VALUE EVALUATION OF THE IRRIGATION INFORMATION SERVICE SYSTEM FOR RICE CULTIVATING FARMERS IN JAPAN

Toshiaki Iida¹, Masaomi Kimura² and Naritaka Kubo³

ABSTRACT

In Japan, rice production currently faces problems shortage of successors and high labor costs. The Japanese central government is taking measures to promote the increase of the management scale of the selected pillar farmers by entrusting farm land to them. Under the future provision of further expansion of the cultivation area per farmer, labor productivity should be enhanced by streamlining water management activities in rice cultivation. In this study, the study areas were selected in Aichi-yosui land improvement districts (LID) command areas in central Japan and Imbanuma LID command areas in eastern Japan. Firstly, practical service needs in regard to water management by the farmers were investigated by precise field observation of water management and interviews. Secondly, based on the needs, a novel “irrigation information service system (IISS)” utilizing ICT was proposed. IISS would enable farmers to check the floodwater depth and the picture of their plots through various information terminals such as smartphones and tablet terminals. Thirdly, IISS was installed in 5 trial plots to demonstrate its functions and performances to the potential users. It was revealed that the farmers felt frequent visits to their fields and the operation of inlet valves as the main burden. Some of the farmers were passive towards IISS, because of their unfamiliarity with ICT devices, great confidence in their conventional methods, and reluctance to additional investment. On the other hand, 79% were positive in their attitude towards IISS. It was also revealed that the potential users were going to pay 1,107 Japanese Yen per 1,000 m² field areas per year on an average. As the current water fees at the study areas are 5,430 Yen and 7,950 Yen per 1,000m² field areas per year respectively, it was understood that IISS has possibility to prevail if its cost would be within 20% of the current water fee. The analysis of the cost structure of IISS showed that the cost down of the water depth sensor has the highest priority and that the participation ratio is also an important factor to reduce the total cost. It was suggested by the interviews that agricultural corporations or farmers cultivating large areas might have needs for IISS to reduce labor for water management.

Keywords: Paddy field, Irrigation information service, ICT, Labor productivity, Plot water management.

1. INTRODUCTION

Though rice has been the principle agricultural product in Japan, her rice production currently confronts serious problems such as a shortage of successors and high labor costs. Because of the shortage of successors, considerable areas of farmland have been abandoned as the farmers get old and eventually retire. During the past 20 years, nearly 4,000 km² farmland has been abandoned (Japanese Ministry of Agriculture, Forestry and Fisheries, 2016). It is likely that the land abandonment would ruin the rural area and induce some adverse effects such as soil erosion,

¹ Associate Professor, Graduate School of Agricultural and Life Sciences, The University of Tokyo. 1-1-1 Yayoi, Bunkyo, Tokyo 113-8657 Japan; E-mail: atiida@mail.ecc.u-tokyo.ac.jp
² Assistant Professor, Graduate School of Agricultural and Life Sciences, The University of Tokyo. 1-1-1 Yayoi, Bunkyo, Tokyo 113-8657 Japan; E-mail: akimura@mail.ecc.u-tokyo.ac.jp
³ Professor, Graduate School of Agricultural and Life Sciences, The University of Tokyo. 1-1-1 Yayoi, Bunkyo, Tokyo 113-8657 Japan; E-mail: anakubo@mail.ecc.u-tokyo.ac.jp
increased flood damages, or spreading of insect pests. Recent high labor cost is another problem which would strain the farmhouse finances as well as weaken international competitiveness of Japanese rice.

To tackle with the above problems, the Japanese central government is taking measures to promote the increase of the management scale of the selected pillar farmers. Especially, entrusting of farm land to the pillar farmers. This policy must realize management of larger paddy fields by less workers, causing the considerable increase in the labor per a farmer. Under the future provision of further expansion of cultivation areas per a farmer, labor productivity should be enhanced especially by streamlining of water management activities in rice cultivation.

On the other hand, owing to recent rapid development of ICT, it has become possible to instantly transmit information on the amount of available water and on the demand of farmers interactively, making use of Internet and various field sensors (Olalla et al., 2003). Taking into these circumstances, it is considered that irrigation systems should be managed as service providing systems for farmers and the service quality should be further improved from a demand-oriented point of view (Renault & Montginoul, 2003).

However, it has been unclear how to lessen the burden of the water management in rice cultivation. Actual concrete needs of individual farmers in regard to water management have not been investigated closely so far. It is necessary to clarify the critical point for reduction of water management labor and to propose effective service for farmers to ease their water management.

In this study, firstly, practical service needs in regard to water management by the rice cultivating farmers were investigated by precise field observation and interviews to the farmers. Secondly, based on the grasped needs, a novel "irrigation information service system (IISS)" utilizing ICT was proposed. IISS would enable farmers to check the floodwater depth and the picture of their plots through various information terminals such as smartphones and tablet terminals. Thirdly, IISS was installed in 5 trial plots to demonstrate its functions and performances. Finally, the value of IISS for the potential users were quantitatively evaluated using the contingent valuation method (CVA).

2. METHODS

2.1 Study area

The study areas were selected in Aichi-yosui Land Improvement District (LID) command areas in central Japan and Imbanuma LID command areas in eastern Japan (Figure 1). Two rice cultivating farmers, Farmer A and Farmer B, were selected
in Aichi-yosui LID command areas as the investigated farmers, while Farmer C and Farmer D were selected in Imbanuma LID command areas. As shown in Table 1, 4 farmers with a variety of properties were selected as the investigated farmers. One plot cultivated by each investigated farmer was selected as the study plot.

Table 1. Properties of the investigated farmers

<table>
<thead>
<tr>
<th></th>
<th>Farmer A</th>
<th>Farmer B</th>
<th>Farmer C</th>
<th>Farmer D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business style</td>
<td>Private Full-time</td>
<td>Private Part-time</td>
<td>Private Full-time</td>
<td>Company 3 employees</td>
</tr>
<tr>
<td>Generation of the main worker</td>
<td>70 s</td>
<td>60 s</td>
<td>40 s</td>
<td></td>
</tr>
<tr>
<td>Total area of paddy fields (m$^2$)</td>
<td>100×10$^3$</td>
<td>10×10$^3$</td>
<td>150×10$^3$</td>
<td>330×10$^3$</td>
</tr>
<tr>
<td>Area of other crops (m$^2$)</td>
<td>0</td>
<td>0</td>
<td>10×10$^3$</td>
<td>190×10$^3$</td>
</tr>
<tr>
<td>Area of the study plot (m$^2$)</td>
<td>1,500</td>
<td>2,300</td>
<td>2,900</td>
<td>14,400</td>
</tr>
</tbody>
</table>

2.2 Measurement methods

The operation hours of the pump station providing irrigation water were 8:00-17:00 for the study plots cultivated by Farmer A and B, and 6:00-18:00 for the study plots cultivated by Farmer C and D. The amount of irrigation water for each study plot was measured every 10 minute by a magnetic flowmeter. The water depth near the water outlet of the study plot was measured every 10 minute by a pressure water level sensor. The photograph around the water outlet was taken every 30 minute by an automatic field camera to observe the surface drainage and the plant condition. The precipitation data at the study area were measured by each LID at each LID office. The time and date to visit the study plot were recorded on the record sheet by the investigated farmer. The time and date to manipulate the hydrant and the opening of the hydrant were also recorded on the record sheet. Each investigated farmer was individually interviewed to grasp their usual patrol activities and to fill out the incomplete record sheet.

3. IRRIGATION INFORMATION SERVICE SYSTEM

3.1 Service needs by the rice cultivating farmers

Practical service needs in regard to water management were revealed by the precise field observation of the water budget at the study plots cultivated by the investigated farmers, ethnographic observation of their water management activities and interviews to them. The following facts were grasped.

(i) Basically, farmers patrols all the cultivating plots every day during the irrigation period.
(ii) The important points to check on their patrol are the floodwater depth and condition of the rice plants. The biggest concern is the sudden water loss by unexpected crumbling, leak or holes by small animals.
(iii) The investigated farmers feel the frequent patrols of the floodwater on their field plots and the operation of inlet valves as a main burden in their rice cultivation.
(iv) The motivation of saving water is low because the water fee is charged by the cultivating areas. On the other hand, the investigated farmers are much interested in saving labor. It is understood that the saving of labor often
causes unnecessary irrigation in which the water overflows from the outlet of the plot while the inlet hydrant is opened.

(v) The farmers figure out various ways to save labor depending on their farming style and plot characteristics.

(vi) It is expected that the water management labor per a farmer dramatically increase when the management scale of the farmer further increase.

3.2 Development of IISS

Based on the grasped needs, a novel “irrigation information service system (IISS)” utilizing ICT was proposed and manufactured on an experimental basis. The outline of the structure of IISS is shown in Figure2. IISS gives the information on the variation of the floodwater depth, the picture of the field plots and the basic meteorological data through various information terminals such as smartphones and tablet terminals to enable the farmers to reduce the patrol frequency. The spread of IISS is beneficial for LIDs as well because a good deal of sound information concerning irrigation water use can be obtained.

![Figure 2. The outline of irrigation information service system (IISS)](image)

4. VALUE EVALUATION OF IISS

4.1 Methods of evaluation

IISS was installed at selected 5 trial plots to demonstrate its functions and performances. The selected trial plots were 3 plots at about 380 m in the southeast of the study plot cultivated by Farmer B, the study plot cultivated by Farmer C, and the study plot cultivated by Farmer D. The floodwater depth at every 1 hour, the picture taken daily and the hourly basic meteorological data at the 5 trial plots were opened to anybody through smartphones or tablet terminals. A questionnaire page was attached to the IISS interface so that the answers from the potential users were sent to a server computer. The questionnaire consists of the following 4 questions as well as asking the age of the user.

Q1: Frequency of the usage of IISS
Q2: Operability of IISS
Q3: Convenience of IISS
Q4: Willingness to continue to use IISS
Q4 consists of 2 sub-questions, Q4-1: “Do you want to continue to use IISS?” and Q4-2: “How much will you pay for IISS (in Japanese Yen per 1,000 m² field areas per year)?” The collected answers to Q4-2 were analyzed using the contingent valuation method (CVM) to quantitatively evaluate the value of IISS for the potential users (Iida et al., 2015, Iida, 2015).

The manual of IISS was provided and the explanatory meetings for the potential users were held at both LID office. In order for the potential users to use IISS, tablet terminals were lent to the attendee of the explanatory meetings. The tablet terminals were shared by other farmers in turn so that as many as possible potential users can try IISS and answer the questionnaire.

4.2 Evaluation results

It was observed at the explanatory meetings that some of the attendee tended to show passive attitudes towards IISS, because of their unfamiliarity with ICT devices, great confidence in their conventional methods, and reluctance to additional investment. On the contrary, it was pointed out that agricultural corporations or farmers cultivating large areas might have stronger needs for IISS to reduce labor for water management.

During the trial period, total 80 potential users accessed to IISS. Among them, 14 complete answers to the questionnaire were collected. The results obtained from the answers are shown in Figure 3. As shown in Figure 3 (a), 79% of the respondents chose positive answers for the system represented by “Want to use” or “Acceptable”. The results of CVA presented in Figure 3 (b) showed that averagely the farmers were going to pay 1,107 Japanese Yen per 1,000 m² field areas per year. As the current water fees at the study areas are 5,430 Yen and 7,950 Yen per 1,000 m² field areas per year respectively, it was understood that IISS has possibility to prevail if its cost would be within the farmers’ additional expenditure of around 20% (=1,107 / 5,430) of the current water fee.

The analysis of the cost structure of IISS showed that the cost down of the water depth sensor has the highest priority and that the participation ratio is also an important factor to reduce the total cost. It was suggested by the interviews that
agricultural corporations or farmers cultivating large areas might have needs for IISS to reduce labor for water management.

5. CONCLUSIONS

In order to clarify the effective service for rice cultivating farmers, practical service needs in regard to water management were investigated. Based on the grasped needs, irrigation information service system (IISS) utilizing ICT was developed. IISS was installed in actual trial plots so that the potential users could monitor the floodwater depth and the condition of the plant growth in the trial plots. Through the questionnaire attached to the IISS interface, the value of IISS for the potential users was quantitatively evaluated. Generally, the potential users presented positive answers for IISS and the analysis using contingent valuation method (CVM) revealed that IISS has possibility to prevail if its cost would be within around 20% of the current water fee.

REFERENCES


