The Study on "Development of Improved Infrastructure and Technologies for Rice Production in Africa (DIITRPA)"

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1. Background

1.1 The study

The Japan International Research Center for Agricultural Sciences (JIRCAS) started the study on Development of Improved Infrastructure and Technologies for Rice Production in Africa (DIITRPA) in 2008 financially aided by the Ministry of Agriculture, Forestry and Fisheries (MAFF) in Japan. The study is currently focusing on drafting a technical manual in which many findings JIRCAS has acquired through three-and-a–half years validation study in Ghana are included. JIRCAS has recently been in the stage of adapting experience gained to other countries in Africa. In this paper, I would like to explain about an idea of dissemination based on the activities implemented so far by JIRCAS to be understood by stakeholders as well as institutes concerned in Ghana.

1.2 Why JIRCAS started the study

Demographic study shows that rapid population growth in Africa is observed, so food shortage in Africa has been one of the world-wide serious problems in near future. On the other hand, since food production in Africa is still not sufficient to demand, imports of food from Asia and North America are currently observed.

In 1970s, rice consumption was growing in Africa, and governments of Western Africa gathered and established a new agency of the West Africa Rice Development Agency (WARDA, currently "AfricaRice Center") aided by international cooperation agencies, such as FAO, etc. WARDA was produced new rice varieties in Africa (NERICA) since established, and Japan also supported disseminating NERICA varieties, but NERICA hasn't been popular yet in African countries because of the poor experience of rice cultivation, etc.

In May 2008, Japanese government, together with the Alliance for Green Revolution in Africa (AGRA), prevailed the concept of the Coalition for African Rice Development (CARD) that targeted to double the rice production in ten years, and started various studies to fulfill the goal simultaneously.

2. Key points to develop rice cultivation

2-1. Main idea

Rice needs three key indicators of natural environment such as (1) appropriate temperature, (2) enough accumulated-sunshine-duration and (3) precipitation to achieve high yield. Agronomic efforts have been done to create good species of rice, effectively grown under particular circumstances of temperature and sunshine-duration at the particular area where rice is planted. On the other hand, irrigation engineers have worked hard to prepare

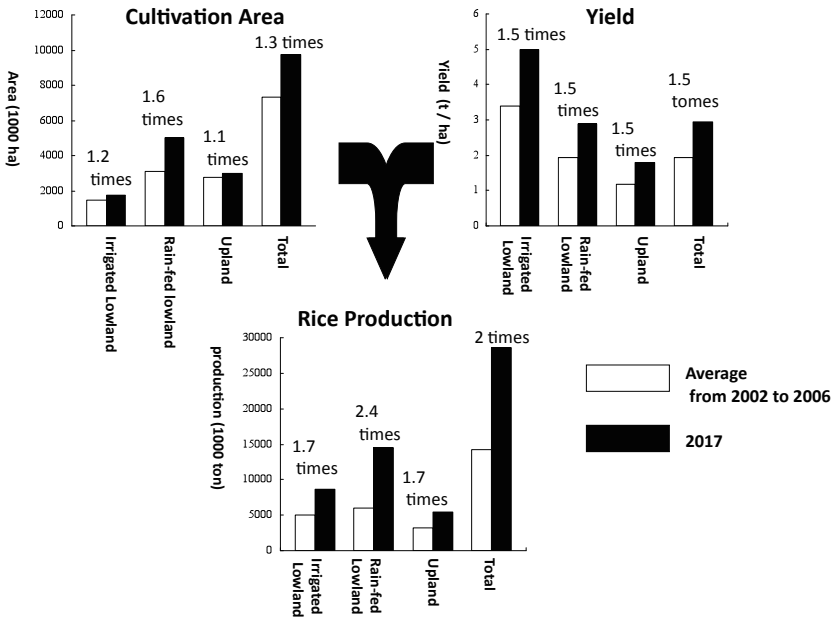

Fig-1: Target of CARD

better condition of irrigation and drainage where enough water resources for rice cultivation isn't stable. Dams, head-works (weirs) and canals are effective infrastructure to propel rice production for large-scale farmland, such as more than ten thousand ha. Besides constructing such huge facilities, practicing micro irrigation method, equipping pipe-lines, using sprinklers and applying covering crops are also implemented in developed countries. JIRCAS, however, took another way of implementing rice paddy field using grass-roots activities shown later.

2-2. Concepts of the study

The study was designed to explore ways to increase rice production in accordance with diverse forms of rice ecosystems in Africa, especially to improve farmland and facilities and develop farmers' cultivation skills in rain-fed lowland areas, by improving methods for rice field construction and cultivation management, introducing appropriate cultivars, and providing seeds as well as equipment and materials. Why JIRCAS selected the validation study sites at rain-fed lowland was not only because rain-fed lowland has potential, but also because it is most effective way of JIRCAS using limited money to establish techniques to be used by local farmers. A basic study of rice production in rain-fed lowlands was conducted in 2008 in the eastern and western regions of sub-Saharan Africa through site visits in each region. Based on that basic study, it was decided to execute a verification study in rain-fed lowland areas in Ghana from 2009 and Ethiopia from 2010 utilizing the results in Ghana. The verification study is being done with farmers at selected model sites on the following topics; (1) establish construction methods of farmland and simple irrigation facilities suitable for topography and water resource, (2) select suitable varieties and improved cultivation techniques, (3) organize farmer groups to manage facilities, machineries and materials. At the same time, (4) on-the-job-training to the extension workers as well as farmers have been also carried out. Moreover, (5) drafting a technical manual disseminating the result of this study is compiled for farmers' leaders to utilize the content reflecting the local condition. Finally, this study is expected to shares the same goal with CARD in increasing rice production in Africa.

3. Lessons learned in Ghana

3-1. Concept of Sawah system

In Western Africa, such as Nigeria and Ghana, a particular way of rice cultivation called "Sawah" system led by Dr. Wakatsuki, professor of Kinki University in Japan, is conducted and remarkable results by the system are reported. Using these experiences, JIRCAS would like to enhance the expertise acquired through the practice of "Sawah" system. According to Buri et al. (2009), technical definition of Sawah, or Suiden in Japanese, is a bunded and well-leveled rice field with an inlet for irrigation and an outlet for drainage, and JIRCAS would like to trace the same method of (a) bunding paddy field, (b) leveling and puddling by power tiller (PT) and (c) delivering irrigation water to the farming plot. Sawah system has no tendency of decreasing yield even continuous production for long years in the same plot has been applied. For example, Japan experienced more than 2000 years of cultivating rice at the same plot, but no serious problem happened induced by continuous use of the same land for rice cultivation.

3-2. Technical aspects to do validation study

3-2-1. Site selection for the project

Validation study sites of JIRCAS were chosen to collect data. But the data wasn't gain during the activities of developing-farmer's-own-field itself, but was collected with JIRCAS's input in order to include them into a technical manual. So, sites selection was under consideration of referring the criteria formerly conducted in Ghana, such as (1) conditions of access to the project sites, (2) whether famers have experience of rice production or not, (3) whether water resources are enough or not, (4) soil condition is wet or dried-up, (5) dry season crop are planned or not, (6) whether palm trees are existing at the project site or not (7) whether farmers organization are exiting or not and (8) whether the land user is as same as land owner or not.

3-2-2. Canal design

During the validation study in Ghana, JIRCAS encountered several difficult conditions of both topography and precipitation. JIRCAS recommended and budgetally aided prepare

Table-1: Selecting Criteria for validy study sites.

Criteria	points	example	Why it is important?
(1) Access	1-5	4	For dissemination
(2) Experience of rice production	1-2	2	Yes=2; No=1
(3) Water resources	1-2	1	
(4) Soil condition	1-2	2	Dry=1; Wet=2
(5) Dry season crop	1-2	2	
(6) Palm tree	1-2	2	For leveling
(7) Farmers Organization	1-2	2	
(8) Land user	1-3	2	
Total	8-20	17	

Source: A discussing material by Dr. Fukuo (2009.11.04)

the canals to convey irrigation water to the field in case-by-case basis, and empilically found in Kumasi, typical type of betterment is shown below, such as (1) dike and weir type, (2) canal type and (3) water-harvesting type to overcome these difficulties, and all of these techniques are effective at paddy fields of bounded and leveled conditions likely to traditionally-practiced paddy fields in Japan.

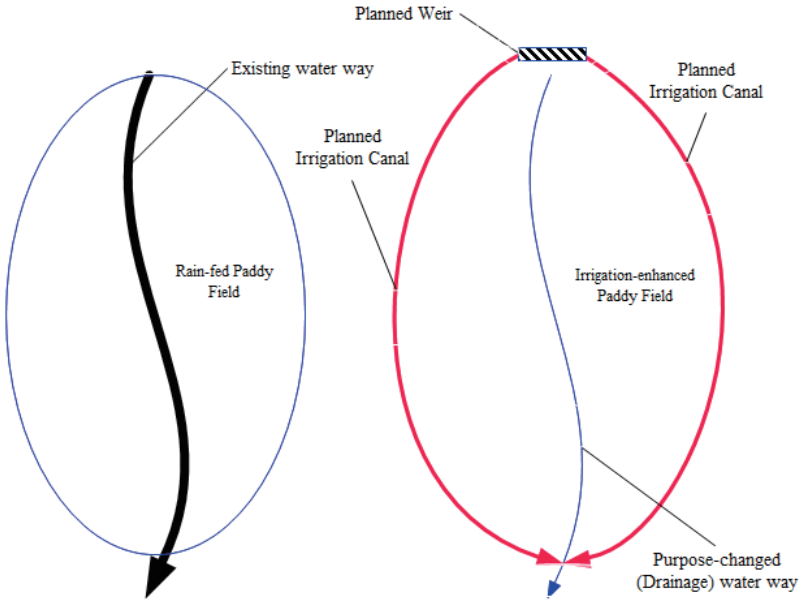

Fig-2: A typical betterment, left to right, for rain-fed paddy field

3-2-3. On the job training

JIRCAS needed in FY 2008, support by CRI and SRI to choose project sites because they knew the places and kept good relation wit farmers. Since JIRCAS has understood the importance of EOs, asked the Ministry of Food and Agriculture (MOFA) in Ghana and its office of District level to help dissemination. In FY 2009, on the job trainings (OJTs) have been conducted by experts of CRI and SRI to extension officials (EOs), who are staff of MOFA and have knowledge of the land conditions of the project sites. In 2010, JIRCAS challenged to expanded 8 sites including 20 farming plots to do same practice of rice production, and Eos who trained previous year did OJT to farmers in several farming plots where Eos are responsible. The challenge was basically successful, although several difficulties were faced in front of us.

3-3. Social Aspects to do validation study

3-3-1. Extention Officials (EOs)

Farmers who starts rice cultivation has a lot of questions before his practice and even more when he continues its activities, since rice production owes much to climate differences that cannot be predictable. Much experience could guide farmers to prepare most critical situation and find remedies to overcome his/her tragedy of producing rice. Perfect timing of applying fertilizer and/or pesticide is not easy to understand. Information of pest and deceases would be conveyed with experienced officials who have no intension of getting own profit from teaching farmers better lectures. So, the role of EOs is of high

importance, and enhancing EOs maybe said one of the fastest ways to achieve the goal of increasing the yield of rice.

3-3-2. Farmers organization

Rice production in its history needed collaborative work to transplanting and harvesting since it may avoid birds attack and promise better quality of rice plant. According to Piper (1993), "As ways of controlling water were developed, societies changed further, investing ever more in the land for terracing, transplanting rice, and eradicating pests," and "the great kingdoms of South-East Asia have usually been based on irrigated rice production." In fact, rice growing farmers have sometimes formed self-defense forces to confronting bulling clan who took all products when harvested, and the some forces became worriers and worrier's groups and governed districts or even states in old historical Japan. Practical farmer's group, however, shouldn't be over expected, but help individual farmers carry out his/her agricultural practice, such as transplanting or using PTs.

3-3-3. Land tenancy agreements

Rice plants needs a lot of farming space to be cultivated and it takes several years to completely level the land, moreover, effectiveness of PT use maybe needs more than couple of years to earn enough money for farmers to pay all the O&M cost. Land tenancy agreement, therefore, needs at least five years, ideally ten years.

3-3-4. Power tiller renting agreement

PT is relatively expensive for individual farmers to purchase, so usually it will be owned by group or governmental organization when farmers start rice cultivation. It is not easy for farmers to operate and maintain PT well enough to reuse in long-term practice of rice cultivation. JIRCAS employed a measure of 'PT Agreement.' Its nature is to use a PT that provided by JIRCAS as break-down free management for long period. JIRCAS suggested EOs to let the village form PT maintenance group and nominate president and chairman who representing the group and responsible to be well managed usage of PT during their rented duration. The tendency, however, differs from place to place to use PT.

4. Lessons learned in Ethiopia

4-1. Conditions

In Ethiopia, there wasn't any experience of using PT in the lives of farmers involved in JIRCAS project too. Although rice was introduced into Ethiopia some several decades ago, plowing is still done by oxen, usually a farmer control using his rod his oxen to go straight or turn at the end of his farming plot. It is said the controlling oxen is very difficult, and the plough made of iron is a kind of house treasure. It should be carefully considered when introducing machinery into such a logging of technique of using machineries.

4-2. Post-harvesting technique

Post-harvesting technique in Ethiopia was far behind from modern technique. The Farmers use oxen to tread the product to husk rice as same as teff, Ergrostis tef, one of the staple serials in Ethiopia. It is said that the stepping teff is effective because teff is difficult to be

husked, but rice is different nature, while farmers use same techniques to rice since this technique is in popular to them.

4-3. Lack in EOs.

EO in Ethiopia was not well trained especially in the field of rice cultivation. And the most serious problem is that they are frequently changed his/her position to next village or district along with annual shuffling. It was very difficult for JIRCAS staff to keep the quality of EOs his/her rice production techniques since they change frequently. It is said that the technique need much time to be learned by him/her, and the effectiveness of his/her training to farmers aren't expected much.

5. Future prospect of disseminating of Sawah system, or Asian-type paddy field, in Africa

JIRCAS would like to apply the techniques above mentioned at several sites in Ethiopia, and finalize the technical manual added new knowledge gained in Ethiopia. Since the first visit to Ethiopia by the staffs, JIRCAS selected in FY2009 several validation study sites in Amhara Region in Ethiopia where water resources are enough to implement the study. In Ethiopia, Sawah system isn't popular, so JIRCAS used Asian-type paddy field instead to be easily imagined by local staff and farmers.

5-1. Draft Manual

Currently, the skeleton of the draft manual are shown in the Table-4. JIRCAS realizes its importance to compile the manual in local language when it's delivered to EOs as well as farmer's group, so the draft manual should be revised after showing to the government officers, EOs and researchers. After that comments and/or questions by them should be acquired. JIRCAS compiled a first draft in 2009, and delivered to EO and farmers inside JIRCAS experimental plot and gained several comments by them. On 28th October 2011, MOFA held a technical committee to check the contents of the technical manual and carry out further inspection of its contents as well as flame work of the manual.

5-2. Remarks for disseminating Sawah system to other countries (in the future)

5-2-1. Site selection

(1) Rainfall (Precipitation)

Rainfall is indispensable to start the Sawah system. According to Fujimoto (2005), 800mm and 1,300mm of annual precipitation is the threshold of choosing policy of cultivating rice or wheat in People's Republic of China, so it is one of the basic indicators to decide rice is appropriate crops for particular area or not. However, high-grade management of rice development, such as twice crop, three times crop or highly mechanized rice cultivation, precipitation should be carefully checked to plan what kind of rice production you would like to apply in the field.

(4) Temperature

Temperature isn't a killer-factor of applying rice cultivation to the particular area or not. Japanese experience of rice cultivation of long history shows that production area of rice cultivation aimed north to finally reach to the northern most island named Hokkaido, average monthly temperature of which is ranging from -4.6 degree (in January) to 21.7 degree (in August), and these lessons could advice you that the temperature can be overcome with human technology of rice cultivation. Of course, the

Table-2: Title of the draft manual.

Main title	Middle titles (if any)
1. Introduction	(1) Background, (2) Why JIRCAS started the study, (3) The Study, (4) Environmental Condition
2. Site Selection	(1) Surveying, (2) the Planning
3. Farmers Organization	(1) Group Formation & Development, (2) Land Tenancy
4. Land Development	(1) Clearing & De-stumping, (2) Construction & Maintenance of Irrigation Facilities, (3) Paddy Field Preparation.
5. Rice Cultivation	(1) Rice Plant, (2) Water Management, (3) Cultivar Selection, (4) Nursery Management, (5) Transplanting, (6) Fertilizer Management, (7) Weed Management, (8) Insect, Pest & Disease Control
6. Harvest	
7. Post Harvest	
8. Operation & Maintenance of Machinery / Tools	

Source: Author (as of 2011.10.28)

mountainous area like Ethiopia should carefully consider the lowest temperature during rice cultivation season, and special consideration/treatment should be applied, such as introducing low-temperature tolerant species, or counter-measure management, such as keeping deep water in the paddy field during the nights would be applied before/when cold air hit or predicted to hit the area.

(3) Land shape (slope)

Concerning the slope of the land, little slope-area is recommended for Sawash system, since gravity irrigation is easier to be applied there than flood-plain area where irrigation water runs highest part of the command area or runs through pipe-lines. Flood-plain area are usually installed with big-proejct facilities to convey much water doth for irrigation and drainage, but the cost of whole project is too large amount for individual farmers to owe. Sawah system don't aim to be applied in this kind of vast land where professional design should be adapted to acquire better result from the project.

(4) Accessibility

It is obvious that the farmers near by could decide their mind after looking the good Sawah site and talk to the farmers who is engaged in the site(s), so if you are the government officer, you should carefully choose the site in a view of accessibility. One of the reason JIRCAS contained accessibility into criteria of selecting validation study sites was this. Good access from a car-running road is important as well for farmers to

carry PTs into project sites.

5-2-2. Conditions of EOs

If a government in African countries is not strong enough to formulate EOs (EO) to help farmers improve their agricultural practices, nor dispatch them into deep rural area, you should enhance the importance of EO to the government officers in the country before you will actually enter into project sites. You cannot do any advanced technical activities in the rural area without good EO who can understand local languages.

5-2-3. Stage of mechanization in the area

Mechanization is not easy to be achieved within several years, since a PT needs continuous activities of operation and maintenance (O&M) when they are introduced in a particular site. Spare parts are needed and sometimes a blacksmith is needed to fix the machines. According to the experience the author acquired in South-East Asia, dissemination of motor-bikes is one of the key indicators for introducing PT for the first time. When the machinery are popular, a lot of tools to fix the machines and factories to prepare spare parts would be required in order to handle machines in good condition.

5-2-4. South-south collaboration

Importance of field-visit by farmers is often cited by many experts of various research fields. A maxim of 'Seeing is believing' is well observed in the dissemination of Sawah system too. JIRCAS invited three Ethiopian experts to Ghana in February 2011 to participate in the SC meeting and field visit to the project sites in Kumasi was successful. All participants were satisfied with seeing the Sawah field by their own eyes and the discussion with farmers and EOs at the project sites.

Remarks

I would like to express my gratitude to the Ministry of Food and Agriculture (MOFA), CSIR-CRI and CSIR-SRI in Ghana who are the counterpart institutes under the Joint Research Agreement (JRA) to help JIRCAS staff conduct pre-validity and validation study. The study was financially supported by MAFF in Japan.

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