3. Sustainable Management for Rural Land & Water and the Role of Agro-Environmental Education in Korea

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I. Introduction

We still believe that agriculture remains still important in the 21st century, because of not only food security, but also the conservation of biodiversity and environment, and the maintenance of rural community. But, we are actually afraid that the structure of agriculture is collapsed and rural society is totally vacant under the continuation of unfavorable WTO system. If WTO is a kind of virtue and stable forever, we can live with imported agricultural products. If not, how can we survive without safe food supply in the system of ruined domestic agriculture and no chance to import food abroad in decades later?

Herein, the present status of project for rural land and water has been evaluated. Investment and finance budget plan for rural land and water to the year of 2013 are investigated. The impending problems for the sustainable development and management of rural land and water are reviewed, and the political and technical strategies of the sustainable project for rural land and water are also discussed. The strategies to achieve the amenity of rural community in a decade have been studied both in the viewpoint of political and technical tactics for the sustainable management for rural land and water.

The agro-environment education for sustainable management for rural land and water is mostly related to the public information of multifunctionality of agriculture, the innovation of education in college, and the accreditation of engineering and APEC engineers system.

II. Brief view on Korean economy and agriculture

1. Korean economy and natural resources

Although the world economy is stagnating, domestic business shows the sign of recovery. Korea is being recognized as one of the most successful Asian countries in overcoming the economic peril in 1997. Unemployment has become one of the most urgent domestic problems. The exchange rate of won/US$ is stable at 1,150. The population as of 2002 is about 47.5 million, with a growth rate of 0.8%. The area of national land is 99,373km^2, which includes 64,413km^2 of forest, 19,235km^2 of cultivated land composed of 7,607km^2 of upland and 11,628km^2 of paddy field, and 12,903km^2 of urban and other uses.

2. Korean agriculture and project of rural land & water

The farm population as of 2002 is 3.6 million, less than 8.0% of the total population. The farm labor force has become one of the most difficult issues in the rural areas. The self-sufficiency rate of rice is 100%, but large amount of wheat and maize are imported for livestock and poultry feed. Other food groups like starchy roots, fruits, vegetables, eggs, fish and shellfish, and seaweed are self-sufficient. The Ministry of Agriculture and Forestry (MAF) is executing the project for rural land and water and its purposes are to insure a stable food supply, the preservation of productive farmland, an environmentally sound agriculture, the reforming of marketing systems, and the improvement of rural living standards.

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III. Demand and supply of water resources

1. Demand and supply of general water resources

The average annual precipitation of 1,274 mm produces 127.6 billion m^3 of water in volume. An average of 73.1 billion m^3 discharges to rivers showing a 57% runoff rate and 54.5 billion m^3 evaporates or infiltrates. But, an annual precipitation of 890 mm in the 20 years of drought produces 88.5 billion m^3 of water. Only 35.4 billion m^3 discharges to rivers showing a 40% runoff rate and 53.1 billion m^3 evaporates or infiltrates. All of the 35.4 billion m^3 water should be used to meet 37.3 billion m^3 of water demand in the year 2011. Korea is classified into the country group of water shortage by UN and would fall under the country group of severe water shortage by 2050. Since such a water shortage is anticipated, it is most favorable to construct dams to store floodwater in the climatic and geographic conditions. The water demand in 1998 amounted to 33.1 billion m^3 which comprises 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 in-stream flow augmentation. The water supply in 1998 was 33.1 billion m^3 consisting of 16.1 billion m^3 of river discharge, 3.7 billion m^3 of ground water, and 13.3 billion m^3 of stored water in dams.

2. Demand and supply of rural water resources

The rural water demand in 1998 amounted to 15.8 billion m^3 which comprises 14.0 billion m^3 from paddy and 1.8 billion m^3 from upland.

The rural water supply in 1998 was 15.8 billion m^3 consisting of 3.0 billion m^3 of river flow, 1.8 billion m^3 of ground water, 5.5 billion m^3 of stored water in reservoirs, and 4.3 billion m^3 of effective rainfall.

Changes in farming pattern and crop diversification have led to an increase of irrigation water. Water pollution caused by residential, industrial, and livestock wastes make water shortage problems worse in the 21st century. Water distribution will be also a critical issue among users.

IV. The present status of project for rural land and water

1. Outline history of rural land and water

In the 1950s, Korea was poor and agrarian country. GNP/capita was US$80.

In the 1960s, military government had strongly driven the economic plan under the new village (Saemaeul) movement. In this decade, we achieved rapidly economic growth and escaped successfully from the absolute poverty under the slogan of "produce fast, cheap & safe". In some cases, this economic policy has been introduced to the developing countries as a dynamic model, even though it is not so sophisticate and/or elegant. In the middle of 1970s, the self-sufficiency of rice was achieved. In the 1980s, Korea has grown up to an industrialized country. In the 1990s, Korea has become a member country of

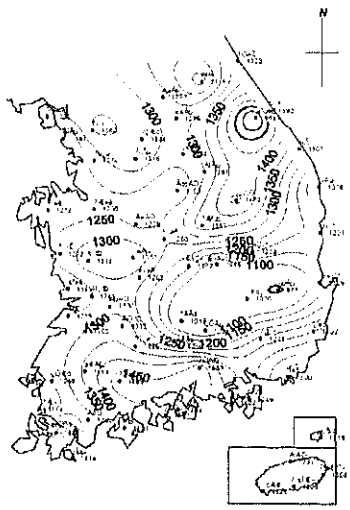

Fig. 1 Annual average precipitation

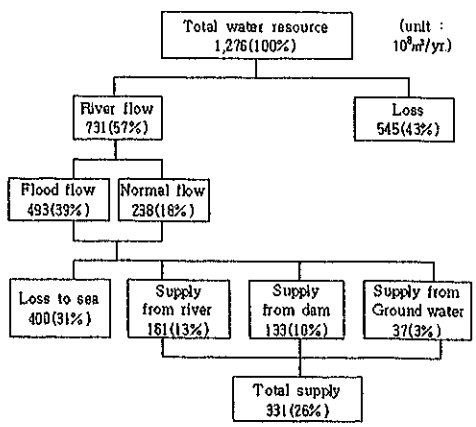

Fig. 2 Water resources and supply in 2001

OECD and WTO. But, Korea has got the rescue fund from IMF to solve the economic peril in 1997. In the 2000s, new participatory government is reforming the financial structure and driving the harmonious policy for inter-Korea and international cooperation.

2. Investment for the project of rural land and water

National budget is increasing steadily and US$101 billion (116.2 billion won in Korean currency) in 2002, but expenditure of MAF is steady and investment for rural development is decreasing after the economic crisis down to US$1.46 billion in 2002. Due to the steady investment infrastructure for agricultural production has been greatly improved. The farm income per household is expected to rise from US$19,650 in 1998 to US$25,650 in 2004.

3. Investment and finance budget plan for rural land and water

In the situation farmers are still poor and rural communities are exhausted, the investment and finance budget plan for rural land and water development has sharply decreased from US$2,012 million in 2003 to US$1,355 million in 2013 in the long term plan.

V. Impending problem for the sustainable management of rural land and water

1. WTO and Agriculture

As far as agricultural sectors are concerned, a free open market system of WTO is unfavorable to the developing countries. Although Ministry meeting at the Cancun in September was cracked down, it seems WTO is inevitable. WTO is tremendously favorable system to the Korean economy in a general sense, but detrimentally disadvantageous to the Korean agriculture in a specific sense. Most impending problems solved are how to harmonize reasonably these contradictions. WTO is not a virtue and there is high possibility to collapse, we prepare such a catastrophe in a future. One of temporary solution is to give the subsidy to the honest farmers in good faith as much as national finance and WTO rules allowed. FTA among the Asian economic blocks should be accelerated to conclude and have a role to promote the regional economy potentials.

2. Over production of rice and shortage of dry crops

Partly over production of rice and partly poor production of dry crops is problem to be solved. Although farmers produce sufficient quantity of rice with good quality, they could not make money satisfactorily because of low price

Table 1 Investment trend for rural land and water

(unit: US$ billion)

Items	1994	1995	1996	1997	1998	1999	2000	2001	2002
National budget	44.1	51.7	59.1	66.1	73.8	80.2	86.2	97.1	101.0
MAF budget	5.57	7.10	7.76	7.90	7.27	7.04	7.19	7.70	7.06
Invest & Finance	3.37	3.96	4.57	4.94	4.22	3.14	3.29	3.12	2.78
Rural land & water	0.79	1.06	1.71	2.02	2.10	1.63	1.56	1.60	1.46
Rural land & water / National budget (%)	1.79	2.05	2.90	3.05	2.85	2.04	1.81	1.65	1.45

Table 2 Investment and finance budget plan for rural land and water to 2013

Projects	2003	Investment and finance budget plan (unit: US$ million)										
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Total	2,012	1,744	1,721	1,711	1,696	1,664	1,661	1,633	1,626	1,411	1,355	16,221
Disaster prevent.	734	562	554	555	544	544	535	532	523	364	364	5,078
Water resource	485	434	424	423	436	428	434	425	432	423	423	4,283
Farm land	787	740	735	725	707	685	685	667	663	615	559	6,781
Research	7	7	8	8	8	8	8	8	8	8	8	80

of rice and the import of rice from foreign countries. Meanwhile, dry crops like wheat, maize, and bean have grown in the poor irrigation and drainage system and the products of dry crops are being in a big shortage and most of them are imported. But they have already lost their international competitions with imported products for the prices. Government starts to introduce the pilot policy of the idle paddy and supports farmers for about US$2,600/ha if they give up the rice cultivation for three years. Government induces farmers to plant dry crops in paddy land and compensates their loss of income.

3. Development of water saving technique

Water resource development by dam construction has become more difficult and several reservoir site planned are caught in disputes due to an increase in construction and compensation costs and strong opposition from the inhabitants and environmentalists. As a countermeasure of water shortage, water saving has become a hot issue. But, the farmers try to keep the traditional flooding method and consequently lots of water is being wasted. It is hard to change the pattern of irrigation method and to save water. They don't want to execute the intermittent irrigation in the paddy land, and water saving by rotational irrigation. But, it should be executed.

Heightened levee and shallow water depth in paddy

Paddy field has function to mitigate flood damage, to recharge groundwater, to stabilize the discharge of stream flow in dry season, to prevent soil erosion, and to purify the water quality, etc. In case the levee is higher and water level is shallow in paddy, such functions become widened.

Introduction of rotational irrigation scheduling

In drought seasons, water should be saved in order to keep the reservoir not to be dried up during the irrigation season. Rotational irrigation scheduling in paddy with the operation rule curve inform water manager how to save water depending on the rice-growing season and water storage volume.

Automation facilities for water management

The rotational irrigation scheduling can be utilized as a software program to install TM/TC system for irrigation water supply by automation facilities. Irrigation water can be saved 15 to 20% and reduced O&M cost up to 9% by automated system.

4. Organization of irrigation management and water price for irrigation

Three independent organizations for rural land and water management were merged in 2000 into a state enterprise called Korea Agriculture and Rural Infrastructure Corporation (KARICO). The coalition created some effective operation of organizations, but lost the regional diversity of water management. This system goes against the global trend of participatory irrigation management (PIM). It is desirable that the promotion of the farmers' roles and participation should be strengthened for the better water management.

Water price for irrigation has been about US$300/ha until 1989. Since no price for irrigation water was politically determined in 2000, all cost for investment and O & M subsidized by government. But, no charge for irrigation water is against the pay-as-you-use principle economically. Little attentions are paid to water saving by farmers.

5. Sustainable agriculture

Sustainability could be defined as combination of development and conservation, growth and distribution, and production and environment resulting in good harmonies. Farmland and labor are scarce and it makes intensive use of fertilizer and pesticides and produces some damage to the environment. Overuse of chemicals causes problems for human health, ecosystem, and water quality. The sustainable agriculture is classified as organic farming and farming without or low agrochemicals. Sustainable agriculture promotion act has been working from 1997 and it is the top priority of the MAF policies. The environment-friendly farming household and area are expected to increase.

VI. Strategy of the sustainable management for rural land and water

1. Selection of the strategy

Experts have two different opinions about the strategy of the sustainable management for rural land and water. One is the development and the other is the conservation of land and water to

achieve the amenity of rural society.

Whichever strategy is selected, it is important to take into account the political and technical tactics mentioned below to enter into the group of advanced country and accomplish the amenity of the rural community.

Strategy for development of land and water resources

This policy is to develop land and water as much as possible in order to supply food in security. Originally the natural resources of Korean peninsular are too scarce for the 47.5 million people to live. In the original MAF planning in 1998, the target of cultivated area was to maintain 1,850,000ha for agriculture use, with 1,100,000ha for paddy and 750,000ha for upland. The irrigated land was 1,038,000ha and the irrigated land safe from a drought of 10-year frequency was 713,000ha The other planned projects for rural land and water were 74,000ha for drainage improvement, 41,000ha for rural water development, 3,000km for irrigation canal repair, 205,000ha for large-block consolidation, 81,000ha for upland arrangement, and 17,000km for cultivating road pavement by investing US$27.8 billion with a duration of 2005~2024.

Strategy for conservation of natural resources

This policy is to conserve the natural resources as much as possible. The cultivation area of rice could be reduced to 850,000ha by 2010 because of rice consumption decrease and MMA import increase. Since 850,000ha has already been consolidated and irrigated, there would be no need to develop the land and water any more. The cultivating pattern should shift from high energy-maximum yield to low energy-optimal yield in order to conserve the soil and water as done in the advanced countries. MAF has revised the long-term plan at the viewpoint of conservation strategy in 2002. In the revised MAF plan, the irrigated land reduced to 900,000 ha or 82% of total paddy land with 59% of total paddy land or 646,000 ha of irrigated land safe from a drought of 10-year frequency. The total investment in the new MAF plan is going to be US$16,221 million with a duration of 2004~2013.

2. Political tactics for the management of rural land and water

For the food securities

The food security is defined as guaranteeing the supply of food safely both in quantity and quality in the long-term basis. More important thing is to have an ability to produce food self-sufficiently. As a result of over production of rice, the total stock exceeds temporarily the optimal amount at an unreasonable level. But, the stock of rice can be used effectively in a year of poor harvest and for the inter-Korea cooperation. The economic globalization has weakened the traditional theory of food security of the developing countries. But, most of the advanced countries are self-sufficient for food and export agricultural products. The report that the shortage of food was the one of the reason of collapse of the former Soviet Union gave us historical precepts, even if he had the big population, vast land, and strong military power.

For the diversity of rural characteristics

Normally the projects for rural land and water have been planned by central government and executed uniformly by administrative downward system. For example, the sub-surface drainage improvement had been implemented without farmers' understanding about the purpose of the project. The projects for rural land and water should be planned and the rank of priority for the projects determined autonomously by the residents and farmers.

For the amenities of rural life

The identity of rural society has been partly lost because the projects for rural land and water have been metropolitan-ward carried out. Even in the modern society of high technology, rural community should maintain its historical identity. Green tourism in the rural villages is recently spotlighted because the system of 5 working days a week is in force. People enjoy working in the wild fields and experiencing the old traditions in the farmers' house. The project of information technique in the rural region has been spread and Internet-network of ASDL has been used to the marketing of agricultural products from the year of 2000.

For the unification of Korean peninsular

The unification of Korean peninsular is the national supreme target and the prerequisite for

the advanced country. It was reported by WFP/FAO that the shortage of cereal food reached 28% of total consumption in 1998. A harmonious policy to assist North Korea should be considered in the agricultural sectors. The Republic of Korea shares several rivers with North Korea and proposes the joint study for the watershed development and farmland restoration. Inter-Korea co-operation will be executed step by step. In an agricultural sector, first step is to provide chemical fertilizer and seeds, second step is to construct fertilizer and pesticide factories, and third step is to support the projects for the integrated development of rural land and water.

For the international collaboration

The other prerequisite for the advanced country is the economic assistance to the 3rd world countries. International cooperation for the development of rural land and water has become more important and active than ever. The government pay more attention to international cooperation for rural land and water projects through the Korea International Cooperation Agency (KOICA).

Meanwhile, KARICO is also interested in the international collaborations such as consulting project, technical training, and technical assistance of specialist.

3. Technical tactics for the development of rural land and water

Eco-friendly irrigation and drainage canal

The concrete-lined irrigation canal is effective to reduce the conveyance loss of water and the concrete-lined drainage canal is effective to remove the floodwater quickly. On the contrary, the concrete-lined canal is bad habitat to the aquatic plant and animal. Eco-friendly and natural materials of canal to reduce the water loss and to remove floodwater quickly, and be good for aquatic creatures should be developed in the long term.

Over-exploitation of groundwater and eco-system

The 3.6 billion m^3 of ground water was mined from 1 million tube wells. Geologists insist on the increase of groundwater use up to 20% of total 7 billion m^3 to be mined in 2010 with a projected 4.2 billion m^3 for agriculture. But, it makes some problems; contamination of ground water, dropdown of ground water level, and no flow in the river in the drought season, etc.

The over-exploitation of ground water drops the ground water table down and reduces the discharge of base flow, and so, deteriorates the water quality and the eco-system in the streams.

Construction of environment friendly reservoir

Considering Korean climate and geography, the most favorable method to utilize water and to control flood effectively is to construct the dam. In the senses, 28 multi-purposed dams and lots of rural reservoirs are planned to construct. But, it becomes difficult to construct the big dam, because of expensive construction cost and environmental and ecological problems.

As an example, national controversy between water development and natural conservation for the proposed Dong-gang dam has been seriously held for some years. Finally, the dam for the water supply and flood control was totally cancelled. For another example, national controversy between tidal land reclamation and swamp conservation for the on-going Saemankeum project has been held. The project is temporarily stopped to investigate the environmental impacts thoroughly.

Rural land and water for regional culture, environment and ecology

The members engaged in the related organizations play an important role not only in water management in the region, but also in preserving traditional culture, environment, and ecology as a spearhead. It is recommendable to organize a NGO with local farmers to conserve water, soil, scenery, and culture by introducing the concept of Groundwork trust movement in UK. It means that agricultural activities contribute the crop production as well as the preservation of lives like a herb, a weed, a pasture, a dragon fly, firefly, and butterfly, etc.

Reduction of construction cost

Average construction cost for irrigation structure is too expensive. Those are US$39,000/ha for reservoir, US$21,700/ha for drainage improvement, US$217,000/km for irrigation canal, US$24,350/ha for land consolidation, US$21,700/ha for upland consolidation, US$34,780/ha for tube well, and US$18,260/ha for pumping station, respectively. For example,

the construction cost of irrigation reservoir called Noti is US$6,087,000 for the 700,000 m³ of water and the benefit area of 100ha. It costs US$8.7 per 1 m³ of stored water and US$60,870 per 1 ha of command area. World bank recommended modern projects should not cost more than US$ 20,000/ha.

Technique for repair & maintenance

Lots of facilities for irrigation and drainage are very old and repair and modernization should be continuously executed. The 55% of reservoirs is older than 50 years and 25% of pumping stations older than 20 years. The 36% of irrigation canals of 59,200km and 11% of drainage canal length of 31,500km are concrete-lined. Techniques should be developed to reduce the cost of repair and maintenance.

Techniques of the disaster prevention by forecasting and flood map

We have recently experienced miserable damages causing 270 deaths and US$5.2 billion of property by the typhoon Lusa in 2002, and causing 130 deaths and US$4.3 billion of property by the typhoon Maemi in 2003. Out of them, large portion of damage was coming from the irrigation and drainage facilities. The disaster could be prevented by the flood forecasting and warning system in the normal flood season and mitigated by the flood map with GIS as much as possible in the emergency.

VII. Role of agro-environment education

Some people criticize the adverse affects of irrigation water on the ecology and environment without specific knowledge. In some case, they oppose the natural and right project for rural land and water. Unfortunately, they sometimes lead the public opinion of the society toward the wrong direction. We, agricultural engineers, should build our theory on the role of agro-environment education.

1. Public information of multi-functionality of agriculture

We are free from food shortage and so do not recognize the importance of irrigation water productivity and no thanks any more for the agriculture. Water for agriculture in Asia monsoon region is not only an economic resource of an individual farmer, but also a common resource of the rural community. On the other hand, paddy field irrigation has the positive functions such as flood control, ground water recharge, air purification, soil erosion prevention, and aqua-eco-system preservation. The reduction and control of non-point source pollution from agricultural lands, are other issues to be solved. The multifunction of agriculture and irrigation water should be rationally evaluated.

2. Innovation of education in college

Ministry of education has driven the innovation policy of college education, and especially has made efforts to reform the 55 agricultural colleges.

Agricultural engineering applies engineering knowledge to the principle elements (water, earth, lives, environment, and structures in the rural space) in order to advance amenities by enhancing productivity, living standards, and natural resources in rural society. The ideology of education for Agricultural engineering in the 21st century should be transferred from a yield increase to an amenity enhancement. Then, job creation for the graduated students could be expected to widen to the fields of the central & local government, company related to water management, rural environment, automated system, measuring sensor, and utilization of natural materials, etc.

3. Accreditation of engineering and APEC engineers system

The object of accreditation of agricultural engineering education is to produce qualified agricultural engineers from college. The criteria for accrediting program are faculty, curriculum, student, program title, administration, and facilities. The program needs the enhancement of existing facilities and faculty members, and the adjustment of sub-majors and relevant courses. The accreditation system is not directly connected to the qualification criteria of APEC Engineer. Agricultural engineers are not in active position. Reviewing the progress, it is planned to establish a cooperative body.

VIII. Conclusions

In the economic and social point of view, Korea is standing at the turning point to enter the group of advanced countries. Consequently, the value system of people is changing from development to conservation, from growth to distribution, and from production to environment Even though infrastructure for agricultural production has been greatly improved, farmers are still poor and rural communities are rather exhausted compared to the advanced countries. We, agricultural engineers in Korea, have to find out new projects that farmers are getting rich both economically and mentally and so they can enjoy the amenities of rural life. New projects are related to disaster prevention, information techniques, agro-eco-environment system, and improvement of public welfare facilities, needless to say water saving and automation for irrigation and drainage.

The crisis of agriculture we are facing have to be overcome both with political tactics for food security, the diversity of rural characteristics, the amenity of rural society, the and unification of Korea, and the international collaboration and with technical tactics for eco-friendly irrigation and drainage canal, recharge of ground water, environmental-friendly dam, technique of repair and maintenance, and techniques of the disaster prevention.

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KOREA: DISCUSSION

Question: Are there some subsidies for agriculture being given by your government?

Answer: Farmers deserve to get subsidy sufficiently corresponding to their roles and functions for the nation and society on the basis of income support policy.

Question: Can you please expound on the salt injected relocation method?

Answer: We have salt-affected soil problems only where the tidal land has been reclaimed in the western coast. The tidal affected soil can be arable by flushing with fresh water after 5-10 years have passed.

Question: What can you say about the automation and the changing role of farmers?

Answer: Farmers should be responsible for the water management of tertiary canal and plot. There are 16,700 volunteers to assist the self-management for tertiary canal and plot.