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Youth Sensors for Sustainable Agriculture

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ABSTRACT

The Youth Mediated Communication (YMC) model is an idea to transfer knowledge to illiterate parents through their children educated at school. In this study, the model was applied to extend agricultural knowledge in rural Asia where farmers tend to use too much chemicals because of their poor knowledge. And such excess use of chemicals is now terrifying the sustainability of agriculture and even their life there. The model was combined with an idea of youth sensors that children work as field sensors, measuring meteorological conditions as well as crop conditions. A Q&A software package was implemented for the children to interact with remote experts through the Internet. The children transfer the queries given by their parents to the expert using the software and receive the answers from the experts. Then, they explain their parents about the answers. The field data collected by the children were used by the experts to provide advices to each of the farmers. We had a test bed in a village in the heart of Mekong Delta in Vietnam and trials were carried out for two cropping seasons from 2011 to 2013 where 29 and 15 families participated in the first trial and the second trials respectively. We concluded the mechanism functioned well in terms of providing illiterate farmers proper knowledge though we still need additional trials to accumulate data for the evaluation of its effectiveness. The youth sensors were very helpful for the experts to understand the truth in the fields of each farmer and to provide optimal advices. The data can be also used as the ground truth to calibrate the satellite based estimation and down-scaling meteorological data.

Keywords: Illiteracy, children, knowledge transfer, youth sensors, sustainability

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1. INTRODUCTION

Proper technology transfer to farmers is inevitable to promote sustainable agriculture of the 21st century particularly in developing countries where excess use of chemicals caused by the ignorance of farmers has been terrifying environment and their life. For example, the Vietnamese government initiated a policy on the sustainability, recognizing the serious impacts on environment by agriculture (Hung 2008). Illiteracy of farmers, however, prevents them from obtaining sufficient information and knowledge. In this study, we use an idea named Youth Mediated Communication (YMC) to transfer agricultural knowledge and information to illiterate farmers in order to solve the issues. The model utilizes their children educated at school as messengers between their parents and remote experts who provide the farmers proper advices. In addition to the illiteracy, the lack of quantitative information such as meteorological data and crop growth data in practical fields has been a big issue for the experts to provide proper advices. In order to obtain field data, we adopted an idea of youth sensors that children work as field sensors, measuring meteorological conditions as well as crop conditions. Combining two ideas, we implemented a software package to evaluate the effectiveness of the approach.

2. YMC MODEL

The YMC (Youth Mediated Communication) model was originally proposed by NPO PANGAEA (Mori *et. al.* 2009, NPO PANGAEA 2012) to solve the issue of illiteracy by bridging illiterate people to remote experts who provide them advices through their educated children. This idea is not only for agriculture but also for other information such as health information. In the model, children serve as bridges between their parent farmers and agricultural experts by informing the problems in their farming to the experts and to transfer the suggestions and advices from the experts to the farmers understanding their farming problems of each farmer. In the process, children first ask their parents about problems in their faming and send the questions from their parents to remote experts using computers available at a village center. Then, the queries are sent to the remote experts through the Internet and the remote experts answer back to the queries one by one. After receiving the answers on the computer, the children take them to their parents.

Considering the extensibility of the model to several different countries where the similar problems exist, language translation mechanisms were also included in the model, namely a machine translator based on Language Grid (langrid.org 2011) and a supplementary function by human assists to compensate the incompleteness of the machine translator. We allocated the English language as a pivot language and all the translations were carried out through English. For the human assists, project staffs named “bridgers” were assigned and they refined the quality of the machine translations. The “bridgers” Fig. 1 shows the schematic flow of the model.

3. QUERIES AND ANSWERS

We assume that it would be rather difficult for children to summarize the queries from the parent farmers and send them to the experts by typing them on the computers. To ease the task, typical questions and corresponding answers were provided in advance and implemented in the software so that the children can easily select the questions from the query list categorized into major topics. At the beginning of the projects, there were about 200 questions listed. The questions and answers were not strictly one-to-one and the expert could choose most optimal answers considering the situation of each farmer. The Q&A sets were translated in related languages in advance, which strongly compensated the weakness of the machine translation.

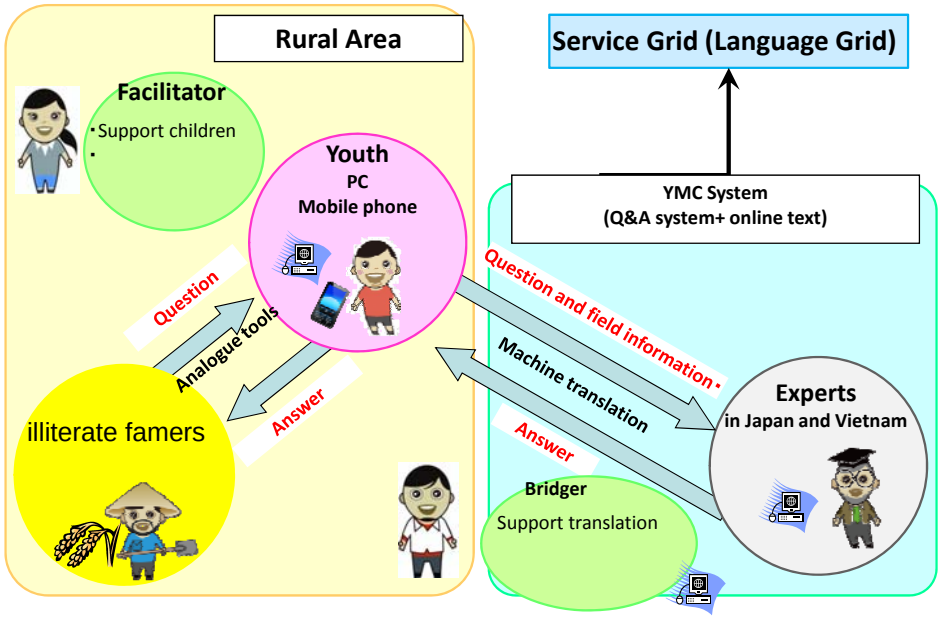

Figure 1. Schematic flow of the YMC model.

Figure 2. Examples of recipe cards in Vietnamese.

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We also assumed that it would be difficult for the children to carry the answers by the experts given on the computer to their parents, handy size print pieces named recipe cards (Fig. 2) were provided corresponding to the typical answers. The remote experts indicated the color and the number of the card on answering so that the children could pick up the proper cards prepared in the village centre where they used the computers to receive the answers and took them back home to explain their parents about the advices given by the remote experts.

When a proper query was not available in the query list, the children and the experts needed to interact by typing questions and answers in free texts. The user interface of the software was carefully designed for the children to access it and to interact with the remote experts easily (Figure 3). The language translator mentioned above was embedded in this function.

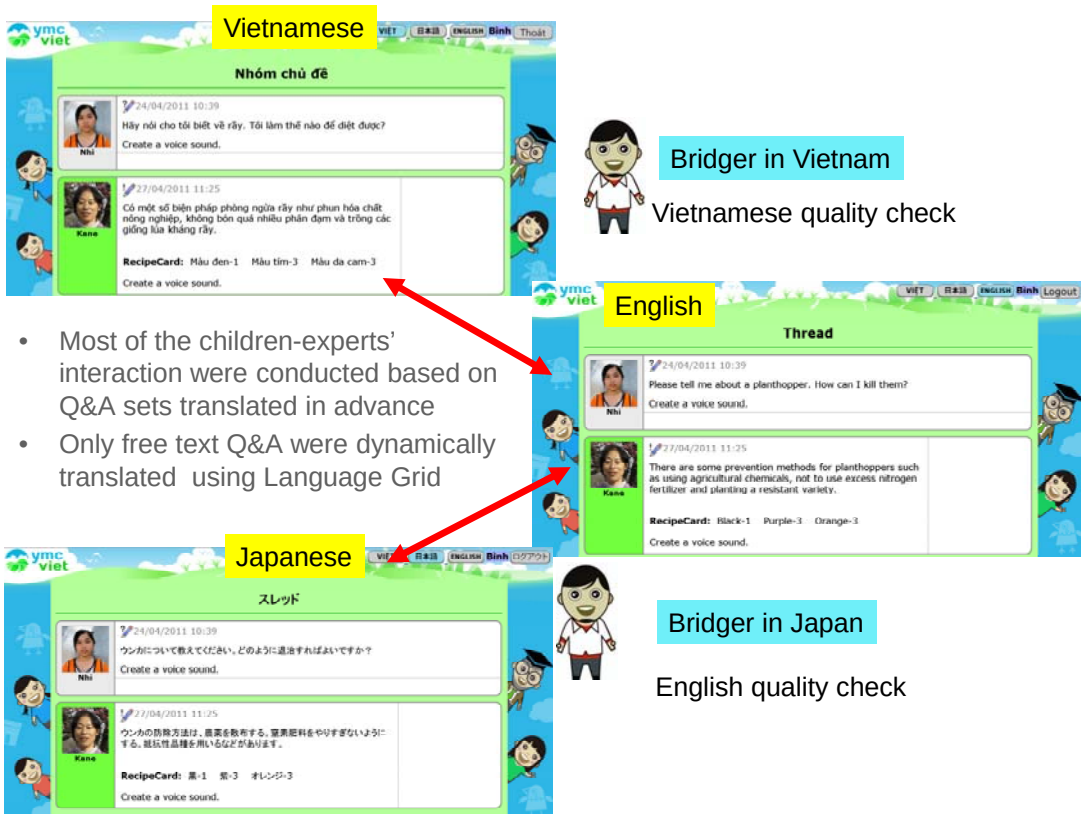

Figure 3. Interaction between the children and the remote experts using free text queries and answers. The case between Vietnamese children and Japanese experts. The bridgers in Japan refined the quality of the English texts machine-translated from the answers in Japanese by the Japanese experts while the bridgers in Vietnam refined the quality of the Vietnamese texts machine-translated from the English answers. The Vietnamese bridgers also needed to refine the texts avoiding the use of technical terms that might be used by the experts, so that the children could easily understand the meaning

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3. YOUTH SENSORS

Every children participating in the project received a tool kit to serve as field sensors (Togami *et. al.* 2012). The kit contained a thermo-hygrometer, a measuring tape, a leaf color chart, an insect plate, a mobile phone and a field notebook. The children were requested to place the thermo-hydrometer on the outside wall of their home at 1.5m high where no direct solar radiation reaches. They were engaged to observe temperature and humidity every morning before going to school and to send the data to the project sever by using the mobile phone (Fig. 4). They were also engaged to visit the fields of their families periodically to measure plant height and leaf color. In addition, they tried to detect insects by swinging canopy and catching them on the insect plate and to take pictures of them by the mobile phone. They were also requested to visually observe the rice canopy and plants to record special findings such as disease phenomena by taking pictures of them. The data collected by the children were saved in the project server so that the remote experts could know the facts in the fields of the participating farmers.

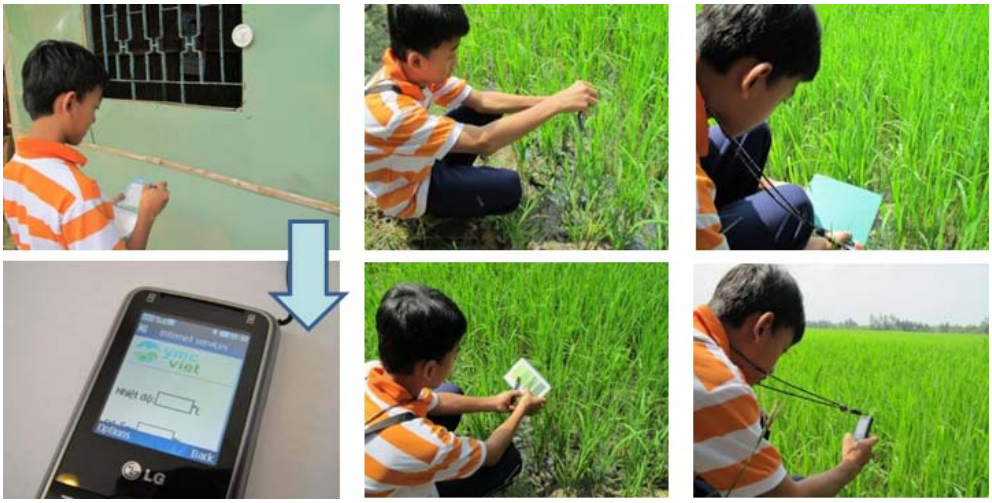

Figure 4. Youth sensor in actions.

4. RESULTS AND DISCUSSION

The total flow of the children's actopms for the knowledge transfer mechanism based on the YMC model and the youth sensors is shown in Fig. 5. To operate and evaluate the proposed mechanism, we selected a village in Vinh Long District as a test bed and conducted the trials twice for two cropping seasons between 2011 and 2013. In the area, the most major crop is paddy rice and the rice yield is quite high in general (4t to 8t/ha). The grain quality is, however, rather low in the village and the selling price is comparatively low. Moreover, the farmers tend to use too much fertilizer, chemical and seed because they believe that high input brings high yield. Such high input is causing environmental damage and aggravating their benefits.

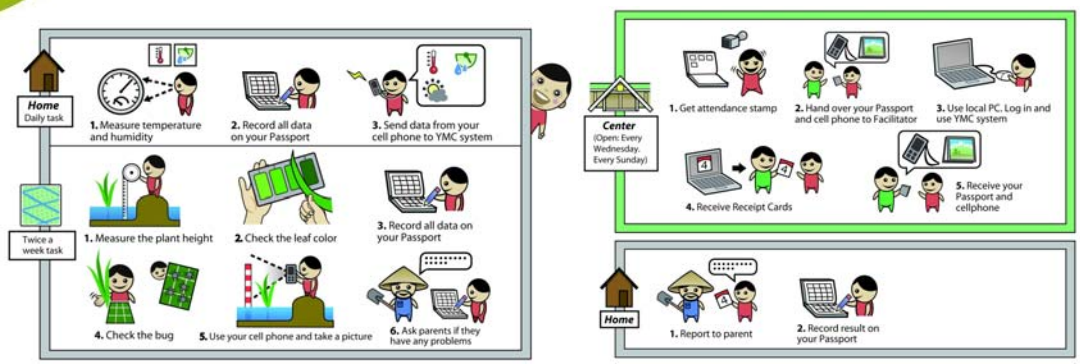

Figure 5. Flow of the actions by the children in this study.

Before the trials, we interviewed paddy rice families of the village and select some of them for the trials, considering their literacy and farm conditions. In the first (January 2011 to April 2011) and second (September 2012 to January 2013) trials, 29 and 15 paddy rice families participated in the project respectively. The age of the children of the selected families ranged from 11 to 15 years old. The children visited a village center to use the PC software to interact with the remote experts twice and once a week for the first trial and the second trial respectively. At the village center, project staffs so-called facilitators supported the children about PCs, mobile phones, the software, data uploading etc. In general, the children were flexible enough to learn how to use those tools quickly and started teaching each other among them. In addition to the tasks of the children in the village center, children could enjoy an entertainment software package named “Rice Doctor” which they could learn about rice production.

Fig. 6 shows the summary of the categorized queries given by the participating families for the first and the second trials. The query patterns were quite similar between the trials and the results indicate that the major concerns of the farmer tended to center on plant damages by pests and diseases. In the second trial, the queries about agrochemical use raised. We understood this as the result of adding the queries about environmental impacts to the Q&A set. This result indicate that our approach works not only for queries and answers but for raising the interests of farmers and leading them to proper farming by providing an appropriate Q&A set.

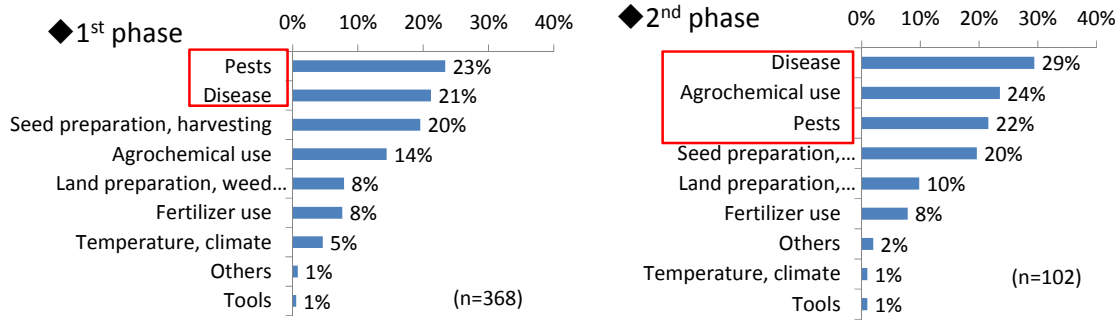

Figure 6. Summary of the queries by the children.

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Through the post project interviews on the participating families, we were convinced that the knowledge of the farmers was definitely enriched. The statistics reported by the local government who has been collaborating with us in the project, showed that the average yield of the participating farmers was higher than the average of the region. An officer of the government mentioned that it was because the farmers properly protected the crops against pests and diseases following the advices. However, the yields declared by the farmers were not correlated with the observed yields originally sampled by us and we believe that we need to accumulate more quantitative data regarding the effectiveness of the proposed approach by continuing the trials.

Figure 7. Pictures from the paddy fields of participating farmers taken by the children.

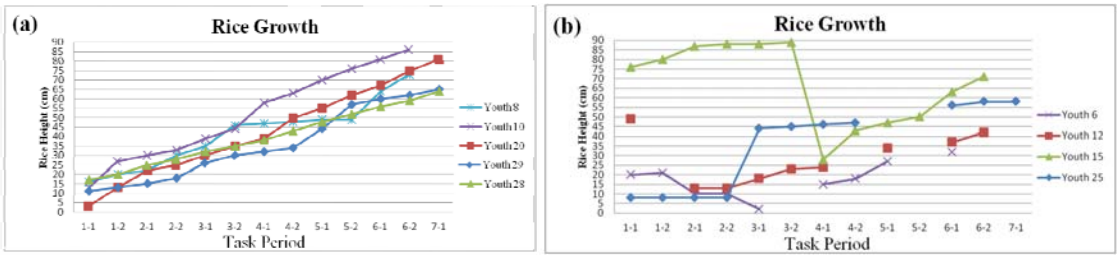

Figure 8. Height of the rice plants measured by the children. They were requested to measure the same individual plants throughout the trial. Line colors indicate each of the participating children.

The youth sensors were proved to be very useful for the remote experts to understand the present statuses of the crops and to provide proper advices. Particularly, the information about leaf color was a good indicator of nitrogen condition of the crops to determine the amount of additional fertilizer application. The images of pests or disease phenomena (Figure 7) also helped the experts to identify the damages and to predict the occurrence of it. Such information is still rather difficult to monitor remotely using

sensor devices while the youth sensors can move around to find out the problems. The average temperatures of the data acquired by children were also quite reliable once we removed apparent outliers. Fig. 8 shows the plant height data measured by the children. Many children could measure it rather accurately while some of the children failed. A few of them didn't visit the field periodically and a few of them didn't understand how to measure the height. Using the pest and decease information acquired by the children, we may be able to develop a disaster warning system by plotting the discovery of pests or diseases on a GIS map. The data can be also used as the ground truth to calibrate the satellite based estimation and down-scaling meteorological data. We plan to use the data to run a rice growth simulator (Tanak *et. al.* 2011) to know the rice productivity and the most optimal cropping timings.

The introduction of the multilingual function will help the extension of the YMC to other countries. The machine-translator is not really reliable and we need the bridgers, which is a serious constraint for the system scalability. Presently, we need to enrich to the Q&A set to solve the issues. Actually, through the trials, we could add some queries and answer based on the queries given by the children.

Many of the parents and children mentioned that the communication between parents and children were accelerated during the project about several topics not only about agriculture but also others. They also mentioned that children became more interested in agriculture. Having such responses, we became convinced that the YMC approach has several potential functions as a tool of rural development in addition to knowledge transfer to illiterate farmers. This study was partially supported by a project "Climatic changes and evaluation of their effects on agriculture in Asian monsoon region (CAAM) / Green Network of Excellence Program (GRENE) " of MEXT, Japan.

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