WATER REUSE AND RECYCLING FOR IRRIGATION OF DIVERSIFIED CROPPING SYSTEM

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FOREWORD

Water is likely to become a major limiting factor in Asia's agriculture, particularly since the region's main food crop, rice, uses a great deal of water. Hence, FFTC in cooperation with the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) held the International Workshop on Enhancing Water Use Efficiency through Improved Irrigation Management Technologies in the Philippines in December 2003. The workshop aimed to promote the sharing of technological advances, innovative participatory approaches, and appropriate policies and support services to ensure water sustainability in agriculture.

This Bulletin illustrates how a river irrigation project in Japan was able to transform the irrigation and drainage systems in the area from the traditional method to an efficient water reuse and recycling system. The transformation from watery paddy field to multipurpose farmland enabled farmers to adopt diversified cropping system. This Bulletin hopes to provide lessons on water reuse and recycling for irrigation toward the conservation of water resources and the improvement of agricultural activities in the region.
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ABSTRACT

This Bulletin illustrates how a river irrigation project in the Chikugo River, Kyushu Island of Japan was able to reform the irrigation and drainage systems in the area. The fundamental transformation of these systems is quite large-scale in terms of both hard facilities and institutional reorganization. It has been 7 years since the project completed its construction stage and entered operation and maintenance stage. From the traditional irrigation method, the project made possible the water level of the canal-reservoir network to become 1 m lower than what it used to be. The transformation from watery paddy field to multipurpose farmland has also enabled farmers to adopt diversified cropping system. Though the project still has several issues to resolve in terms of water management, it is expected to contribute significantly to the improvement of agricultural activities in the area.

INTRODUCTION

A total of 2.7 million ha paddy field in Japan can produce more than 14 million tons of rice. However, the total consumption of rice in the country has been decreasing (65 kg/person/year in 2002) (Figures 1 and 2). To avoid over production, more than 30 percent of total paddy field is under restriction. On the other hand, to take measures against the importation of agricultural products, it is necessary to strengthen agricultural activities in the rural areas. The Ministry of Agriculture, Forestry and Fisheries (MAFF) is encouraging farmers to transform their rice-oriented farming to diversified crop farming. To support this program, paddy field needs to be converted from saturated paddy to multipurpose farmland with controlled irrigation system.

THE CHIKUGO RIVER

Chikugo River is the biggest river in Kyusyu Island, Japan (Figure 3). In the downstream portion of the river, which is generally a lowland area, there are many canal-reservoir network systems for water preservation and recycling. Chikugo River has a relatively small basin and it cannot provide enough water for the water demand of the river basin and of the Fukuoka metropolis. Especially in the downstream portion of the river, irrigation farmers had to control the water level as high as their canal-reservoir and creek canals. Since the downstream area of Chikugo River is lowland or delta, it is very risky for the farmers to keep the water level high. In addition, the yield of rice in this area is not so high because of the high moisture content of the soil. This report shows the traditional irrigation method and a land improvement project to reform the irrigation and drainage system in this area, to enable the water level of the canal-reservoir network one meter lower than what it used to be. The transformation from watery paddy field to multipurpose farmland has also enabled farmers to adopt diversified cropping system.

Keywords: water reuse, recycling, diversified cropping system, multipurpose farming, Ao-intake method, integrated institutional mechanism

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RICE FARMING IN THE CHIKUGO RIVER

Irrigation farming in the lower portion of Chikugo River, northern Kyusyu, Japan suffered severe conditions in terms of water management. Though Chikugo River is the biggest in Kyusyu, it has a relatively small basin. The water demand mainly for irrigation purpose is larger than the potential water supply (Figure 4). Especially in the down portion of the river, the most critical issue is how to take in and keep the water within the area. That situation brought about a unique water reserve and recycle system. Since Chikugo River runs at the lowest location in the area, it was impossible to develop an ordinary irrigation system with a barrage and free-flow open canal. During land preparation period in spring, massive water usage for irrigation starts from the upper stream of the river to the down area. In the upper portion, the land preparation starts in April, then moves to the middle stream area in May. Then, in the lower portion, it starts in June.
Fig. 3. Lower Chikugo River area.

Fig. 4. Flow of water supply from the Chikugo River basin.
CREEK CANALS AND AO-INTAKE METHOD

June is the beginning of rainy season, and rain provides supplemental water for rice planting. Rice planting is highly dependent on the amount of rain. Since severe water shortage hits rice farming frequently, farmers had been extending canal-reservoir networks, so called "creek" canals in the area to keep the water from small stream and use it again and again (Figure 5). Furthermore, they had been practicing unique water intake method from the Chikugo River, the so called "Ao-intake". Ao means river-flow water. Ao-intake method is a way of pouring the river water pushed up to the upper stream or inland area by the rise movement of tide into the creek canals (Figure 6). Ao which is lighter than sea water because of its salt content stays at the upper layer and at the sea water conjunction portion. Chikugo River flows into Ariake Sea where the difference between the highest and lowest level of the sea level reaches up to 5-6 m as full tide. When the tide comes in, the upper layer portion, which is the Ao, pours into the creek canals through intake gate. The gate operator opens and closes the gates depending on the water level and salt content based on his own judgment (Figure 7). If the operator missed the timing to open or close the gate, the salty water taken into the creek canals can harm the rice growth.

The water in the creek will be scooped again to the paddy field by bucket and water wheel with human power (Figures 8 and 9). Almost all paddy fields are facing to the creek and most of irrigated water return to it. The water in the creek is to be used again and again. To minimize water shortage as well as the labor work to take the water into the paddy field, farmers keep the water level of the creek as high as possible (Figure 10). The Ao-intake method was based on farmers' indigenous idea. However, it is unstable. Since the creek network work as a drainage system too, keeping the water at high level induces flood and submerge easily by a light rain. The agricultural productivity, mainly rice, is then affected adversely.

Fig. 5. Unique creek network (before).
Fig. 6. Ao-Intake mechanism.

Fig. 7. Gate operator at Ao water intake gate.
LOWER CHIKUGO RIVER IRRIGATION PROJECT

Fukuoka metropolis, the most populated area in Kyusyu, seeks additional water resources from the Chikugo River Basin in order to secure domestic water supply. The agriculture sector in the lower portion of Chikugo basin agreed on water sharing with the Fukuoka metropolis only if the government would settle the problems in the area such as water shortage and inferior drainage system. It seemed impossible to divert a part of the river flow for another basin's domestic use without necessary measures to stabilize the irrigation and agricultural foundation.

Those issues led the government to start a big project for the fundamental transformation
of irrigation and drainage system in this area. Huge pipeline systems and pump systems were constructed at both right and left side of Chikugo River, as well as open canals and central controlled operation system to distribute irrigation water in place of Ao (Figures 11 and 12). Irrigation water, maximum 25 m³/sec, was pumped up from Chikugo River at the upper stream of the newly constructed Chikugo Barrage (Figure 13) located at 23-km point from the estuary. The integration and consolidation of creek canals built up a new creek network system. Improvement of the drainage system was also implemented simultaneously. In May 1996, the gigantic irrigation device started its first test operation successfully (Figures 14 and 15), and the farmers were finally free from fear of drought.

Fig. 11. Main pipeline system.

Fig. 12. Saga pump system.

Fig. 13. Chikugo barrage.
Fig. 14. Outline of lower Chikugo Irrigation Project (main system).
Fig. 15. The water system before and after the project.
INSTITUTIONAL REORGANIZATION AND NEW WATER MANAGEMENT

Together with facility improvement, institutional organizations for appropriate water management were established. Small-scale water management practices by the farmers' group were changed to be a part of overall institutional water management organization. The main pipeline and pump systems are managed by the WARDEC (Japan Water Resources Development Public Corporation, now the Japan Water Agency). Newly organized land improvement districts (LIDs) and the local government units (LGUs) manage operation and maintenance of creeks, lateral canals, and drainage systems.

The consolidated and well-shaped creek canals of 15-30 m width and 2-3 m depth have four purposes: irrigation, drainage, reservoir, and adjustment. The water level of the creek canals is controlled basically at 1 m below the level of the paddy field (Figure 16). Some areas close to Chikugo River used to be able to access the river water through the Ao-intake method before the implementation of the project. Now the fresh river water pumped up at the upper portion of Chikugo Barrage is distributed from the upper area to the down area through the control gates by overflow control, not underflow control. Small area pipeline systems that enabled the distribution of irrigation water to the paddy fields individually were installed. The irrigated water returns to the creek canals except the portion of seepage and evaporation, and the main system supplies supplemental water through the controlled turnout just to keep the water level at 1 m below the paddy field. Therefore, the water once taken into the creek canals is recycled several times.

During drainage operation when the canal water level is rising up, there are two ways on how to operate the control gates, depending on the water level of the river (Figure 17). When the tide goes out and the water level of the river is low enough, the control gates are operated to open starting from lower portion to upper portion to release the floodwater smoothly (Figure 18). When the tide comes in and the level of the river is high, sub-gate of the control gate is pulled up and the water is temporarily stored in the volume of 1-m depth to avoid water saturation in the down stream. This operation practice needs close coordination within the network. Integrated institutional mechanism was set up.

Fig. 16. Water management (irrigation).
Fig. 17. Water management (drainage).

Fig. 18. Control gate.
MOVEMENT TOWARD DIVERSIFIED CROPPING SYSTEM

Currently, the water level of the creek that used to be as high as the level of paddy field has been lowered at 1 m below the paddy field level. The paddy field has changed from watery paddy field to multiuse farmland by the implementation of the land improvement project. Simultaneously, the farming style has changed. Rice-based farming is transformed into multi-cropping farming. Since 1997, the total area of rice-planted paddy field has been decreasing, while that of diversified farm products such as wheat and soybean has been expanding constantly (Figure 19). This diversification brought by multipurpose farmland will be maintained.

CONCLUSION

The fundamental transformation of irrigation and drainage systems in this area is quite large-scale in terms of both hard facilities and institutional reorganization. It has been 7 years since the project completed its construction stage and entered operation and maintenance stage. Though the project still has several issues to resolve in terms of water management, it is expected to contribute significantly to the improvement of agricultural activities in the area.

Fig. 19. Trend in area planted to rice, wheat and soybean at the Chikugo River area.
**NOTE**

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