing stages as evidenced by the experience and research results of rice cultivation.

There are two ways of irrigating paddy fields. The first type is direct irrigation from tertiary or secondary canals to each paddy field and the second type is paddy to paddy irrigation where each paddy field has not facilitated with an irrigation canal and a drainage canal.

About 75 percent of paddy lands are fed by intermittent irrigation, while about 25 percent are fed by continuous irrigation or rain-fed. However, in the case of intermittent irrigation, the irrigation timing is irregular and different from that of the so-called rotational irrigation. In general, an irrigation dose of as much as paddy lands could admit is applied at a time and it is replenished irregularly when the water is depleted.

Recently, newly developed water management and cultivation techniques have enabled a systematic irrigation water supply according to the rice growing stages (rooting, tiller, panicle formation, sprout bearing, sprouting and flowering and maturing, etc.), and they are performed under the guidance and supervision of

farm land improvement associations and extension offices.

The main crops grown in the irrigated uplands are economically profitable orchards, vegetables, and other horticultural plants. In addition, vegetables are now normally cultivated in the irrigated uplands to increase production.

Surface drainage and sub-surface drainage systems with either open ditches or pipes or culverts with gravitational drainage are provided to remove excess water from paddy fields. Where gravitational drainage is not possible, pump drainage is used. Levees and sea dikes are constructed to protect inundation of farmlands from external water such as river floods or spring tides of the sea. Intercept drains are installed to divert excess water drained from outside highlands. In some special area, the drainage conditions are also improved by raising farmland elevations by earth filling. The drainage area improved by these means totals to 14 thousand ha. Pipe drains are placed to realize double cropping in the paddy lands where groundwater table in the farmlands is high and permeability of the soil is low.

## 8. STATISTICS RELATING TO IRRIGATION AND DRAINAGE

### (a) Irrigation area

Year	Arable Area (ha)	Paddy Fields (ha)	Irrigated Paddy Fields (ha)	Percentage of Irrigation ----- (4)/(2)      (4)/(3)	
(1)	(2)	(3)(4)	(5)	(6)	
1955	1,955,000	1,187,000	407,000	20	34
1960	2,025,000	1,206,000	664,000	33	55
1971	2,271,000	1,265,000	746,000	33	59
1981	2,188,000	1,308,000	908,000	41	69
1990	2,109,000	1,345,000	988,000	47	73
1995	1,986,000	1,206,000	907,000		75
1998	1,910,000	1,157,000	881,000	46	76

### b. Irrigation development cost per hectare (1999 price)

Surface irrigation development: 90,800,000 Won (reservoir)  
50,000,000 Won (pumping station)

Groundwater development: 20,000,000 Won

Operation and maintenance: 530,000 Won

### d. Drainage improvement cost per hectare (1999 price)

Drainage improvement: 35,500,000 Won

Operation and maintenance: 550,600 Won