Global Water Resources and Water for Agricultural Use in Japan

February 2003

The Planning Subcommittee

The Committee of Agricultural and Rural Development

The Council of Food, Agriculture and Rural Areas Policy (in MAFF)

Table of Contents

Introduction

International concerns regarding water and water use have recently increased.

Following discussions in forums such as the Water and the Environment Conference (Dublin conference) and the United Nations Conference on Environment and Development (Earth Summit) in 1992, the 1st World Water Forum was held in Morocco in 1997. This forum sought to promote in-depth discussions among the international community aimed at solving water-related problems, and to heighten global awareness of the critical importance of this issue. Since 1997, discussions have continued. In particular, the 3rd World Water Forum will be held for the first time in Asia when it opens in Japan next month, and is expected to become the starting point for launching concrete actions intended to solve water-related problems.

When contemplating global water resources, water for agricultural use is an important factor because such use accounts for 70% of all water use worldwide. Moreover, given current circumstances in which the world's population continues to grow, ensuring supplies of water for agricultural use will be indispensable to achieve stable food supplies. Appropriate use of water resources for agriculture is also necessary in order to achieve sustainable development of the rural village regions that are home to the majority of the world's poorest citizens.

Based on such concerns, the Planning Subcommittee of the Committee of Agricultural and Rural Development of the Council of Food, Agriculture and Rural Area Policies (in Japanese Ministry of Agriculture, Forestry and Fisheries) have met three times to study these issues. Together with analyzing the current state of global water resources, subcommittee members have conducted investigations concerning topics such as the position of water for agricultural use as one component of global water resources, the regional characteristics of water for agricultural use and the direction of water use for agriculture in the future.

This report summarizes the results of these investigations, and is organized as follows.

The first part is a general summary of water use and water use issues. The report then looks at the characteristics of water for agricultural use. The report highlights the fact that water for agricultural use exhibits many regional characteristics that depend upon natural conditions, and divides the major water use issues according to dry and wet climatic regions, respectively, based on what is considered to be the most obvious difference among regions. The report also touches on the current status of water for agricultural use in Japan, which is located in a humid region. Finally, based on the conditions and characteristics observed, the report suggests several approaches that we consider to be necessary regarding future policy for water for agricultural use in Japan and around the world that seek to resolve the various water resource-related issues.

1. Current status of global water resources

(1) Potential water resources

① Quantity of global water resources

Our earth is sometimes called the water planet, for abundant water covers the earth's surface. The majority is seawater, however, and only about 2.5% of the earth's total water is fresh water. Moreover, most of this fresh water exists as ice in regions such as Antarctica and the Arctic. The quantity of fresh water available in rivers, lakes and marshes and which is comparatively easy to use is no more than 0.008% (104,620 km^3) of all the water on the earth's surface.

Along with being an indispensable resource that sustains all living things including the human race, water is also an indispensable material for productive activities such as agriculture and manufacturing. We therefore must share this limited water resource through the water circulation process (hydrologic cycle) not only among all people, but also with all other living things, and use water in a sustainable manner.

② Quantity of water resources used

The history of mankind is the history of water resource use. Together with the increase in human population, improvement in living standards and an expansion of various human activities, such as the development of agriculture, the quantity of water resources used has increased. Indeed, the increase in the quantity of water resources used was necessary for the spread of human activities. For example, for the four great ancient civilizations nurtured by the catchment basins of the Tigris and Euphrates rivers, the Nile River, the Indus River, and the Yellow River valley, the development of farming using the water of these rivers enabled people to accumulate wealth through stabilization of their food supplies, and gave birth to city-states and great dynasties.

Although it required several thousand years from ancient times for the world to reach an annual water use quantity of 1,000 km^3, it took less than 30 years to double water usage to 2,000 km^3, and less than 20 years to increase this to 3,000 km^3. In recent years in particular, the annual quantity of global water use has been increasing rapidly. Water use has been estimated to have grown by a factor of 2.6 during the 45 years from 1950 to 1995. By category of use, during this same period the quantity of water use per person for agricultural needs was nearly unchanged, but the quantities of water used for industrial purposes and daily domestic needs showed remarkable increases of 1.8 times and 3.0 times, respectively.

Today, roughly 70% of all fresh water used around the world is used for agriculture, and approximately 70% of all agricultural water used is in Asia. This means that when contemplating the use of the world's water resources, it is essential that we thoroughly understand water resources in Asia, including Japan, and the characteristics of water for agricultural use in this region.

Furthermore, water use possesses its own unique characteristics in each region of the world.

For example, despite the fact that Asia has the highest quantity of water use as a region, on a per capita basis North America ranks first in all categories of water use, whether water for daily necessities, water for industrial purposes or water for agriculture.

(2) Water resource-related issues

① Future quantity of water use

a. Increases in population and grain consumption

According to the United Nations, as of 2000, the world had a population of approximately 6.6 billion, and by 2050, it is estimated to exceed 9.3 billion.

Moreover, in 1961, the world's annual grain consumption was about 800 million tons, and within 30 years, consumption had increased 2.3 times to approximately 1,800 million tons in 1999. This rate of increase exceeded the global population growth rate during the same period. Such a change can be viewed as the result of factors, such as more diverse and higher quality dietary habits that accompanied increases in living standards, in addition to population growth. Furthermore, the global trend of rising per capita calorie consumption is expected to continue in the future, particularly because of changes such as increased consumption of meat and dairy products in developing countries. Coupled with the rise in population, the world's annual grain consumption is forecasted to climb to approximately 2.8 billion tons in 2030.

Until about 1990, the total area of arable land, an important production factor for producing grains and other farm products, showed an increasing trend, but since then, it has leveled off. Because the increase in population is particularly remarkable compared to the increase in cultivated acreage, the arable land acreage per person continues to decline.

b. The need for irrigation

As the demand for grains and other farm products is expected to continue increasing, in contrast to the stabilized amount of cultivated acreage, improving farmland productivity will become even more important for increasing the production of grains and other products. The total worldwide area of irrigated arable land has expanded by more than three million hectares annually over the past 40 years, and it is conjectured that the improvement of land productivity through methods such as irrigation has helped increase food production. Particularly in Asia, where arable land area per person is low, the irrigation ratio (the ratio of irrigated arable land area to all cultivated acreage) has increased greatly in recent years, which is also thought to be the result of more efforts to improve land productivity through irrigation, than in other regions.

We should not overlook the fact that in agriculture there exist critical factors other than irrigation for improving land productivity, such as crop improvements and the use of fertilizers and pesticides. Among factors that contributed to increases in Asian rice production in 1965-1980, one study suggested that irrigation made the greatest contribution. We believe that irrigation is a very important farm management activity supporting current dietary habits, and that it will be difficult to supply food for the planet's expanding population in the future if further improvements to land productivity through irrigation are not pursued.

c. Future outlook for water use volume

Because the world's population and the demand for food are expected to continue growing into the future, the quantity of water for agricultural use is also expected to increase. It has been estimated that in 2025, annual water use will be 26% higher than that in 1995. Additionally, the quantities of water for industrial purposes and daily domestic necessities are projected to jump by 55% and 82%, respectively, as economies grow and living standards improve.

When these factors are combined, the annual quantity of water use in 2025 will increase by approximately 1,300 km^3 from that in 1995. The world will have to provide for this massive increase, roughly equal to 15 times Japan's annual quantity of water use, by developing new water resources.

Given that development of many locations well-suited for dams or related infrastructure has already been completed, however, the development of new water resources is expected to become more difficult, not only because of lower economic efficiency but also because of the impact of developmental processes on the environment, ecosystems, etc.

Furthermore, in arid regions where water resources are inadequate, examples of water-related disputes and political tensions abound. Because the demand for water resources is expected to increase steadily, international cooperative efforts to achieve peaceful solutions to such disputes and prevent conflicts will become even more necessary in the future.

② Environmental impact

In every corner of the world, improper water resource use has resulted in diverse negative effects on the environment. For example, freshwater water systems nurture diverse networks of living organisms. Over 9,000 types of freshwater fish are known to exist around the world, but in recent years it has been reported that 20% of these species have become either extinct or endangered. In addition, even though underground water supplies 19% of the world's water needs, examples can also be found where the volume of water pumped is greater than the annual volume of water available to replenish underground aquifers, raising concerns that underground aquifers will run dry. Furthermore, the accumulation of salt from causes such as improper irrigation practices and drainage water management are increasing, making large areas of once-arable land unsuitable for production of farm products and in some cases is one of the leading causes of desertification.

2. Global water for agricultural use by region

(1) Regional characteristics of water for agricultural use

As described above, various issues concerning water use including water for agricultural use have been highlighted. Water for agricultural use in particular is the sector that uses most water, and so individuals involved with water for agricultural use must take aggressive actions to solve these problems. On the other hand, the characteristics of water for agricultural use differ according to region. Conducting discussions about water for agricultural use by assuming uniform characteristics throughout the world is therefore not a reasonable approach.

Because agriculture involves cultivating useful plants under natural conditions that include soil, solar radiation, temperature and rainfall, it is an industry intimately and inseparably linked to the natural environment. Therefore, the water supplied for agricultural use will entail purposes, methods or related issues that differ depending upon factors such as the natural conditions including rainfall, or the volume of water required for farm product growth. Compared with water for industrial purposes and daily necessities, water for agricultural use possesses a variety of regional characteristics. In some situations this fact will even apply within a single country, as can be clearly seen in the case of comparing the arid northwestern and humid southeastern regions of China, for example.

Accordingly, we will attempt to adjust the relationship between water for agricultural use and natural conditions.

(2) Regulation of farm products and water for agricultural use by the natural environment

① Precipitation

As a typical example of the natural conditions regulating the regional characteristics of water for agricultural use, consider the volume of precipitation.

Precipitation levels will affect the quantity of water circulating in a region, and will affect the selection of cultivated farm products and the consumption of water for agricultural use. Of course, even in regions where precipitation is plentiful, the selection of farm products and agricultural water use will be limited when the amount of evapotranspiration is large. Alternatively, when the amount of evapotranspiration is small, a region will be suitable for cultivation of farm products even if the region has comparatively little precipitation. Moreover, the selection of farm products and water for agricultural use are likely to differ depending upon differences in precipitation patterns. Nevertheless, the characteristics of agriculture and water for agricultural use will generally differ among regions with large amounts of precipitation and those with scant rainfall.

② Farm products

Because natural conditions such as precipitation differ according to region, farm products are grown in regions where natural conditions are the most suitable for each crop. For example, even considering only rice, wheat, and corn, the three largest grain crops, each cultivation region has its own characteristics.

For example, over 90% of the world’s rice production volume is produced in countries and regions centered on eastern and southeastern Asia, where annual precipitation exceeds 1,500 mm per year, reflecting the unique plant physiology of the rice plant, which requires comparatively large quantities of water for growth and suffers minimal damage even if inundated in water. The planting ratios for rice in these countries often exceed 75% of the total planted acreage for all grains, a condition very close to single cropping. Thus, the regional characteristics of rice production in humid regions are extremely strong.

To take another example, three-quarters of the world's wheat is produced by the ten top-ranking wheat-growing countries. Nearly all of these countries are located in regions having comparatively smaller annual precipitation (1,000 mm or less). This reflects the fact that while a comparatively small quantity of water is necessary for growth, the physiology of the wheat plant makes it susceptible to damage from large quantities of water.

③ Purposes of irrigation

Just as the selection of farm products will differ depending upon precipitation, the purposes of irrigation also basically differ depending on the amount of precipitation.

Generally, the purpose of irrigation is to provide the quantity of water needed in order to grow crops – that is, to supply as agricultural water the difference between evapotranspiration and precipitation.

In other words, supplementing quantitative shortages in rainfall and the supply of water for agriculture is often the major purpose of irrigation in arid regions with scant precipitation.

In humid regions boasting ample precipitation, when dry spells continue, the purpose of irrigation resembles that in arid regions. But usually, the primary purpose of irrigation is to supplement the non-uniform temporal and spatial distribution of rainfall. Furthermore, paddy field irrigation, which accounts for the lion's share of irrigation in the humid regions of eastern and southeastern Asia, achieves a broad range of farm management objectives including simplification of tilling activities, control of thickly growing weeds, application of nutrients suspended in irrigation water, and elimination of salts from the soil, by flooding level fields through irrigation. Moreover, other possibilities are also created, such as preventing typhoon damage immediately prior to harvesting through early planting assisted with water supplied when precipitation is insufficient, for example, and in this manner the amount of freedom to choose planting or harvesting periods may also be increased by irrigation.

(3) Irrigation in arid regions

① Traditional irrigation

Although precipitation in arid regions is limited, such regions generally enjoy abundant sunshine. If water resources can be secured, it is possible to anticipate stable and efficient production and the cultivation of high-quality farm products. For this reason, irrigation including extraction of underground water using simple excavated underground water channels, water channeling and water storage of rainy season floods and catchments using rainfall cisterns has been carried out for hundreds of years.

Such traditional irrigation is a highly sustainable system that follows the natural pattern of water circulation. However, because simple excavated underground water channels and earthen dikes frequently are buried by sediment and are subject to collapse, in recent years there are numerous examples where traditional methods have been replaced with modern irrigation systems, such as pumping of underground water, as described below.

② Modern irrigation systems and their related problems

a. Large-scale water conveyance systems (use of precipitation from remote locations)

To further improve production and grow high-quality crops, one example of overcoming the uneven temporal and spatial distribution of water resources to irrigate crops is the building of reservoirs to store rainwater and snowmelt waters in remote watershed locations where precipitation is comparatively plentiful, and the construction of large-scale water conveyance systems to supply the water to regions where precipitation is inadequate.

Although desert and similar arid land can be radically changed and converted into a vast granary area when these systems are constructed in arid regions that enjoy other advantages such as much sunshine, problems related to irrigation may also occur due to the characteristics of the arid region.

Israel, for example, constructed large-scale water conveyance and irrigation systems but faces severe shortages of water resources and the quantity of water demanded still exceeds the volume that can be supplied. Another example is the state of California in the United States, where a number of problems have been noted, including gradual accumulation of salinity in the crop root zone from low-salt irrigation water.

A further example is the inland area of southeastern Australia, where the annual precipitation is about 400 mm. The underground water table is rising because of the infiltration of water from paddy fields, and rootzone waterlogging and soil salinization have occurred in the surrounding fields. To combat this problem the underground water is being forcibly discharged, but the discharged water containing large quantities of salt cannot be drained into rivers, and so the government has purchased farmland and created ponds to evaporate the water as a disposal method.

b. Pumping of underground water

In arid regions lacking rainfall and surface streams, underground water has long been used as agricultural water. With the invention of the turbine pump in the 1920s, it became comparatively simple to pump groundwater, and the use of water from underground aquifers to maintain stable water use unaffected by rainfall is increasing.

In arid regions where precipitation is minimal, the flow of water replenishing underground aquifers is minimal. As the use of groundwater pumping irrigation spreads, examples can be found in arid regions around the world where the volume of pumped water exceeds the quantity of water replenishing an underground aquifer. This has also resulted in situations where the continuation of irrigation agriculture itself has become difficult, because of the rise in pumping costs caused by the drop in the underground water table.

(4) Irrigation in humid regions

① Characteristics of paddy field farming

a. Merits of paddy field rice production

By taking advantage of rice plants' physiological characteristics, which protect the plant from damage even when soaked in comparatively large volumes of water necessary for growth, rice plants are grown in paddy fields under immersed conditions in humid regions around the world, particularly in the region referred to as the Asia monsoon region, including eastern and southeastern Asia.

These regions have very high annual precipitation, and typically large areas of steep land. This means that efforts to prevent soil erosion due to rainfall are indispensable for sustained farm production. The terrace-type farmland surrounded by levees such as paddy fields is extremely useful for preventing soil erosion. Moreover, in the low-lying plains along rivers, rice plants grown under flooded paddy conditions also play a valuable role in combating the inundations and flooding that often occur in wet climates.

As described earlier, paddy field rice farming possesses numerous advantages for farm management, including simplification of tilling activities, control of thickly growing weeds, practical use of the nutrients borne by the irrigation water and elimination of salts from the soil. It enables sustainable productive capacity without causing soil exhaustion from continuous cropping, and is a form of sustainable agriculture that provides stable and high yields. This clearly shows that the history of several hundred to several thousand years of uninterrupted paddy field rice farming in many regions of Asia, is linked to the widespread formation of societies of high population density.

b. Paddy field rice farming and water circulation

Moreover, in the Asia monsoon region where precipitation is plentiful and the quantity of water circulation is substantial, paddy field rice farming and irrigation for paddy fields not only offer numerous advantages from the perspective of farm management, but they also fulfill diverse roles such as replenishing underground water and preventing flooding as parts of the water circulatory system, and are utilized as so-called local water for various needs such as drinking water, fire fighting and waterborne transportation.

Although part of the water diverted to paddy fields is lost to the atmosphere through evapotranspiration, the largest portion flows into underground aquifers and rivers through infiltration, ground seepage and outflows through drainage channels. Then, it can be diverted into paddy fields again downstream, or used as water for industrial purposes and daily necessities. For example, in Japan, the paddy fields along the middle reaches of the Shirakawa River catchment basin in Kumamoto Prefecture provide about 1,000,000 m^3 per day to replenish underground water, and this underground water wells up to the surface further downstream, to be used for daily necessities and other purposes by about 900,000 residents of Kumamoto.

In regions where there are many rivers with steep gradients, the abundant water resources provided by rainy season precipitation or other sources are frequently allowed to discharge ineffectually into the sea. Therefore, in order to use water resources effectively, methods to maximize the aboveground holding time are required.

In the Asia monsoon region, paddy fields and irrigation systems such as channels, constructed and maintained with the investment of enormous amounts of money and labor, fulfill the important role of extending the aboveground holding time. Water taken from rivers for agricultural use and temporary torrential rains is circulated into underground water or rivers after being stored in paddy fields. Together with allowing repeated use of the water again downstream and increasing the efficiency of water resource use for the catchment area as a whole, this arrangement supports sound water circulation within the catchment area.

Furthermore, paddy fields can be called a kind of “wet land”. Because paddy fields and irrigation channels form a water network that includes rivers, they provide a space where a richly diversity of plant and animal life can live and grow. In Japan, for example, in the Survey of Paddy Field Living Organisms conducted in fiscal 2001 through the cooperation of the Ministry of Agriculture, Forestry and Fisheries and the Ministry of the Environment, 72 varieties of freshwater fish were confirmed to be living in local paddy fields, channels and other such structures, including threatened species such as medaka (killifish).

c. Community-based management

Paddy field irrigation in the Asia monsoon region provides examples where irrigation facilities are being excellently managed by farmers’ communities, such as those in <u>Subak</u> on the island of Bali in Indonesia, <u>Muanfai</u> in northern Thailand or the land improvement districts in Japan. In addition to matters concerning the coordination of agricultural water supply periods or the management of irrigation facilities, such communities are often also associated with local religious affairs and have a large influence on the construction of local society.

② Current conditions and problems of paddy field rice farming

Expectations for productivity improvements in paddy field rice farming through the introduction of irrigation runs strong in Asia, where the population density is high and the rate of population increase is also large. Because of this, Asian countries have pursued the construction of large-scale irrigation facilities based on government initiatives and continual international cooperation, mainly since World War II, focusing on areas such as rain-fed paddy fields or the deltas along the lower reaches of large rivers. The result has been that countries have achieved large increases in irrigated land area and rapid increases in the production of foodstuffs such as rice.

Such large-scale irrigation, however, has also resulted in cases where farmers are indifferent towards irrigation facilities management and have come to rely excessively on government assistance. This has occurred because such irrigation frequently targets land such as muddy or swampy ground where expansion of arable land at the individual farmers' level is difficult, for example, or where there is no community groundwork among farmers, or because the scale is too large and exceeds the farmers' management capabilities. Although such situations are not limited to humid regions and are also found in arid regions, from the standpoint of irrigation facility management or restoration, problems exist from both a fiscal and human management standpoint. That is, in situations where public participation in irrigation facilities management declines because of a deterioration in the government's fiscal health or other reasons, the management level will drop and a situation may develop where irrigation facilities no longer function sufficiently.

3. Water resources and water for agricultural use in Japan

(1) Water resource use

Japan lies in the Asia monsoon region, a part of the world with frequent heavy rains. Average annual precipitation (about 1,700 mm) is about twice the global average. It has been estimated, moreover, that the average annual amount of evapotranspiration is about 600 mm. As a result, the quantity of potential water resources per unit area is comparatively large.

However, because of unique conditions such as Japan's steep topography and the short length of its rivers, and because rainfall is concentrated in the typhoon season, rainfall tends to be discharged quickly and ineffectively into the sea. These conditions make effective use of Japan's water resources an important issue.

(2) Agricultural water use

① Formation of sound water circulation systems

Therefore, in order for Japan to effectively use precipitation for paddy field rice farming, efforts have been undertaken to extend the length of time during which precipitation can be stored through 1) channeling water from rivers into irrigation channels, 2) measures to store water (reservoirs) and 3) measures to support water retention by the soil (afforestation of mountainous areas).

In conjunction with the development of farmland such as paddy fields, uninterrupted efforts have been carried out to create facilities for using agricultural water, such as intake weirs, irrigation and drainage channels and reservoirs.

As a result, currently the total length of major irrigation and drainage channels in Japan is more than 40,000 km. Furthermore, when small- and medium-size irrigation channels and drains are included, the total length is roughly 400,000 km, equivalent to ten times the earth's circumference.

These irrigation and drainage channels for agricultural use crisscross the land like human arteries and veins. Along with supporting Japan's farm production, they help the water held in paddy fields to be repeatedly used in other paddy fields further downstream, thereby improving water resource use efficiency as a complete catchment basin and contributing to the formation of a sound water circulation system.

② Status of irrigation facilities management

Some of Japan's irrigation facilities such as the irrigation and drainage channels for agricultural use are facilities of a highly public nature that are operated by the central or local governments, but management for the majority of Japan's irrigation facilities is provided by land improvement districts composed of the users of agricultural water (farmers). For example, approximately 80% of the 40,000 km of irrigation and drainage channels mentioned above is managed by land improvement districts. Individual farmers pay the land improvement district a prescribed levy to operate the irrigation facilities, and in some cases also provide occasional labor. This kind of farmer participation-type irrigation management (PIM) has made possible a smooth supply of water for agricultural purposes.

In addition, there are also examples in which the water conservation percentages accepted by farmers during water shortages are higher than the percentages for water usage for daily domestic necessities or industrial purposes, based on a "spirit of compromise." Farmers also strive to conserve water by providing extensive labor and shouldering the economic burden by means such as receiving water in turns, inspecting water channels and using the same water repeatedly.

(3) Issues related to water for agricultural use

① Harmony with the environment

Situated in a humid region, the paddy fields and irrigation facilities in Japan provide habitats and nesting grounds for various creatures and support the rich ecosystems in rural agricultural areas as a waterside environment. In addition, they also play a large role from the standpoint of water quality, scenery, and helping to create positive attitudes towards water resources.

However, as illustrated by examples such as the medaka, a typical well-known fish designated as an endangered species, in recent years the importance of harmony with the environment has become even more critical.

② Appropriate management of irrigation facilities

Although 70% of the costs required to manage irrigation facilities is borne by the land improvement districts, which are the main management entities for such facilities, these costs tended to increase for reasons that range from the need to treat wastes to safe facilities siting as rural areas undergo urbanization and greater mixed residential use.

Moreover, the environment surrounding agriculture continues to evolve, including changes in land use patterns, and as even more advanced and detailed agricultural water management has become necessary, land improvement districts are being asked to appropriately manage irrigation facilities even as they respond to these changes in circumstances.

③ Obsolescence of irrigation facilities

In 2002, irrigation facilities such as dams and water channels for agricultural use that have been built to provide water for agricultural use in sites such as paddy fields were worth approximately 25 trillion yen on a replacement cost basis. These facilities contribute not only to agricultural production, but also to other important aspects of society such as catchment basin water circulation and the preservation of local ecosystems.

The number of irrigation facilities approaching the age at which they will have to be refurbished will increase in the future. In order to pass these facilities down to the next generation, efficient maintenance and renewal has become an important issue.

④ External economic effects accompanying appropriate management of irrigation facilities

As international trade of agricultural products has grown, discussions on the water used to grow agricultural products have increased.

On the other hand, in Japan, to effectively utilize precipitation despite the conditions of steep topographic features and short river lengths, a network of irrigation and drainage channels reaching some 400,000 km in length has been built. This network supports sound water circulation as the “arteries and veins” of the national land, and creates many external economic effects that are not evaluated by the market.

It is also predicted that in the future, water will increasingly be directly and indirectly traded as a good for production and services in the market. We believe that in order to maintain and improve sound water circulation in Japan, it is necessary to promote research on water as a public good. The external economic effects of properly using water for agriculture, and the large amounts of labor and capital invested to construct and maintain the network of water channels, must also be properly evaluated.

4. Directions for optimum water use in the future

(1) Promoting awareness of water for agricultural use

① Recognition of the need

Given that the world's population is projected to continue growing in the future and that demand for food will gradually increase, the question of how to increase farm production has become an issue. On the other hand, the world's cultivated acreage has recently leveled off, and so improvement in land productivity through irrigation has become a more effective and important means for global agricultural production. It is therefore necessary to recognize again that securing water for agricultural use to meet the increase in food demand will become more important in the future.

② Recognition of regional characteristics

Agriculture is carried out by taking advantage of local resources such as soil and water, and is an industry intimately linked to and inseparable from the natural environment. This means that water for agricultural use also displays various aspects determined by the local region from every aspect, including the amount of water necessary for the crops grown, irrigation methods, the kinds or scale of irrigation facilities such as drainage and irrigation channels or reservoirs, and methods of water supply management.

Moreover, in each region of the world, the water circulation that supports water resources varies from arid regions to humid regions, as represented by rainfall for example, and the water for agricultural use that comprises part of water circulation is greatly affected by the water circulation of each region, so the conditions for using agricultural water will vary.

Thus we should recognize that the water for agricultural use has significant regional characteristics in terms of supply and demand.

(2) Optimum use of water for agriculture around the world

① The need for discussions based on regional characteristics of water for agricultural use

Together with the increase in the world's population and social and economic development, the world's demand for water continues to increase. Fresh water available in easily used forms on the earth's surface such as lake and river water, however, is extremely limited, which demands that we use these limited water resources in a sustainable manner as we continue to maintain sound water circulation. Yet despite the fact that agricultural water forms one part of the water circulation cycle, and is an indispensable factor for producing food, arguments are also being made that because 70% of the world's total volume of fresh water use is consumed by agriculture, this sector should reduce its water requirement so that more water can be diverted to other uses.

Water for agricultural use around the world is quite diverse, however. For example, considering the sustainable use of underground aquifers, there are examples in arid regions where pumping of agricultural water for irrigation has depleted groundwater resources. In contrast, agricultural water used to irrigate paddy fields in humid regions frequently serves to replenish underground aquifers. As this illustrates, the characteristics of irrigation on which any discussion is based will differ depending on the region.

Accordingly, when discussing the world's water for agricultural use, such discussion should be adequately based on regional characteristics.

② Desirable water use for agriculture in arid regions

In arid regions where the water circulation quantities are comparatively small, soil salinization or the exhaustion of underground aquifers is a serious threat to irrigation agriculture, and it is necessary to seek sustainable utilization of water for agricultural use while taking steps to avoid or minimize conditions that can destroy the sustainability of irrigation efforts.

A preferable approach, for example, will be to promote the development and introduction of new irrigation techniques, such as promotion of water conservation combined with prevention of soil salinization through techniques such as micro irrigation (drip irrigation), or the recycling of treated sewerage to agricultural use in regions suffering from a shortage of water resources.

③ Desirable water use for agriculture in humid regions

Agricultural production provides multifunctional roles such as land conservation, recharge of water resources and conservation of the natural environment. These functions are demonstrated after water is properly used as an important element for agricultural production.

In humid regions where the water circulation quantities are comparatively plentiful, these functions related to water circulation, such as groundwater recharge, are demonstrated mainly by irrigated paddy field. In the future as well, to maintain and form sound water circulation, it is necessary to appropriately demonstrate such functions.

④ Independent efforts by all individuals concerned with water-related issues

In traditional irrigation, organizations centered on farmers independently handled matters such as the efficient, impartial distribution of water resources, and came to play a key role in the maintenance and formation of sustainable water use and sound water circulation.

But, with the large-scale irrigation facilities developed after World War II, examples also can be cited in which adequate functions are not evident; frequently in such cases, irrigation facilities are managed under government direction, and management efforts have become erratic as demands on government finances have grown. In these kinds of cases, efforts to resolve such issues through a transition to participatory irrigation management (PIM) involving local farmers have become a global trend.

Moreover, in local communities, individuals capable of recognizing water-related issues – such as the volume of water required for food production and drinking water or the influence and effect that water use exerts on the natural environment – as their most immediate problem are precisely those individuals who use water to produce goods in that local community, and whose lives and livelihoods depend on water.

Therefore, in order to maintain and form sustainable water use and sound water circulation, all people who are concerned about and affected by water use, including farmers, should recognize the role that each individual can play and work independently to fulfill his or her own role.

⑤ Mutual cooperation by farmers who play a central role

Because water for agricultural use accounts for such a large portion of total water use, it is a critical element in the maintenance and formation of sustainable water use and sound water circulation. For this reason, among the independent efforts by all individuals who are concerned about water use, the farmers who manage and use agricultural water are expected to play a central and active role.

We hope that in the future, the world's farmers and agricultural groups that utilize water will take advantage of opportunities such as the world water forums to develop mutual cooperation, by pursuing their common experiences with irrigation management, and contribute to solutions to global water issues.

(3) Optimum use of water for agriculture in Japan

① The road to solving problems begins from concern about water for agricultural use

On a calorie basis, Japan's food self-sufficiency rate is about 40%, and Japan is dependent on imports for many food items. If we restate Japan's current condition to focus on the agricultural water used when such imported agricultural products are grown, one could say that through its imported agricultural products Japan is using the agricultural water in regions outside Japan to enjoy an abundant diversity of food. While it is believed the producing areas for imported agricultural products are diversified among various regions, it is also possible that agricultural products produced in arid regions, where water resources are not abundant, are included among these imports.

To help solve the water-related issues facing the world, each citizen must first develop a concern regarding issues such as the need for water for agricultural use and its regional characteristics, and the relationship between the world's water for agricultural use and lifestyles. Next, to develop this understanding, we should recognize that achieving sustainable utilization of water for agricultural use is important both for the earth and for Japan. For this purpose, efforts to disseminate information on topics such as population, food products, and water and agricultural land conditions , and activities such as education or study for every age group from children to senior citizens, in various locales including local communities and the home, will also be effective.

② Securing appropriate water for agricultural use, sustainable use, and sound water circulation

Originally, individuals in rural villages of Japan engaged chiefly in agriculture and lived in close touch with nature, going about their lives as they maintained the national land. Agriculture was the central activity of a society based on recycling, where man and nature lived together, and people used various resources such as rice plant straw and “night soil” by re-circulating them. Water for agricultural use also played a key role, and was deeply interwoven with traditional Japanese culture and way of thought.

As time passed, numerous production resources were invested into the resource circulation of rural communities from the outside, as farmers sought greater economic efficiency in agricultural production. Even today, however, as part of regional water circulation, water for agricultural use is combined with the natural water circulation and helps not only agricultural production but also demonstrates the multifunctional role of agriculture.

In order to provide stable food supplies in the future and appropriately demonstrate the multifunctional role of agriculture in Japan, it is important to appropriately ensure water for agricultural use. In addition, to construct a society where people and nature coexist and agricultural production and the natural environment are in harmony, the preferred approach will be to utilize water for agricultural use in a sustainable manner, based on the recycling-type society experience that has been practiced in rural communities, and to form and maintain sound water circulation in which the utilization of water for agricultural use and local naturally available water circulation patterns are integrated.

③ Expectations towards land improvement districts

Japan’s irrigation system has acted as “arteries and veins” that have enriched the country through long years of use. Moreover, viewed from a global perspective, the majority of Japan’s irrigation facilities have been maintained and operated extremely well by the land improvement districts made up of local farmers; indeed, roughly 80% of the 40,000 km of major irrigation and drainage channels is managed by land improvement districts.

Since the high economic growth period, however, as the gap in profitability between agriculture and other industries has widened, and the aging of farm households and the shortage of individuals to take over existing agricultural holdings is becoming more severe as the farm population shrinks and more farmers work at second jobs in other industries. There are misgivings concerning issues such as the management required to address irrigation facility obsolescence, even though land improvement districts are working to fulfill this role.

In order to achieve sound water circulation that combines local natural water circulation with appropriate and sustainable water circulation for agricultural use, both agricultural production by farmers and their associations, and suitable management of agricultural water mainly by the land improvement districts, must be continued.

As part of this effort, it is important that the land improvement districts overcome the issues they face today, and continue to fulfill their role in the management of water for agricultural use and irrigation facilities.

④ Toward the formation of sound water circulation; efforts by land improvement districts and all local individuals

Water for agricultural use, which accounts for a large share of total water use, is combined with natural water circulation in a region, and is an important element for the maintenance and formation of sound regional water circulation. Nevertheless, it is also important that water use be sustainable in all forms of use.

Therefore, for water circulation from the time when rain falls on the land until it flows to the sea, the best approach is for every individual who uses that water to recognize the role fulfilled by land improvement districts or the issues addressed by land improvement districts, such as increase of waste processing and installing safety facilities as part of the ongoing urbanization and mixed residential use of rural communities, and to cooperate in overcoming all issues.

Moreover, land improvement districts must also not merely continue to fulfill their present role, such as management of irrigation facilities, but should aggressively strive to gain the understanding and cooperation of all of the people in their area with regard to the district’s role and issues.

⑤ Land improvement district efforts as a model approach

We believe that this type of land improvement district effort will provide a case model for the maintenance and formation of sound water circulation in every part of the world. We also believe that efforts by farmers’ organizations in Japan, such as the land improvement districts, to continue providing information on examples of their various undertakings and support mutual cooperation with farmers around the world, will be an effective contribution by Japan to help solve water-related issues which have became global in scope.

Conclusions

Water is a resource that places limits on our existence as it circulates around the earth. Together with nurturing diverse living things, including human beings, water is indispensable for the farm production that supplies our food. Therefore, the quantity of water for agricultural use, which is indispensable for agricultural production, is also expected to continue increasing in the future as the world's population continues to grow.

To achieve sustainable development in the future and to eradicate poverty, human beings must maintain sound water circulation patterns in each region of the world, but must secure the water necessary for food security and rural development, and use water in a sustainable manner based on the characteristics in each part of the globe.

We believe that sound water circulation means that the entire water circulation process in a region, combining the original natural water circulation with the artificial water circulation needed for agricultural production and daily human needs according to the characteristics of each region, can be sustained in a superior mode both qualitatively and quantitatively. Naturally, this demands that sound water circulation also be harmonious with local ecosystems and other aspects of the natural environment.

Despite the fact that water for agricultural use displays local characteristics, such use accounts for a large portion of global water demand and makes a vital contribution to the maintenance and formation of sound water circulation. A good example is paddy field irrigation in humid regions, which demonstrates the multifunctional role of agriculture such as groundwater recharge, when water for agricultural uses is utilized appropriately.

Because the multifunctional role of agriculture is displayed through agricultural production, the manifestation of these functions depends upon agricultural production carried out by farmers and their organizations or the management of water for agricultural use. In other words, farmers' independent activities contribute to the maintenance and formation of sound water circulation.

We hope that in every region, each individual concerned about regional water issues will strive to appropriately understand and evaluate the effects of these types of independent farmer activities, pursue cooperative relationships, and work towards the maintenance and formation of sound water circulation by fulfilling their respective roles.

In every part of the world, we look forward to the creation of sound water circulation societies by promoting proper development of the social infrastructure such as irrigation facilities, the technology for managing these facilities or water for agricultural use, social systems such as regional agreements and common practices that make such facilities perform adequately. This requires the independent participation of every individual who is involved with water, including farmers.