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Institutional Improvement of Irrigation Management System in Korea

Sang-Ok Chung
Professor, Department of Agricultural Engineering
Kyungpook National University

Abstract □ There are two major operation and management (O & M) systems in Korea, one by the Korea Agricultural and Rural Infrastructure Corporation (KARICO), a government corporation, and the other by non-KARICO, which includes Irrigation associations (IAs) and individual farmers under the supervision of city or county authorities. Main issues and constraints in the irrigation facility management are: (1) The dual system of the irrigation water management system; management by KARICO and that by IAs, and (2) From the commencement of KAICO in 2000, farmers were exempted from water charge. This is opposite to the international trend, which follows 'user pay principle.'

Main specific strategies to improve irrigation management system are: (1) Introduction of water metering for water charge as well as water conservation, (2) Adoption of demand-oriented irrigation rather than supply-oriented to reduce waste of water, (3) To augment farmer's participation by forming water user associations, (4) To maintain consistency of government policy, (5) To promote roles of local governments, and (6) To reestablish the role of KARICO.

Keywords □ Irrigation management, Institution, KARICO, Irrigation association, Water charge.

I. Introduction

Total agricultural land area is 1,888,765 ha as of 2000 in Korea. About 60% of the total agricultural land area is paddy field and the rest is upland field. Total paddy area is 1,149,041 ha, of which 76.6% is irrigated and the rest is rain-fed (Table 1).

Table 1 Paddy field area by managing organizations and irrigation conditions (Unit : ha)

Irrigated paddy				Rain-fed	Total
KARICO	IAs	Farmers	Sub-total		
520,355 (45.3%)	190,084 (16.5%)	170,005 (14.8%)	880,444 (76.6%)	268,597 (23.4%)	1,149,041 (100%)

(Source: Ministry of Agriculture and Forestry, 2001)

Uphoff (2002) grouped irrigation management into two, the hardware and the software of irrigation. The hardware is full set of physical

structures that acquire, distribute and drain the water in the command area, and the software is the organizations, which are needed to operate the physical structures. The software has administrative organizations and water user associations, the former is main system level software and the latter is user level software.

Institutional irrigation system management plays an important role in water management. Problems in institutional irrigation system management and strategies to improve them are discussed in this paper.

II. IRRIGATION SYSTEM DEVELOPMENT

1. Agricultural water use

Total water use in 1998 was 33.1 billion m^3 which includes 16.1 billion m^3 of river water, 13.3 billion m^3 of reservoir water and 3.7 billion m^3 of ground water (MOCT, 2001). The amount of water use represents 26 % of the total water resources. The total water use was composed of 7.3 billion m^3 of municipal use, 2.9 billion m^3 of industrial use, 15.8 billion m^3 of agricultural use, and 7.1 billion m^3 of stream low flow augmentation.

Water resources development in Korea is mostly from rivers and streams. Natural lakes are rare and ground water development is not well progressed yet. Therefore, the main facilities of water supply are dams, headworks and pump stations along the rivers and streams, and estuary fresh water reservoirs.

Agricultural water use is 15.8 billion m^3, which accounts for about 48 % of the total water use. Therefore, efficient water use in agriculture is very important for the national water conservation. The majority (97 %) of the agricultural water is for the paddy rice, and only very small amount is used for upland crops.

2. Physical irrigation facilities

Table 2 shows Irrigated land area with regard to water sources and managing organizations as of 2000. Total number of irrigation water source facilities is 64,543 with beneficial area of 880,444 hectares. The main facility is reservoirs with beneficial area of 516,783 hectares, followed by pump stations 123,634 hectares, headworks 102,499 hectares, and tube wells 35,382 hectares. The irrigated rice field experiences frequent drought damages because of the insufficient drought-frequency design year. Number of irrigation reservoirs is 17,913, among

Table 2 Irrigated land area with regard to water sources and managing organizations (2000)

Facilities	KARICO		Non - KARICO		Total	
	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)
Reservoir	3,299	379,677	14,614	137,106	17,913	516,783
Pumping station	3,044	93,936	2,893	29,698	5,937	123,634
Pumping & Drainage Station	95	29,685	24	360	119	30,045
Drainage Station	433	535	57	655	490	1,189
Head works	3,897	14,052	14,453	88,446	18,350	102,499
Infiltration gallery	446	2,371	3,234	16,688	3,680	19,059
Tube well	1,081	98	16,973	35,284	18,054	35,382
Others				51,853		51,853
Total	12,295	520,355	52,248	360,089	64,543	880,444

(Source: Ministry of Agriculture and Forestry, 2001)

Table 3 Lengths of irrigation canals (2000)

(Unit : km)

Managing Organization	Main		Sub-main		Lateral		Total	
	Earth	Structures	Earth	Structures	Earth	Structures	Earth	Structures
KARICO	6,315	8,516	10,092	9,063	20,248	8,562	36,655	26,141
Non-KARICO	7,202	3,314	11,285	5,074	14,570	5,593	33,057	13,980
Total	13,517	11,830	21,377	14,137	34,818	14,155	69,712	40,121

(Source: Ministry of Agriculture and Forestry, 2001)

which 54 % were constructed before 1945, hence very old and have problems in operation and maintenance.

Total irrigation canal length is 109,833 km. Earth canals account for 63% of the total irrigation canal system (Table 3). They are prone to large seepage loss and are difficult in maintenance.

In some project sites, earth canal lining, concrete canal, and pipeline system in paddy fields showed improved water use efficiency. Automation of irrigation water management system with TC/TM is in the test stage in Korea.

III. INSTITUTIONAL IRRIGATION MANAGEMENT SYSTEM

1. Introduction

Various institutional arrangements and operating modes of the irrigation systems are presented in Jensen and Lord, Jr. (1990). Five types of the more common organizations and institutional arrangements are as follows:

(1) Government-Agency water allocation and distribution,

(2) Public-managed water distribution system serving water user groups,

(3) Farmer-managed irrigation system,

(4) Quasi-public systems operated by project

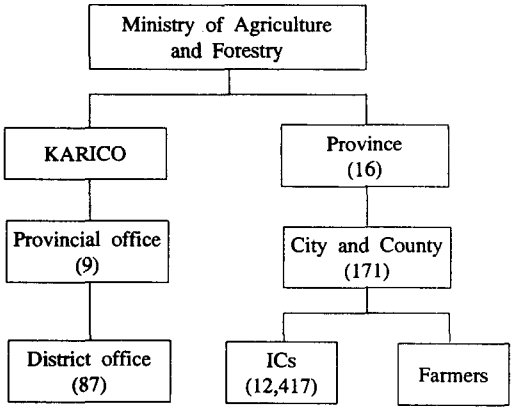

Fig. 1 Organization chart of irrigation management system in Korea

personnel, and

(5) Independent farmer-owned water supply system.

There are two major operation and management (O & M) systems in Korea, one by the Korea Agricultural and Rural Infrastructure Corporation (KARICO), a government corporation, and the other by non-KARICO, which includes Irrigation associations (ICs) and individual farmers under the supervision of city or county authorities. The present O & M system of agricultural water system as of 2002 in Korea is shown in Fig. 1. Institutional arrangements are government-agency type in the KARICO area and farmers group type in IA area.

KARICO is composed of one headquarters, one research institute, 9 provincial offices, 87 district offices, and 4 comprehensive project offices. District offices are responsible for the water management from the source to the tertiary canals. Within the city and county managing area, there are 12,417 Irrigation associations.

KARICO manages large-size land areas exceeding 50 hectares, while IAs manage small-

size lands of 5~50 hectares. Individual farmers manage irrigation facilities in the land area less than five hectares. KARICO, a government corporation, was founded in January 2000 through merger of three organizations, Rural Development Corporation, 103 Farmland Improvement Associations and Federation of Farmland Improvement Associations.

The notable features of water management in Korea are the integrated management of agricultural water system from water sources to tertiary canals in a package, and the exemption of irrigation charges in the areas managed by KARICO.

2. Korea Agricultural and Rural Infrastructure Corporation (KARICO)

In January 2000, KARICO was born by combining Rural Development Corporation, 103 Farmland Improvement Associations and Federation of Farmland Improvement Associations. KARICO aims to contribute to the economic and social development of rural areas by means of increasing farmer's income. Other goals are comprehensive management of agricultural infrastructure facilities, construction of environment-friendly production system, among others. In addition, it formulates agricultural policy for the future.

Furthermore, KARICO intends not only to develop rural area into affluent community harmonized with nature, but also to take the leading role as the key agency in charge of executing agricultural policies such as rice production, efficient management of national resources, and disaster prevention.

KARICO manages 59% of the total irrigated paddy areas in Korea. The number of reservoirs in KARICO area is 3,299, representing only 27%, however, the benefit area is 73%. This indicates that the reservoirs are the major water source for the paddy fields managed by KARICO.

The O & M works for irrigation and drainage systems by KARICO are categorized into two parts, i.e., water management and facility maintenance. Table 4 shows the detailed functions of KARICO. The agricultural water system in KARICO area is operated and maintained through the financial support from the central government, and no water fees are collected from farmers.

In 2001, KARICO selected 58 autonomy management districts with total command area of 5,480 ha and let farmers manage irrigation facilities with financial support for the management cost. Based on the assessment of the autonomy management system performance, KARICO has to determine the best direction of the autonomy management system.

3. Irrigation Associations

Irrigation Associations (IAs) are typical rural fraternity to manage irrigation facilities at the village level. IAs were born as mutual cooperative farmer groups with long history and background. They played important roles in overcoming agricultural disasters such as droughts and floods, and helping each other in various agronomic activities. They also preserved local traditions and community spirit. Each IA has members no less than five and of land area not smaller than five hectares.

The IAs operate and maintain small-scale

Table 4 Operation and management functions of KARICO

Category	Detail works
Water quantity management	Database set up and planning for water supply Canal flow gauging and prevention of natural disasters Water saving for drought mitigation Preventive measures for flood protection Appropriate supply of water at proper time Proper allocation of water to canals Proper drainage of excess water Weed control and dredging in canals
Water quality management	Monitoring agricultural water contamination Treatment of polluted irrigation water Planning for water pollution control
District/user management	Enrollment and exclusion of benefit area Bookkeeping of user list
Record management	Transfer and takeover of facilities Registration and abolition of facilities
Inspection and maintenance	O & M planning of irrigation system Inspection of facilities Maintenance and rehabilitation of facilities Planning emergency measures Construction of safety and disaster prevention facilities, and communication systems Decision on utilization of facilities for purposes other than normal Diagnostic inspection of facilities

(after Lee, 2001)

water sources such as small reservoirs, diversion weirs, and wells to supply water for the scattered small scale lands. The operation of IAs and collection of operation and management fees are subjected to Province regulations.

Among the 360,089 hectares of non-KARICO managed paddy area, 190,084 hectares are managed by 12,417 IAs with 415,517 members as of 2000 (Table 5). The rest 170,005 hectares are managed by individual farmers or small farmers groups. Within the IA area, reservoirs and pumping stations supply irrigation water to 58% of the authorized area, while diversion weirs and others cover the rest.

4. Issues and constraints

OECD suggested on irrigation water management policy as follows (OECD, 1998):

(1) collect water charge,

(2) increase water supply to other sectors by saving agricultural water use,

(3) improve water quality, and

(4) enhance favorable environmental impacts of agricultural water use

From the commencement of KAICO in 2000, farmers were exempted from water and operation and maintenance fees. Until 1999, farmers in this area paid part of the operation and maintenance

Table 5 Status of Irrigation Association with respect to facilities (2000)

Facility	No. of Facilities	Benefit area (ha)	No. of IAs	No. of IA members	Assessed area (ha)	Amount assessed (1,000 Won)
Reservoir	6,537	88,606	5,465	195,530	66,888	2,369,017
Pumping Station	1,440	22,218	1,159	42,418	16,860	1,124,977
Pumping and Drainage Station	24	821	25	1,244	648	97,052
Head work	3,319	40,176	2,587	93,922	31,639	1,273,381
Infiltration Gallery	598	6,317	412	12,421	4,464	274,829
Tube Well	3,204	19,212	2,397	53,057	13,989	1,049,433
Feed Canal	17	810	17	1,103	704	29,973
Sea Dike	338	11,672	324	14,940	1665	86,365
Others	34	252	31	882	182	18,356
Total	15,511	190,084	12,417	415,517	137,039	6,323,383

(Source: Ministry of Agriculture and Forestry, 2001, 1 US Dollar = 1,200 Korean Won)

cost. This change is opposite to the international trend, which follows 'user pay principle.' In addition, the institutional system of KARICO is government oriented, which is also contrary to the 'public participation principle' suggested by OECD.

Major issues and constraints are as follows:

(1) Duality of management system: The dual system of the irrigation water management system is the largest problem in Korea: management by KARICO and that by IAs. Farmers in the KARICO area receive better service without any fee, while those in the IA managed area farmers pay part of the operation and maintenance cost of the irrigation facilities. Generally, in this area the service level of the irrigation system is inferior to that in the KARICO area. Therefore, many farmers in the IA area appeal to transfer their management system to KARICO (Mo, 2001). This dual system should be changed for equity as well as for efficient water management.

(2) Cost allocation of irrigation facilities management: Irrigation system projects have various effects such as increasing crop production, conserving rural environment, preventing disasters and improving rural amenity. The recipients of these effects are not only farmers but also central and local governments representing general public. Therefore, in principle, farmers and central and local governments should share the construction, operation and maintenance cost of the irrigation facilities (Kim, 2001).

Operation and management techniques have been steadily improved, however, there are still much more to be improved. More general issues and constraints in the water management system in Korea are as follows:

(1) The main general issue of the irrigation system management is that many facilities are old, and should be replaced or repaired in the near future.

(2) Budget for new development, rehabilitation, repair and management of the irrigation system is limited.

(3) Water courses at the head of distribution canal receive more than sanctioned, and those at the tail, less.

(4) Farmers often do not receive adequate notification of canal closings.

(5) No water measuring devices are installed in the farm level causing excess water supply.

(6) Optimal operation and management of the farm irrigation system is required for better performance of the system.

(7) Water supply system is supply-oriented, this should be changed to the demand-oriented system for a better water use efficiency.

IV. FUTURE PERSPECTIVES

1. Future irrigation perspectives

Water distribution among sectors will be a critical issue in the future, and the portion of agricultural use will decrease. Due to very old irrigation facilities and lack of adequate management, water loss is large. In addition, basic data, which are prerequisite for the well planned water management, are limited. Water quality deterioration, budget constraint, and lack of farmers' cooperation are problems for more efficient water management.

Ten year agricultural water development plan from 1995 to 2004 by the Ministry of Agriculture and Forestry is undergoing. The total capital investment for the plan is 14.4 trillion Won (US 11.5 billion dollars). At the end of this plan the irrigation ratio of the paddy fields is aimed at 88% from the present 77%.

The basic method of the irrigation water development is construction of new facilities such as reservoirs, pump stations, headworks, etc. Rehabilitation and repairing of the existing old facilities, such as dredging old reservoirs and canal lining, are also important.

2. Strategies to improve irrigation management system

To improve irrigation system management practices in general, the followings should be accomplished.

(1) Systematic data collection by installing sufficient flow measuring devices.

(2) Proper canal maintenance to keep out sediment and plant growth so as to keep canal conveyance.

(3) Introduction of water metering for water charge as well as water conservation

(4) Adoption of demand-oriented irrigation rather than supply-oriented to reduce waste of water.

(5) Change of water charge policy. Farmers have to pay for the services they receive and water charge with metering system will reduce water usage.

More important specific strategies to improve institutional irrigation management system are as follows (Kim, 2001):

(1) To augment farmers' participation

Korea is classified as water deficit country by U.N. We will face water right conflicts in the near future because of increasing competition among water use sectors. Among water use sectors, agricultural sector receives low priority in water distribution policy in Korea. In addition, agricultural water use has lower productivity than

other uses. Therefore farmer participation in the irrigation facility maintenance by forming water users association will be very important in securing the water right.

(2) To maintain consistency of government policy

Recent government policy, which exempted water and maintenance charges from farmers, is regarded as a backward movement. This change increases government burden and cannot get a national consensus.

So far, the government has played an important role in agricultural water supply and maintenance of irrigation facilities, while it has neglected effective use and management of agricultural water resources.

Considering various problems on irrigation water and facility management, the government has to develop policies and maintain them consistently by setting farmer's role in water management, impose certain responsibilities on farmers and improving water service level.

(3) To promote roles of local governments

Local governments have to consider agricultural water in terms water quality, environment, preserving traditional culture and sustenance of rural community as well as water supply aspect. Therefore, they have to share the cost of the irrigation facility maintenance.

(4) To reestablish the role of KARICO

KARICO has to improve water supply system such as year round water supply. Then, it has to ask farmers to participate and charge farmers water and maintenance charges. In addition, KARICO has to endeavor to reduce maintenance cost through effective management of irrigation facilities.

V. CONCLUSION

Institutional framework of irrigation management in Korea was reviewed, and constraints and strategies to improve the irrigation management system were discussed. There are two different types of irrigation management systems in Korea; the KARICO and non-KARICO. Main issues and constraints in the irrigation facility management are as follows:

(1) The dual system of the irrigation water management system is the largest problem in Korea; management by KARICO and that by IAs. This dual system should be changed for equity as well as for more efficient water management.

(2) From the commencement of KAICO in 2000, farmers were exempted from water and operation and maintenance charges. This is opposite to the international trend, which follows 'user pay principle.' In addition, the institutional system of KARICO is government oriented, which is also contrary to the public participation principle suggested by OECD.

(3) Irrigation projects have various effects such as increasing crop production, conserving rural environment, preventing disasters and improving rural amenity. The recipients of these effects are not only farmers but also central and local governments representing general public. Therefore, both farmers and central and local governments should share the construction, operation and maintenance cost of the irrigation facilities.

Main specific strategies to improve institutional irrigation management system are as follows:

(1) To augment farmer's participation by

forming water user association.

(2) To maintain consistency of government policy.

(3) To promote roles of local governments.

(4) To reestablish the role of KARICO

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