Promoting the Managing Capabilities of Rice Farming Agriculture

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ABSTRACT

Rice paddy is formed by confining water around field block borders with short levees. The inflow (irrigation) and outflow (drainage) functions on this mild sloped land keep the soil within the borders under saturation conditions, in which some water-borne economic crops, such as rice, or water caltrop, are planted.

From the aspect of water, the irrigation water first flows into field areas through irrigation systems to provide the evapotranspiration as required by crop growth, as well as the conditions to regulate regional climate, seeps underground on this vast land to recharge the groundwater, underflow, as well as return flows, then soaks within borders to form temporary reservoirs to detain downstream runoff, as well as optimized wetland to create an intimate space, and finally the drainage water discharges into downstream farmland to improve the sanitary environment as well as to provide reuse of return flow, thus, a rice paddy irrigation mechanism is completed.

1. MANAGEMENT SYSTEMS OF RICE PADDIES

There has been an ancient history for rice paddies. And as the promotion of irrigation efficiency is concerned, rice paddies can be classified into two categories by their management scales, one is the large-area rice paddies, and the other the small-area rice paddies.

The large-area rice paddies are focused mainly in the United States of America, and Australia, where the land is broad and population density is comparatively low. Rough agricultural management is applied in these countries as labor costs are high, and from land-preparation, seeding, fertilizing, to harvesting, all works are carried out by large machines, or even airplanes. The advantages are that the irrigation management is simple, and the labor costs are lower, however, the disadvantages are that detailed abnormal crop phenomena can not be observed and taken care of, so that the production and quality are worse.

Small area rice paddies are focused mostly in Asian countries, such as Indonesia, and the Philippines. In this case, an irregular shaped rice paddy field is confined by shallow levees in one single village where water resource is attainable. Another rice paddy field is encircled at lower reach when original crop production does not meet the requirement, and a fish-scale type of land use is formed as time goes by. The advantage is that the irrigation management is simple; however, the disadvantages are that the areas are small and shapes irregular, and enormous human labor is needed due to low machinery efficiency. Because of the fish-scale land form, no upland crops can be planted during rice cultivation period. In addition, as labor costs are high, this farming type is suitable for family or village members, and would be incompatible to the high-efficiency as well as low-cost of the large-area farming type, especially after joining WTO.

2. TRADITIONAL RICE FARMING MANAGEMENT SYSTEM FACES CHALLENGES

Due to the speed-up of globalization, the effects of WTO to rice paddy management in various countries are different. There may be more opportunities for the low-cost yet high-quality industries, nonetheless, there may be more competition pressure on the high-cost yet low-quality industries. As a result, the challenges that traditional rice farming management systems face are discussed according to the multi-utilization of farm land, better utilization efficiency of water resources, promotion of equipment efficiency, lowering of labor costs, and maintenance of ecological functions as follows.

2.1 Multi-utilization of farm land

The dieting habit has been changing from single main crops to multiple choices, and the small-area rice paddy of single crops is fading out. Hence the rice-paddies are modified to medium-sized areas in eastern Asia, such as Taiwan, Korea, and Japan, where rice paddies are well planned. Each block has its independent irrigation and drainage system, which can be operated individually on its own planted crops. However, the freedom to select crops to be planted as well as to conduct irrigation and drainage has also brought difficulties on irrigation management.

2.2 Better utilization efficiency of water resources

In order for the promotion of water resources utilization efficiency, the management responsibilities and obligations should be clearly defined first. From the concise viewpoint of "supply" and "demand", the internationally accepted terms of "on-farm" and "off-farm" systems are introduced. The borderline to divide the two systems is defined as the water measuring facilities, namely, check gate, where the off-farm (supply) side is normally operated by the government or water resources authorities to provide water sources, and the on-farm (demand) side is normally operated by various water-use sectors. This concept has been widely accepted internationally, and the water utilization efficiencies due to institutional problems are expected to be improved and promoted.

2.3 Promotion of equipment efficiency

It has been a worldwide trend to cost down the rice cultivation by large machineries. However, it is still a problem for the medium or small-area rice farming bodies to introduce large machineries as the lengths of the field blocks are too short, thus the expansion of management scales seems to be a must for these areas. Nonetheless, the accompanied problems of dense population, as well as over-dissection of land-ownerships, have shown it a rather difficult task.

2.4 The lowering of labor costs

The export of farm labor force seems to be a common trend in the areas of medium or small management scales. It can be foreseen that the need to lower labor cost would be an important subject, and can be started from the management of water resources as well as farming cultivation.

2.5 Maintenance of ecological functions

For the countries with medium or small scales, the interests in managing rice farming would be forced to reduce as the competitiveness weakens after joining WTO. However, from the viewpoint of national security as well as land protection, rice paddy land is irreplaceable and irreversible. Hence, most governments would make every effort to reserve rice-paddies.

When the area of rice-paddy reduces, the abundant agricultural water resource is requested to transfer to other purposes. In the mean time, not only the significant agricultural "return flow" diminishes as the amount of seepage reduces, agricultural production is also affected due to water contamination from domestic and industrial wastes. As a result, the government is now promoting the policy of "water planting". In other words, the basic functions of ponding and irrigating are retained even during fallow or when rice is not planted, and this seems a nice choice to reach the sustainable use of farmland.

3. PROMOTING THE MANAGING CAPABILITIES OF RICE-FARMING AGRICULTURE

Among WTO issues, the withdrawal of tariff and non-tariff trade barriers is widely discussed. For those industries with comparatively low competitiveness, the crisis of suffering losses or even bankrupt would be faced if the management style or technology innovation is not adjusted to upgrade their global competitiveness. Taking Taiwan as an example, the uneven precipitation both temporally and spatially has always been a headache problem for the water management. In order to resolve the water problems among sectors, as well as to respond to the impact of joining WTO, the government in Taiwan assists the farmers to promote fallow by the unit of collective farming group (e.g., rotational tertiary block). As all plots in the rotation block of the same water supply system are covered under this fallow format, the water conservation effect is significant. Nevertheless, the fallow behavior performed by the random farmers in the non-fallow areas draws considerable worries. According to Japanese experience, these area accounts for nearly over 50% of non-fallow area. As the area as well as locations of this fallow land cannot be expected, the establishment of an effective analyzing model is needed in order to reach water-saving purposes.

In response, the author proposes three suggestions, which are elaborated as follows:

3.1 The expansion of rice-farming management scales

There have been plenty of resources in the area of agriculture, however, these resources gradually export due to numerous reasons as explained below.

3.1.1 human resources

As economy grows, the request for living quality and material increases, and the general low income gradually can hardly meet the demand of young generations. Besides, the increase in incentive and job offers of non-agricultural department also causes agricultural labor to export, as well as the aging problem becomes significant, the quality and quantity of human resources both weakens. Although the plan of speeding up the extension of agricultural machineries had long been promoted, the problem still exists. In fact, the "man-hunting" problem in the agricultural department from non-agricultural sector is becoming serious.

3.1.2 water resources

All civilizations started with agriculture, and agricultural water accounted for most of the total water resources after all the efforts had been put in to the irrigation business. However, in many developed countries, such as Taiwan, Japan, and Korea, due to the prosperous of industry and business, the improvement of living standard has led to the demand of more public, domestic, as well as industrial water supply. Again, due to the difficulties of developing new water sources as well as the environmental protest problems, the request for transferring agricultural water resources to non-agricultural sectors has been increasing.

In addition to the decrease in quantity as a result of transferring to non-agricultural purposes, the agricultural water quality also degrades owing to the discharge of domestic and industrial waste water. In many cases, the agricultural water has been contaminated even not suitable for irrigation purposes. In fact, the "water-fighting" problem in the agricultural department from non-agricultural sector is also becoming serious.

3.1.3 farmland resources

Due to the economic growth, the demand for city development, city renovation, transportation, regional planning delineation, and other public infrastructure, has led to the transform of much fine farm land to non-agricultural uses. Although new farmland is developed, its productivity is hardly as good. Once the farmland resources is transformed to non-agricultural uses, its productivity can hardly recover even when it is returned to agricultural purposes. Nonetheless, in a free democratic society, there is no absolute yes or no on public policies, the so-called public of national interest may be the final judgment, if there is a widely-accepted standard.

If under proper control, the export of agricultural human resources is generally a normal process. The necessary effective incentive to attract or recruit new generation with creativity and competitiveness is needed.

Once the agricultural water resources is transferred, the management on the farm land with water shortage would face change. The possible measures include adopting water conservation method, enforcing water management, or, quitting agricultural uses.

The irrigation system in the rice-cultivation countries such as the United States or Australia has great difference with the Asian countries. For example, the agricultural states are vast in farmland and low in population density. That is, each farmer owns enormous farmland, the cultivation style is rough in which land preparation, seedling, fertilizing, or harvesting is carried out by machines. Although the unit area production and crop quality at this moment cannot compete with those in the Asian countries, their low cost is a favorable advantage. By the time when better production and quality are reached, the agricultural products from Asian countries will loose their competitiveness.

After joining WTO, the willingness of the farmers to plant rice is expected to decrease, and the rice paddy is expected to be deserted. Under this circumstance, the original irrigation water may be wasted. Following suggestions are proposed for reference as well as discussion.

In Asian countries, the agricultural management is normally based on families in which the farming scales are mostly small, and the farming willingness normally decreases when joining WTO is expected. The author would like to point out a direction. That is, to design a series of accompanying rewards and controlling measures by providing enough incentives so that a collective area of farm land is formed by uniting several farmers' land by means of leasing or area weightings. The farming practice of this collective land is conducted by an expertise organization, adopting the similar rough farming like the United States in order to reduce production cost and to promote competitiveness. As long as the legislative and controlling measures are appropriate such that people's interests are not harmed, then not only the impact of WTO on rice-paddy could be reduced, but the cultivation techniques could be improved to increase rice quality for further export opportunities.

Once the small farmlands are collected and concentrated, the ridge borders as well as the small ditches in between blocks will be leveled, and the cultivation area could be increased as well. In other words, the agricultural machinery could be introduced, and production could be increased consequently. In addition, the number of gate operation by the water controllers would be greatly reduced, and the irrigation management efficiency would be highly promoted. It is believed that under the profit incentive conditions, more people would participate in the agricultural scientific research, and the extension of agricultural and irrigation technology to the international stage is expected.

The current irrigation management in the medium-scale rice-paddies has the merits of independent operation, however, the irrigation and drainage practices are sophisticated that considerable labor is needed to control the gate operations, and are economically inefficient when labor costs are high in these days. As a result, a new rotational block with an overflow type of irrigation ditches, which have higher outer ridge walls and eliminated inner ridge walls, is proposed by the author. This type of rotation blocks with overflow ditches could not only promote the farming efficiency, but also reduce the labor costs. In addition, the low efficiency problems of introducing large machineries are also resolved.

In order to solve the confusion of land ownership problems when plot ridges are eliminated, a delineation method by installing marking posts at the conjunction of field plots as border lines is also proposed by the author. With these marking posts, there would be little property dispute problems, there would be more farmland for crops, and there would be higher efficiency for agricultural machinery operations.

As for the irrigation efficiency problem, the concept of deep-water irrigation cultivation technique can be introduced. That is, to provide rice crop over-amount of irrigation water when precipitation is plenty. The number of irrigation practice could be reduced, and irrigation efficiency could be upgraded. In the mean time, the effective rainfall ratio as well as conveyance loss problems can be effectively resolved.

For example, before 1945, the rice-paddy irrigation water depth in Taiwan was following Japanese rule of 6 cm. In 1994, the rice-paddy water depth has raised to 18 cm, then further to 25 cm by 2001. But in Taiwan, some rule has been followed for 60 years without change.

The reaction of people when they first heard about the term "deep-water irrigation" was the survival of the plant under 25 cm depth of water, if it would get drowned during seedling period. As a matter of fact, "deep-water irrigation" doesn't start with 25 cm of water depth at the very beginning. Instead, the water depth is raised gradually according to the growth of the crop. In other words, the true meaning of deep-water irrigation is the maximum water depth the field structure could sustain.

The case in Taiwan is that Taiwan has been suffering from frequent droughts recently, so the promotion of deep-water irrigation seems a conflicting idea. Agricultural water is already insufficient for the 6-cm depth irrigation, not to mention the deep-water irrigation. But in fact, since the temporal distribution of rainfall is uneven, if the excess water during rainfall season could be stored in the vast rice-paddy field, the percentage of agricultural water in the reservoirs could be significantly reduced. This can be exemplified by the 350 thousand acres of rice-paddy field in Taiwan, the volume of the excessive 19 cm depth of water, equivalent to 665 million tons of water, is greater that any of the reservoir capacity in Taiwan.

Whenever rice growth is not affected, the water resources, which would normally be discharged to the sea, is diverted and stored in the paddy fields. When water shortage occurs, irrigation practice could hold for some time, furthermore, the utilization efficiency may be increased by transferring the stored water downstream for agricultural or other purposes

In irrigation management, as the irrigation water depth in deep-water irrigation could be increased to 250 mm, the estimated rotational irrigation period could thus be lengthened to around 20 days. When the idea of above-mentioned large-area farms is introduced, the work load of the water controller could be reduced to 1.25 day each time, the irrigation cost is greatly reduced, and the rice price would possess more global competitiveness. Furthermore, if more efforts as well as research are put in, such that a rice species more suitable to deep-water irrigation, and with better quality and quantity, the feasibility would be even more favorable.

3.2 The irrigation response strategies during droughts

The rice-paddy field is like a "natural reservoir" with vast area although shallow in depth, and should be carefully utilized. When the "excessive" agricultural water is stored in this natural reservoir, it would be recharging groundwater, underflow, and return flow continuously. The way the irrigation practice consumes water is simply to provide evapotranspiration needed for normal growth, and is far different from those of industrial and domestic water. Consequently, from the viewpoint of effective use of water resources, the introduction of water to be stored in the rice field during wet seasons should be encouraged without restrictions. In other word, water conservation during wet season when water is abundant is meaningless. In stead, how to detain excessive rainfall water in the rice field for operation purposes, to maintain appropriate seepage, to increase ground recharge, to reduce irrigation management cost, and to create a water-friendly environment, is in fact the reasonable way of irrigation water management, and is truly the goal for we the agricultural professionals to devote to.

The current irrigation water distribution strategy to aid industry by agriculture is to include the industrial body as a normal operation unit in the Irrigation Association system. When water shortage or drought occurs, the industrial water demand is first fulfilled. Agricultural water distribution measures are then applied according to the drought-endurance of the crops (however, this scenario can be applied only occasionally as saline problem may be unfavorable for the sustainable development of farm land). And when extreme severe water shortage occurs when industrial could not get what it need even when complete fallow is carried out, emergency measures such as drilling deep wells in river beds are needed.

The condition of the plan is solely based on the existence of agriculture. Once the agricultural water right is decreased under pressure from various sources, the lack of flexibility may lead to a worst case that even the emergency withdrawal of groundwater is inoperable because the recharge is too few.

3.3 The application of multiple agricultural water resources

The increase in industrial and domestic water demand due to the development of economy as well as change in industrial structures has put pressure in the decrease of agricultural water. Moreover, as the development of water resources is becoming difficult, especially after joining WTO, how to effectively distribute and manage water resources has become an urgent issue. As agricultural water used to account for most part of the water resources in almost every country, a comprehensive water resources policy and regulations are needed. In the future, the goals for agricultural water would be "ecology, living, and production". In fact, the benefits of paddy fields in ecological and living functions are far great than their production functions, and their roles could not be ignored. The beneficiaries include not only the low-income farmers, but the entire people. Consequently, the agricultural business must stress on sustainable management in order to provide the major as well as safe food, but also for the sake of long-term national security. It is thus urged that rice-paddy fields and agricultural water need to be rationally secured and protected.

Although shallow in depth, the agricultural area is a "natural reservoir" with vast area, and should be better used. Unfortunately, some people suggest to increasing water of other sectors by cutting down the agricultural water simply because the agricultural production value is lower, the rice-planting area is decreasing, and consequently the application water would be less. By doing this, only the ratio on the effective use of rainfall is decreased, and it is definitely not an effective use of water resources.

An idea of leasing the fallow areas to the government or industries in order to convert to ponds for water storage purposes could be considered. The surface water storage would not be decreased because of the decrease in rice production, the functions of climate adjustment, groundwater recharge, as well as flood reduction could be retained. In other words, the conventional purpose of rice paddy irrigation is transformed from production to joint functions of production, living, and ecological.

By introducing more water during wet seasons, the stored water in paddy ponds stays "running", and provides the best "wetland" ecology for animals as well as plants, groundwater recharge, and environmental conservation, etc. The running water also improves the rural sanitation, creates a friendly environment for farms or villages, and satisfies the demand for the joint functions of production, living, and ecological. In addition, as the utilization ratio is high, this ponded water could provide the auxiliary water sources for miscellaneous purposes in normal time, but could extend the capability of fighting water deficit during droughts.

From the viewpoints of the three joint functions of paddy field, the effective use of water resources, and the maintenance of sustainable productivity of soils, in order to provide the basic income for farmers without changing yet improving the current paddy field structures, the directions of future agricultural development may include:

A. maintaining the contribution of rice paddy production,
B. strengthening the functions of paddy fields to living and ecological,
C. emphasizing the meaning of rice paddy irrigation to the effective use of water resources as well as the maintenance of soil productivity, and
D. finding a solution to irrigation water by making fully use of fallow areas.

4. CONCLUDING REMARKS

The society has been evolving, every business nowadays has to keep in pace in order for sustainable management, and above all, the multi-directional management has become a trend with farsighted view. Hence, the role of agriculture in the society is not simply the producer, but the multi-directional role emphasizing in the three joint functions. The three joint functions of agricultural irrigation water can be described below:

Table of the three joint functions of agricultural irrigation water

function	items
production function	1. increase production per unit area 2. increase cultivation area 3. avoid damages of continuous crops 4. improving field soil by settling silts in the irrigation water 5. maintain soil productivity
ecological function	1. replenish groundwater resources 2. stabilize river flow 3. flood control by reducing peak flow (paddy fields as reservoirs) 4. mitigate land subsidence 5. clean water quality 6. purify air quality 7. adjust micro-climate 8. prevent soil erosion 9. desalt 10. conserve wetland, and provide sanctuary for water birds 11. water resources cycles
living function	1. improve living environment and sanitary of farms 2. provide miscellaneous water and fire hydrant in farms 3. aid domestic water supply during water shortage 4. promote communication and cooperation among villages via management organization systems 5. provide comfortable living environment and fair scenery 6. provide leisure of cultural education 7. stabilize people's living

Taiwan has joined the WTO in 2001, and the impacts of low-priced agricultural products, cancellation of tariff protection follow. These impacts are un-ignorable crisis to the fragile agriculture in Taiwan, *and are also difficult problems for the countries with small farmland area as well as expensive labor costs, namely Japan and Korea. How to face the crisis, and to quickly propose effective* response measure, are the urgent tasks for the governments. If the crisis is viewed as an opportunity while the traditional agriculture could be transformed into an industry with more managing competition forces, it is believed that agricultural science and technology would have a bright future.