Induced Institutional Change in the Development of Korean Farm Irrigation System

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ABSTRACT

This paper is to present a relatively concise introduction to the circumstances under which the Korean farm irrigation system is developing. We focus on the demand and supply for farm irrigation system within the framework of induced innovation theory in which technical and institutional changes are treated as endogenous rather than exogenous to the economic system. The demand for institutional changes in Korea is due to the important role of technical changes such as the introduction of high-yielding rice varieties and direct-seeding method in determining the new institutional arrangements. The Korean government in fact responded to the demand and a scheme for a new system of farm irrigation gradually evolved.

Keywords: Induced Innovation, High-Yielding Variety, Direct-Seeding Method, Irrigation System, Land Productivity, Labor Productivity

1. INTRODUCTION

We can view the farm irrigation system in Korea as an institutional innovation to centralize the mobilization of resources in order to meet farm production and social welfare goals. Institutional change has generally been treated as exogenous to the economic system. Ruttan (1984) attempted to explain institutional change in terms of the theory of induced innovation in which technical and institutional changes are treated as endogenous rather than exogenous to the economic system. It is widely recognized that the results of the application of the induced innovation hypothesis to problems in agriculture have enhanced the understanding of the process of institutional change in agricultural development.

One purpose of this paper is to present a relatively concise introduction to the circumstances under which the Korean farm irrigation system is developing. A second purpose is to apply the theory of induced institutional innovation to interpret the process of farm irrigation system development in Korea.

The plan of this paper is as follows. In the next Section II we will try to develop our basic analytical framework by elaborating the theory of induced institutional innovation. Section III is devoted to exploring the demand for the development of the farm irrigation system. Section IV discusses the development of farm irrigation system and Section V draws conclusions and makes suggestions for policy implication.

2. CONCEPTUAL FRAMEWORK

The demand for institutional changes may arise due to the changes in resource endowments, the size of the market, technology, and the basic decision rules of government that create the disequilibrium. Institutional changes can be induced by the pressure of the potential benefits associated with the achievement of economies of scale, technical change and reduction of risk or transaction cost. All of these factors represent major sources of institutional innovation.

Agriculture is a highly risky and uncertain sector. Farmers have always faced the hazards of weather, biological process and uncertain markets, which have an important effect on their decision making. In recent decades, there has been an increasing source of new technology available for adoption and utilization in Korean farm production, promoted by publicly supported educational endeavors and research institutes. New technologies often lead to more highly specialized production, which means greater instability in farming.

Simultaneously, due to the characteristics of semi-subsistence farming, the main motivating forces in small farmers may be the maximization not of income, but rather of their family's chances of survival. Accordingly, when risk and uncertainty are high, small farmers may be very reluctant to shift from a traditional technology to a new one which promises high yields but may entail greater risks of crop failure. One of the most important barriers to the green revolution for the small farmers is their lack of access to affordable irrigation. With appropriate irrigation equipment, small farmers could plant high yielding varieties of rice. They could eliminate the risk of crop losses from unseasonable drought and the development of a variety of affordable irrigation devices would profoundly improve the productivity of small farmers. However, before a lot of these devices can be put in the hands of small farmers, traditional paradigms for the design and diffusion of technology need radical revision.

Technological innovation probably has been the most persuasive of all the forces affecting the structure of agriculture in Korea. Such changes in technology have been exerting strong pressure on the institutions that mold under relatively stationary conditions. Advances in technology can be expected to set in motion attempts by individuals to reallocate their resources and the new income stream generated by technical change can represent a major incentive for institutional change to initiate collective action so as to achieve greater equity in the partitioning of the new income stream. One of the clearest examples might be the demand for changing farm irrigation system which is motivated by a need to increase new, more water-efficient farming practices in correspondence with technical change in Korean farming.

When the induced innovation model explains institutional change, the changes result from a cumulative process of relatively marginal adjustments within existing pattern of social, political and economic systems. Such institutional changes allow minimal risk or spread it more evenly among those potentially affected and generate new organizational forms which provide specialized services as the economy becomes more integrated.

The analysis of the demand for the institutional change turns our attention to situations in which there are potential benefits that are only attainable through the creation of new institutional arrangements. However, whether changes in the real world will indeed occur depends upon the supply of institutional change based on the willingness and capability of the fundamental institutions of government to provide new arrangements. The capability depends in part upon the cost of institutional innovation which is determined by the state of existing social science knowledge on the design and operation of institutions. Thus, advances in social science knowledge offer an opportunity to reduce the cost of institutional innovation. It seems clear that the supply curve for institutional change shifts to the right as a result of advances in the social science knowledge and related profession such as law, administration, social services and planning.

This is not to argue that institutional change is solely dependent on the cost. Equally important is the willingness of the elite decision makers of government to provide new arrangements. In some cases the elite's incentives will be consistent with actions that maximize social welfare; in other cases their incentives may not be compatible. In addition to being affected by all of these factors, it is also affected by ideology and conventional wisdom.

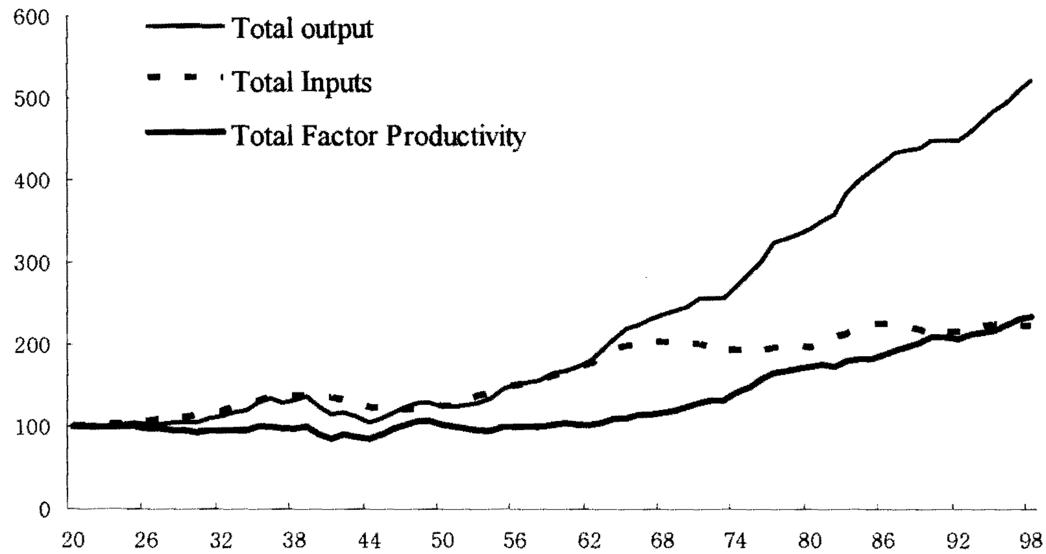
Therefore, it is not that there is no exogenous innovation strategy, but that the strategy should not be treated as exclusively exogenous. The process can be viewed as the result of recursive interrelation within the framework of induced institutional innovation, and not completely left outside of it.

3. DEMAND FOR CHANGING FARM IRRIGATION SYSTEM

In the induced institutional innovation model briefly sketched in the previous section, our attention is focused on the important role of technical changes in determining the new institutional arrangement such as farm irrigation system. Thus, in order to apply the model, an examination of those relationships in Korean farming is needed.

With substantial shifts in economic growth, structural change, and resource endowments, Korean agriculture entered a sustained growth path with 1960 as a transition point. The major historical facts about growth of output and input in Korean agriculture are presented in Figure 1. It1 exhibits both the similarity of the time series of

Figure 1. Indices of Total Output and Input and Total Factor Productivity
(Five years moving average)



output to that of input and the divergence of these two series after 1960. The expansion of output can be brought about by the increase of inputs used in production and improvement of agricultural productivity. Table 1 presents thee growth rates of agricultural output, input and total factor productivity and relative contributions of increased input and improvement of productivity to the growth output for the period of 1918-2000(five- year moving averages).

Table 1. Growth Rates of Total Agricultural Output and of Total Measured Inputs and Total Factor Productivity (Five years moving average)

	Growth Rates			Relative Contributions	
	Output (□)	Input (□)	Productivity (□)	Input (□/□)	Productivity (□/□)
1920-1960	1.28	1.19	0.09	92.86	7.14
1960-1998	2.94	0.80	2.12	27.43	72.57
1920-1940	1.00	1.44	-0.44	-	-
1940-1960	1.50	0.89	0.61	59.33	40.67
1960-1980	3.41	0.90	2.49	26.47	75.53
1980-1998	2.27	0.65	1.60	29.00	71.00
1920-1998	2.11	1.01	1.09	48.19	51.81

Source: 1) Sung Hwan Ban, "Growth Rates of Korean Agriculture, 1918~1971", 1974.
2) Agricultural & Forestry Statistical Yearbook

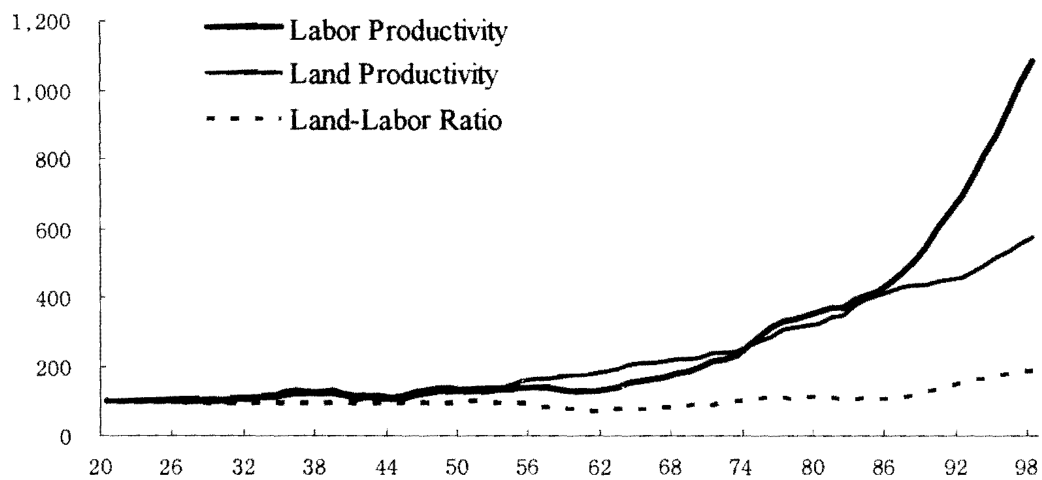
Over the entire period from 1918 to 2000, the average annual compound growth rate has been remained at 2.11 percent while total input and total productivity has grown at an average rate of 1.01 and 1.09 percent, respectively.

Korea followed a natural resource-based agricultural tradition until the early 1960s. Since then, transition has taken place to a science-based system of agriculture in which productivity growth is a key element. In a science-based system of agriculture, output growth depends predominantly upon increase in productivity.

Figure 2 and 3 depict the growth paths of labor and land productivities in the two partial productivity growth of Korean agriculture for the period since 1920. From 1920 to 1940 both productivities increased moderately. Then during World War II both decreased. After the war both productivities again began to gain, until 1950, when Korean War broke out. From the end of the Korean War in 1953 until 1961, land productivity increased, but labor productivity decreased. After 1960s, labor productivity has made impressive gains.

Figure 2. Indices of Labor, Land Productivity and Land-Labor ratio

(Five years moving average)



In Table 2, changes in the two partial productivity growth of Korean agriculture are presented for the period since 1918. Until well into the mid 1950s the overall movements in these two partial productivity areas have been very similar; however, labor productivity has grown faster than land productivity since the early 1960s.

Figure 3. Trends of Indices between Labor and Land Productivity

(Five years moving average)

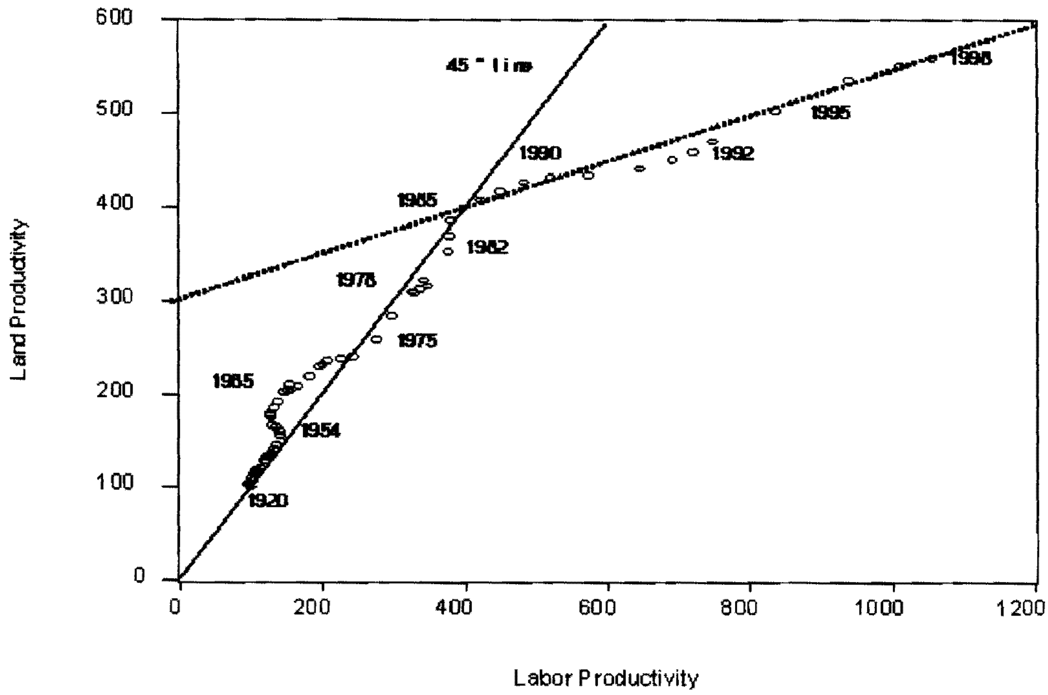


Table 2. Annual Compound Growth Rates of Labor, Land Productivity and Land-Labor Ratio

(Five years moving averages)

(Unit: %)

Year	Productivity Growth Rates		Land-Labor Ratio
	Labor Productivity	Land Productivity	
1920-1960	0.61	1.38	-0.75
1960-1998	5.61	3.09	2.44
1920-1940	0.62	0.91	-0.29
1940-1960	0.58	1.79	-1.18
1960-1980	5.05	3.01	1.98
1980-1998	6.27	3.19	2.99
1920-1998	3.06	2.24	0.80

Source: 1) Sung Hwan Ban, "Growth Rates of Korean Agriculture,1918~1971", 1974.

2) Agricultural & Forestry Statistical Yearbook

Prior to the early 1970s productivity growth in Korean agriculture was dominated by growth in land productivity. In 1961 Korea launched its first five-year economic development plan and it has made every effort to lay the foundation for a self-sufficient economy. The plan was followed by a second five-year plan covering the period from 1967 to 1971. The first and second five-year plans made possible long-range programming for the development of agriculture. Together with the increase in arable land through land reclamation and clearings, intensive farming was persistently promoted in the interests of greater productivity. Since 1967 additional policies had been implemented. High priority had been given to the development of water resources and to the improvement of land conditions in an attempt to reduce damage due to drought and, consequently, to raise land productivity. Of the total government investment and loans in the agricultural sector, land and water development projects received the largest share. During the second plan, the government emphasized small-scale irrigation projects, such as construction of weirs, pumping stations, and the tube well irrigation, but emphasis was shifted to large-scale development projects. The integrated plan for four major river basins development was set out in 1971 and included the construction of 13 dams and power plants. At the end of 1966, non-irrigated land accounted for 41.2 per cent of total arable land.

Labor productivity has been a major determinant of total productivity since the early 1970s. In Korea, the potential for increasing the area planted was relatively limited. The analysis of agricultural output growth shows that a significant achievement of the growth during the past three decades has, in fact, come from increasing yield per hectare. The yield per hectare is the main indicator of land productivity. Increases in yield per hectare can be partitioned into the increase due to land improvement, such as an expansion of the irrigated area, and to changes in the amounts of other inputs such as labor, fertilizer or the introduction of new high-yielding varieties. Having reached the limits of land frontiers, the Korean government invested heavily in irrigation development to increase land productivity. Irrigation provides increased production and reduces the risk of drought and production variability.

The introduction of high-yielding varieties of rice, improvement in the irrigation system and the high level of fertilizer consumption contributed to increasing the yield of rice. In 1978 the area where high yielding varieties were planted reached 85 per cent of the total paddy area, but a new race of disease struck the high-yielding varieties and decimated thousands of hectares, causing significant drop in production. Furthermore, in the 1980 crop year cold weather brought about widespread rice failure, which resulted in an overall decline of 30 per cent in rice production. Since the 1980 disaster the area planted to the high-yielding varieties has declined; it was 26 per cent in 1980 and 28 per cent in 1985.

The land uses for vegetables, fruits, and special crops have increased rapidly since the 1980s. In the past they had been grown chiefly for home consumption. As per capita income increases, the demands for fruits, vegetables and livestock products have increased and become an important source of farmer's cash income. Until this time the irrigation activities were confined to rice cultivation. However, in the current drive to increase the production of other agricultural commodities, irrigation for dry farms and orchards was being conducted. The additional policies for the work on the aspect were needed to redesign conventional systems to produce a series of dependable and affordable systems that more adequately meet farmers' needs.

The technology of the direct-seeding in rice cultivation is an innovation mainly induced by factors in market economy and is rapidly diffused among individual farmhouses during 1990s. The Korean farm labor force declined at very rapid rate over the past three decades. The decline in the labor force may be associated with dramatic increases in machinery and the equipment which resulted in the increases in land-labor ratio and machinery-labor ratio. The technology of the direct-seeding in paddy rice cultivation may be the scale-neutral technology as high-yielding varieties. The technology of the direct-seeding has been designed to solve the problem that results from the bottlenecks of labor shortage and high labor cost. The technology of the direct-seeding may be the technological innovation that is induced by changes in factor endowments in the market economy while the high-yielding rice varieties may be the technological development that is led by the government's initiative to attain self-sufficiency of staple food. Since labor shortage and high labor cost are the main impulse of direct-seeding technology development, it is important to analyze how man-labor hour is reduced by direct-seeding relative to transplanting practice. Direct-seeding method demands much less labor because it excludes seedling, transplanting, and making-up in its working procedure. There are different methods of water seeding and drill seeding in direct-seeding cultivation. Rice yield is not different between the seeding practices.

However, working-hour saving was about 17 percent in drill seeding and 28 percent in water seeding. Production cost was decreased 20 percent in drill seeding and 32 percent in water seeding, respectively. Amount of rice production per unit of working-hour in direct seeding could increase 14 percent in drill seeding and 39 percent in water seeding compared to that of traditional transplanting, respectively. Therefore, direct seeding could save significantly working hour and production cost without reducing rice yield. Water seeding was more effective than drill seeding in saving labor and production cost.

Table 3. Inputs of Work-Hour and Cost in Three Different Methods of Rice Culture

Source	Transplanting	Water seeding	Drill seeding
Work-hour(hours/man/10a)	39.60	28.44	32.88
	(100.0)	(72)	(83)
Costs(won/10a)			
Seed	7,769	6.913	7,827
Labor	156,919,	112,696	135,561
Chemical fertilizer	17,120	18,120	18,210
Herbicide	10,000	8,100	16,100
Pesticide	840	840	840
Fuel	6,068	5,145	3,901
Machinery depreciation	36,770	28,303	27,820
Other supply	29,180	630	630
Total	264,816	180,837	210,889
	(100)	(68)	(80)

* Other supply included cost for nursery and seed fungicide

Source: Lee, Ho Jin (1996), "Low-Input and Energy Efficiency of Direct Seeding Method in Rice", Korean J. Crop Science. pp 115~122.

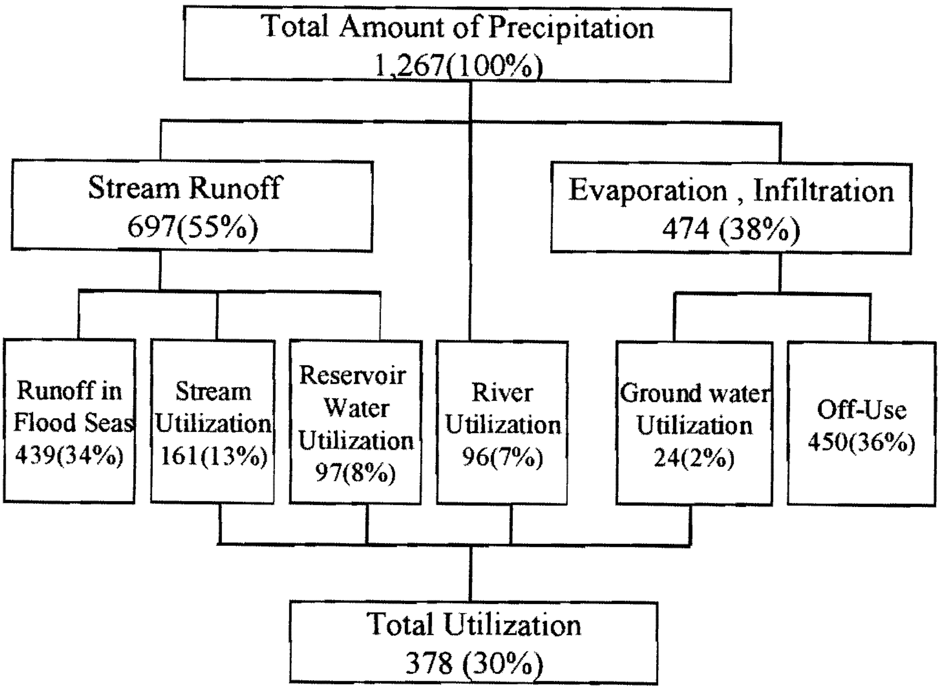
The total rainfall in Korea is ranging annually from less than 800 millimeters in the east central part of the country to over 1,400 millimeters in the southern and western coastal area. However, it is poorly distributed throughout the year with almost 70 percent falling during June-September. Rainfall is very light from November to February, the "dry winter period."

Figure 4 shows the water balance of Korea. From the total annual precipitation of 126.7 billion tons, 38 % is lost through evaporation and/or infiltration, and about 55 % (69.7billion tons) become surface runoff. However, since 43.9 billion tons are directly discharged into the sea mainly due to flood, the available annual surface runoff becomes only 25.8 billion tons. Therefore, 37.8 billion tons (30%) including groundwater utilization (2.4 billion tons) and river runoff (9.7 billion tons) can be utilized for agricultural, industrial and domestic water supplies.

However, the demand for water is on an ever-increasing spree due to the formidable effects of population expansion, economic development, and life-style changes. The water resource development is fast approaching the limit of ultimate utilizable potential in Korea. Even in areas with undeveloped water resource potential, further resource development is constrained by environmental concerns, technical inadequacy, and budgetary limits.

Figure 4. Water Resources and Utilization

(Unit: 100million m^3)



Source: Ministry of Agriculture and Forestry ; Rural Water Management and Long-Term Integrated Water Resource Plan, 2000. 11

Table 4. The Prospect for Water Resource

(Unit : 100million tons)

	2001	2006	2011
Demand for water	336	350	367
Supply of water	344	346	347
Shortage of water	7	△4	△20

Source: Ministry of Construction & Transportation

The estimated supply of water in 2011 will be 34.7 billion tons, while the estimate demand for water will be 36.7 billion tons. Korea will suffer from a shortage of water in the next ten years. The main result of a growing demand-supply gap is the intensification of inter-sect oral and inter-regional water conflicts. In agriculture, the pressure to use less water but more efficiently is increasing. Farmers will face greater competition to secure water from growing industries and cities in which sectors generate more revenue from water than farming. Water scarcity due to increasing water demand for non-agricultural uses and a deteriorating infrastructure are at the forefront of issues facing irrigation and the agricultural sector.

Besides supplying water to domestic, industrial, and agricultural users, we are increasingly facing with major environmental problems related to the management of water resources. Moreover, in many places, groundwater resources are seriously at risk from overexploitation and contamination by urban and agricultural pollutants and salt water intrusion. In the case of non-renewable groundwater, greater attention needs to be paid to possible future uses for these resources before they become exhausted or polluted.

The crisis in the water sector has also made apparent the inherent limitations of the existing institutions in dealing effectively with the new set of problems that are not related to resource development but to resource allocation and management. In fact, as a country moves from a state of abundance to a state of scarcity, water institutions, that define the rules of water development, allocation, and utilization, have to be concurrently reoriented to reflect the changing supply-demand and quantity-quality realities. With increasing water scarcity, the opportunity costs of status quo are indeed tremendous and increasing fast to exceed the corresponding transaction costs. Therefore, allocation and conflict resolution mechanism have to be either created or strengthened both in the legal and politic spheres. This means that the original opportunity costs of a crisis-ridden water sector though remain a potent force for change, need to be reconsidered and given an additional supports and contexts to get political economy thrust to promote and sustain the process of institutional change.

4. DEVELOPMENT OF FARM IRRIGATION SYSTEM

In the proceeding section we focused on the demand for farm irrigation system within the framework of induced institutional innovation in Korea. Changes in the demand for knowledge in economics are primarily a function of changes in demand for institutional innovation and for efficiency in institutional performance (Ruttan: 1985). We would now like to turn to the development of institutional innovation in Korea.

In ancient times the construction of the oldest irrigation facilities in Korea, the Pyukgol Dike, was built 1770 years ago (AD. 330) and water could be stored in this facility. The length of the bank was 3.3 km, its girth was about 140 km and its gross area was 286,254 m^2. They could irrigate about 10,000 ha.

The modern farm irrigation system in Korea does not have of relatively recent origins. It can be traced back to 1908, when under the Japanese colonial government the Okku West Irrigation Association was established in Chonbuk province. The colonial government directed the institutional framework toward modern irrigation systems: The establishments were made in (1) the Joseon Land Improvement Agency in 1938; (2) the Joseon Union of Irrigation Association in 1940; and (3) the Joseon Farmland Development and Management Group in 1942.

After Korea became independent from the Japanese occupation and established the Korean government, Joseon Irrigation Association was renamed as Korea Irrigation Association in 1949 and Joseon Farmland Development and Management Group was consolidated with the

Union of Korea Irrigation Association in 1950. Korea Irrigation Association was renamed as the Land Improvement Association in 1961 and the Union of Korea Irrigation Association was renamed as the Union of Land Improvement Association in 1962.

In Korea, the dynamics of farm irrigation system was strongly conditioned by the role of government and by the continuous search for economic efficiency. The objectives of farm irrigation system were closely related to national objectives such as food self-sufficiency. Under the first five-year plan (1962-1966) the government launched various programs to boost agricultural production by expansion of irrigation facilities. For expanding and improving irrigation facilities 22.2 percent of total agricultural investment was allocated and 53,000 hectares of paddy land were brought under irrigation during the plan period. Beginning in 1964, paddy consolidation projects also assumed increasing importance. These projects involved consolidation of small irregularly shaped paddies into single, larger units of uniform shape. Included in this effort were improvements of irrigation and drainage ditches, installation of on-farm water control structures, and construction of feeder roads to provider better access to the fields. Tideland development and slope land development projects were also intensively carried out during 1962-1966. Roughly 8 percent of the total investment in the agricultural sector was allocated to this effort.

The basic goals for the agriculture in the second five-year economic development plan were: 1) increasing food-grain production and attainment of self-sufficiency in staple food by 1971; 2) development of intensive farming areas under the principle of suitable-crop-for-suitable-area; 3) farm price supports to provide greater incentives for increased production; 4) increased agricultural exports through promotion of exportable farm products.

Table 5. The History of Korea Farm Irrigation Institutions

1908.2	Established the Okku West Irrigation Association in the Province of Jeonbuk
1938.5	Established the Joseon Land Improvement Agency
1940.7	Established the Joseon Union of Irrigation Association
1942.12	Established the Joseon Farmland Development & Management Group
1949.6	Joseon Irrigation Association Renamed as Korea Irrigation Association
1950.6	Joseon Farmland Development & Management Group Consolidated with the Union of Korea Irrigation Associations
1961.12	Korea Irrigation Association Renamed as the Land Improvement Association
1962.1	The Union of Korea Irrigation Association Renamed as the Union of Land Improvement Association
1969.2	Established the Groundwater Development Corporation
1970.1	Renamed Farmland Improvement Association
1970.2	Established the Agricultural Development Corporation (The Union of Land Improvement Associations Consolidated with the Groundwater Development Corporation)
1971.9	Established the Society of Farmland Improvement Association
1973.9	Renamed as the Union of Farmland Improvement Association
1978.4	Established the Federation of Farmland Improvement Association
1981.3	Farmland Improvement Association Consolidated and Restructured
1990.4	Promulgated the Rural Development Corporation Act and Farmland Management Fund Act
1990.7.2	Established the Rural Development Corporation (Merged Agricultural Development Corporation)
2000.1.1	Established the Korea Agricultural and Rural Infrastructure Corporation (Consolidated the Farmland Improvement Associations, Federation of Farmland Improvement Associations and Rural Development Corporation)

The government enacted the Basic Agricultural Law in 1967. The highest priority was given to the development of land and water resource projects. Construction and improvement of small irrigation systems were by far the largest program, accounting for about 70-80 percent of the total investment and loans in land and water development programs in most years during 1967-1972. Large-scale development projects did not become important until 1971 and 1972 when large investments were initiated for the river irrigation projects.

Following severe droughts in 1967 and 1968, the government embarked on tube well construction and a massive scale in 1969 and 1970. The Korean government established the

Groundwater Development Corporation in 1969 and renamed it as the Farmland Improvement Association in 1970. However, in 1970 the Union of Land Improvement Associations was consolidated with the Groundwater Development Corporation and established the Agricultural Development Corporation.

Table 6. Status of Tideland and Slope-land Reclamation Development Projects

(Unit: ha, million Won)

Year	Total Amount Of Project Costs	Slopeland Reclamation		Tideland Reclamation		
		Completed Area	Project Cost	Planned Development Area	Completed Area	Project Cost
1940-49	0.497				236	0.497
1950	0.074			781	97	0.074
1951	1			1,321		1
1952	7			3,357		7
1953	28			3,357	203	28
1954	46			3,154	163	46
1955	127			4,163	411	127
1956						
1957	154	159	1	4,573		153
1958	178	2,355	43	5,197	1,697	135
1959	111			4,767	848	111
1960	147	2,197	20	4,541	1,038	127
1961	186	2,406	94	3,813	898	92
1962	412	12,961	308	3,865	3,102	104
1963	399	15,445	357	2,256	388	42
1964	1,176	22,363	1,07	3,605	1,567	98
1965	2,456	37,220	2,301	2,688	1,116	155
1966	2,870	22,286	1,292	8,182		1,578
1967	2,850	16,770	1,300	8,182		1,550
1968	2,515	13,495	927	8,182		1,588
1969	751	7,690	592	8,182		159
1970	251	2,953	251	1,178		
1971	151	1,137	151	1,178		
1972	426	1,002	426	1,178		
1973	1,125	739	1,125	1,178		
1974	1,702	3,664	1,633	1,331	153	69
1975	6,155	7,833	5,591	2,603		564
1976	6,151	4,486	4,842	3,310	391	1,309
1977	4,982	1,471	2,060	3,718	607	2,922
1978	6,079	2,862	3,568	3,622	399	2,511
1979	5,398	1,403	4,128	3,223		1,270
1980	6,028	1,246	3,741	3,223		2,287
1981	6,232	1,218	3,544	3,223	126	2,688
1982	11,223	1,073	3,894	3,268	73	7,329
1983	11,390	348	1,877	3,344		9,513
1984	11,274	313	1,364	4,075	1,523	9,910
1985	11,530	225	4,820	2,689	850	6,710
1986	4,761	223	1,827	1,951	1,190	2,934
1987	25,342	732		7,440	493	25,342
1988	51,431	920		11,661	352	51,431

1989	61,577	571		11,935	3	61,577
1990		433			1,649	
1991		221			93	
1992		287			1,655	
1993		175			4,674	
1994		427			2,168	
1995		230			11,629	
1996		59			281	
1997		161			711	
1998		397			1,047	

Source : Ministry of Agriculture and Forestry ; Yearbook of Agricultural Land and Water Development Statistics

In Korea all farmland improvement activities, including irrigation projects were planned by the Government. On the other hand, the survey, design and supervision of irrigation projects were carried out by the Agricultural Development Corporation. However, after completion of the project, the facilities were handed over to the Farmland Improvement Associations for their operation and maintenance. Water charges were collected by the irrigation associations and were spent for the operation and maintenance of the irrigation facilities and for the repayment of long-term loans. In Korea, about 70 percent of the installation cost of the irrigation facilities was covered by the government subsidy and the balance met by long-term loans payable in 30 years.

The integrated plan for Four Major River Basins development was set out in 1971 and included the construction of 13 dams and power plants. Projects for developing multi-purpose large-scale farming areas were undertaken in the areas, where reservoirs, tidal dikes, water pumping and draining plants, and water canals were under construction. The two tidal dikes were completed at Asan and Namyang Bays in 1974. The first comprehensive country development plan was established for the period of 1972 to 1981. The basic goals of this plan were efficient land use, enlargement of infrastructure for development, protection and preservation of natural environments, and improvement of living conditions. In 1972 the Society of Farmland Improvement Association was established and it was renamed as the Union of Farmland Improvement Association in 1973. The Federation of Farmland Improvement Association was established in 1978 and it was consolidated and restructured in 1981. The second comprehensive country development plan was started for the period of 1982 to 1991. The idea of an integrated rural development planning was introduced as a new program for rural areas.

Since 1989 Korea has continually taken steps to open its agricultural markets in line with the import liberalization schedule. The government, in 1991, announced a ten-year agriculture and fisheries restructuring plan to improve efficiency in agriculture and rural living conditions. The plan gave major priority to the land reform program to transform the current system of absolute and relative land into agricultural promotion zones. A considerable proportion of the budget was allocated to land reorganization, consolidation, and irrigation. These policies were effectively backed up by the special law (Agricultural Development Act) enacted by the

National Assembly.

Table 7. Status of Agricultural Land and Water Development Project

(Unit: ha, million won)

Year	Farmland Improvement and Expansion Project												Large Scale Area Development Project	
	Total (million)	Land consolidation		Irrigation Water Development		Drainage Improvement		Repair of Irrigation Facilities		Seadike Construction			
		Area	Project Cost	Area	Project Cost	Area	Project Cost	Area	Project Cost	Area	Project Cost	Area	Project Cost
45-49	6,439			15,756	6,361			17,067	0.078				
1950	2			809	2				0.095				
1951	18			3,471	15				3				
1952	108			10,222	94				14				
1953	313			6,222	313								
1954	643			9,663	510			14,942	133				
1956	1,904			23,612	1,679			336,737	225				
1957	1,768				1,629			96,382	139				
1958	2,021			13,334	1,787			77,769	234				
1959	1,453			11,980	1,374			53,990	79				
1960	1,778			56,116	1,653			125,670	125				
1961	2,212			86,558	1,977			72,142	235				
1962	1,058			17,142	956			17,544	102				
1963	952			19,113	878			19,543	74				
1964	1,665	5,954	176	27,722	1,434			24,391	55				
1965	2,555	17,769	1,100	18,559	1,394			22,986	61				
1966	4,806	19,466	1,570	25,726	3,087			19,321	89	16,315	60		
1967	5,809	23,246	2,348	14,533	3,230			35,675	158	10,221	73		
1968	6,630	15,973	2,301	15,590	4,037			26,638	171	19,140	121		
1969	20,120	13,527	2,167	230,761	17,631			6,900	161	19,320	161		
1970	18,102	15,380	2,606	71,045	14,450			7,085	136.000	17,077	175		735
1971	14,614	26,953	2,798	19,534	8,579			16,923	126.000	15,835	168		2,943
1972	23,448	23,134	4,887	20,827	9,702			10,147	354	17,829	206		8,299
1973	28,614	29,802	6,400	19,146	6,371			33,262	382	21,893	179		15,282
1974	35,967	22,151	8,063	17,192	8,960			30,264	595	11,521	189		18,160
1975	66,638	16,135	11,057	18,592	20,123	8,251	2,155			10,342	198		33,105
1976	80,954	20,417	11,911	17,565	31,508	2,276	1,578	13,174	591	14,855	225	12,148	35,132
1977	94,783	17,502	16,734	5,877	32,311	2,676	1,480	18,565	637	11,579	226	19,559	43,395
1978	105,939	13,631	18,318	13,549	34,457	1,824	1,500	45,903	1,741	4,012	305		49,618
1979	121,918	11,867	26,392	11,321	35,847	1,499	3,717	39,428	3,163	6,242	310	37,000	52,489
1980	153,762	12,447	36,633	8,200	41,550	986	2,519	82,101	6,888	6,044	4,697		61,475
1981	257,077	11,077	52,232	2,606	71,653	1,044	6,053	16,825	7,622	8,486	4,109	2,269	115,408
1982	267,291	13,130	63,323	8,912	71,095	1,922	8,969	107,272	6,379	22,096	8,078		109,447
1983	265,012	11,941	50,765	5,743	98,679	2,832	5,721	103,205	6,606	14,662	4,013	7,185	99,228
1984	283,073	11,918	63,622	8,092	106,363	976	7,066	82,271	6,990	31,301	4,653		94,379
1985	267,393	13,027	74,420	12,459	96,312	925	9,382	97,948	7,700	12,317	2,869	3,600	76,710
1986	326,845	16,489	117,263	5,812	101,211	5,031	21,679	123,026	9,480	30,944	2,848	5,754	74,364
1987	355,569	20,807	129,198	5,411	102,640	7,404	32,615	148,690	12,099	29,729	4,809		74,208
1988	417,958	25,242	171,623	5,661	105,728	1,703	44,022	125,992	11,321	23,693	5,224		80,040
1989	455,122	24,681	200,945	5,986	103,271	2,960	48,393	159,372	17,431	19,615	7,000		78,082
1990	569,627	34,742	191,504	4,557	214,511	2,074	43,528		29,809		15,825	11,554	74,990
1991	621,418	22,377	215,043	2,426	229,338	4,201	45,000		32,442		31,000		68,595
1992	697,418	23,396	219,005	2,334	265,819	2,733	53,000		43,715		38,000		77,879
1993	838,052	20,290	342,650	3,386	268,977	3,140	53,000		46,230		62,334		64,861
1994	842,295	18,749	414,515	7,128	152,919	4,155	63,000		67,816		88,000	24,700	56,045
1995	1,246,601	27,700	513,645	7,135	231,266	1,771	78,000		95,309		98,100		80,978
1996	1,358,955	23,931	604,290	5,399	279,215	2,952	106,000		142,502		135,038	7,700	91,910
1997	1,870,845	26,967	832,240	6,656	390,695	9,195	154,441		218,354		154,279		120,836
1998	1,897,087	22,894	744,675	6,016	525,202	3,244	164,500		256,724		88,000	20,700	117,986
1999	1,395,730	14,108	465,889	2,151	351,465	5,931	162,500		224,727		96,000		95,149
2000	1,365,935	9,683	300,119	3,301	360,322	7,872	218,100		284,762		76,400	4,430	126,232

Source : Ministry of Agriculture and Forestry , Rural Development Corporation ; Yearbook of Agricultural Land and Water Development Statistics.

On February, 1994, the Korean Government announced its liberalization schedule followed by the GATT agreement. Under WTO, Korea agreed to increase rice imports from 1 to 2 percent of domestic consumption for five years beginning in 1995, increasing to 2 to 4 percent of consumption by 2000 through 2004. With its developing-country status and a special clause in the Uruguay agreement, the implementation period has been extended to 10 years, from 1995 through 2005.

The Korean government promulgated the Rural Development Corporation Act and

Farmland Management Fund Act in 1990 and established the Rural Development Corporation which merged the Agricultural Development Corporation.

The Korea Agricultural and Rural Infrastructure Corporation (KARICO) was established in 2000 and the Farmland Improvement Associations, the Federation of Farmland Improvement Association and the Rural Development Corporation were consolidated into KARICO. Since then, water charges for farmers have been abolished in the area of KARICO coverage, 58.1 percent of the total irrigated paddy field. In 1965, 42 percent of paddy field was irrigated and its portion has increased to 76 percent in 1998. In 1999, 62.8 percent of total irrigated area was covered by reservoirs, 18.3 percent by pumping and drainage stations, and 12.4 percent by weirs. The total number of irrigating facilities is 63,547. The numbers of reservoirs and weirs are 17,956 and 18,320, respectively.

The coverage of KARICO' s service is as follows: First, KARICO is executing the agricultural infrastructure development and improvement projects such as the agricultural water development, farmland consolidation project to enable stable rice production and enable security for farmers engaged in agriculture. Second, KARICO is carrying out O&M of agricultural water management to enable farmers to concentrate on the farming in a secure environment. Third, KARICI is accelerating the farming-scale improvement project, which will back up necessary farmlands for key-farmers against the limitless competition era of the 21st century. Fourth, KARICO is also focusing the rural living environment improvement project to develop sub-district areas those have comparatively fallen behind the urban areas considering regional characteristics and natural conditions.

Several changes are occurred in agricultural water management system after birth of KARICO merged from 3 agencies responsible to agricultural infrastructure development and O&M of the irrigation and drainage facilities respectively. After the birth of KARICO, water management system was centralized from the local cooperative level to the national level. The centralized management system can solve not only the imbalances of inter-regional water supplies but also all kinds of disasters by efficiently coping with drought and flooding.

KARICO operates and manages 11,707 water resources among the total number of 62,936 facilities such as reservoir, pumping station, weir and tube well on a national scale. In case of reservoir, the number of reservoir managed by KARICO is 3,261 sites, equivalent to 18 percent of the total reservoir of 18,000sites. The irrigated areas by KARICO's reservoir record 372,409 ha, which is 72 percent of the total benefited area. Considering the fact that 14,739 facilities under districts administration irrigate 144,670 ha, 28 percent of the total benefited area, the role of KARICO is very important. KARICO is operating an integrated rural water management plan including integrated management of water amount, water quality and water basin control at the same time based on the increasing necessity for an integrated water management system to cope with the water shortage period of 21 century.

5. CONCLUSION

Hayami and Ruttan (1985) illustrate the elements of a model that maps the general equilibrium relations among resource endowments, cultural endowments, technologies, and institutions. It is true that the model goes beyond the conventional general equilibrium model in which resource endowments, technologies, and institutions are given as external conditions. Based on this framework, the relations among the several variables in the social and economic changes of agricultural development can be illustrated.

Historically, the Korean land reform in 1950 was intended to remove the constraints of the old land tenure system; however, the reforms resulted in a small-scale, basically owner-operated farm system. This change can be viewed as the impact of an institution on the individual farmer's resource endowments.

Within the state/society relations the development of high-yielding rice varieties in Korea can be viewed as the result of direct institutional factors. Thus, Burmeister(1987) views Korean bureaucracy in the agricultural development as a primary factor leading to the development and diffusion of a new high yielding rice variety. However, the appreciation of technical change led to an increase in the demand for a more systematic set of procedure for constructing irrigation facilities in Korea. In part the demand evolved as a practical solution to the unstable production that became as common as technology became more important in farming. The constraint of water control depressed the payoff of investment in the diffusion of the high-yielding varieties. The first technical condition of rice production is nothing but water control. The Korean government in fact responded to the demand and a scheme for a new system of farm irrigation gradually evolved.

What are the implications of this interpretation for Korean agricultural development? This interpretation seeks the maximum application of neoclassical economic theory to agricultural development as far as possible. The changing process of farm irrigation system in Korea can be viewed as the result of recursive interrelations among various variables and can be treated in part within the framework of economics.

The supply and demand mechanism for institutional innovation in agriculture is centered on the pay-off matrix and is conditioned by the socio-economic structure on the one hand and the politic-bureaucratic structure on the other hand(de Janvry1979). The relative power of different economic and social groups over the political-bureaucratic structure is an important factor in getting their own demands eventually translated into a supply of new institutions.

Agricultural policy should not be confined only to a supply-side (top-bottom) view and that a demand-side (bottom-up) to the policy process can in fact provide useful insights. If not, there might be a long time lag between the emergency of a problem and the institutional change in Korea. In spite of these qualifications it is clear that Korea has developed an effective farm irrigation system for agricultural production. The system now has substantial capacity to operate within an induced innovation mechanism for the agricultural development.

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