ISSN 0919-8822

Information and Public Relations Magazine
on Agriculture, Forestry and Fisheries Research
in Developing Regions

JIRCAS Newsletter

November 2022 No.93

Special Feature

International Joint Research Projects in Africa under the Food Program

JIRCAS Japan International Research Center For Agricultural Sciences

In This Issue

Foreword

Special Feature

JIRCAS TODAY

Towards Building Sustainable and Resilient Food Systems in Africa

Despite the impressive progress made since 2000, Africa's food system remains vulnerable. Seventy-five percent (75%) of the growth in agricultural production has been driven by the expansion of arable land, while crop yield improvements have contributed only 25%. Crop yields in sub-Saharan Africa improved by only 38% over the 38-year period from 1980 to 2018, a third of the yield gains achieved in South and Southeast Asia over the same period. As Africa needs to feed a population that is projected to double by 2050, the risk to agricultural production will become more severe under increasing uncertainties in climatic variabilities. Improving productivity in existing farmland plots is one of the most important measures to increase the resilience and sustainability of the African food system.

Low fertility and lack of nutrients due to highly weathered soils have been among the underlying factors for the stagnant agricultural productivity in Africa. Another limiting factor is the low application of fertilizers, which are most often imported and thus not always available and affordable to resource-constrained farmers. In addition, a recent surge in fertilizer prices in the international market is expected to worsen the food and nutrient security in Africa.

JIRCAS has achieved outstanding results in developing technologies to address soil fertility and poor nutrient management in Africa through its long-term engagement in international multi-disciplinary collaborative research with countries such as Madagascar and Burkina Faso. In the Food Program, we collaborate with related domestic and international organizations in two projects (the "African Rice Crop Systems" project and the "African Land-based Agriculture Systems" project) and in their related externally funded projects, to develop technologies that will contribute to stable food production, international food supply and demand, and stable food and nutrition security in Africa.

Meanwhile, the 8th Tokyo International Conference on African Development (TICAD8), a policy forum for sharing knowledge on African development, was held last August 27-28 in Tunisia. JIRCAS organized two official side events to exchange views on agricultural research and development in Africa. The first, titled "Healthy Soils for Food Security in Africa: The Potential of Regenerative Agriculture," was co-hosted with the Sasakawa Africa Foundation on August 5 and the second, "Managing African Soil for Food Security and Environmental Sustainability –Opportunities and Challenges of Agronomy to Solve Low Fertility/Nutrient Bottlenecks –," was held on August 30.

Accordingly, on the occasion of TICAD8, we are featuring Africa on this issue of the JIRCAS Newsletter. This issue introduces the international joint research projects currently being conducted by the JIRCAS Food Program to realize the establishment of sustainable and resilient food systems in Africa.

NAKASHIMA Kazuo
Program Director, Food Program

Development of Sustainable Rice Cultivation and Food Production Systems in Africa

Sub-Saharan Africa (SSA) is the world's most food-insecure region, with one in four people chronically hungry. In order to secure a stable supply of food for the region and eradicate hunger by 2030 as set forth in the SDGs, food production technologies that can adapt to the increasingly unstable growing environment and effectively utilize limited resources such as water and nutrients are required. To this end, we started the 'Africa Rice Farming System Project' in which we will create new technologies and knowledge that will lead to increased production of rice (a key crop in the region) and improved nutrition for the people, with the aim of building a sustainable food production system centered on rice cultivation.

The implementing areas for the project include Tanzania, Guinea, and Madagascar, all of which are major rice producers and consumers in SSA. The project consists of three themes: Theme 1: Elucidation of the potential of paddy rice cultivation in Africa and development of technologies to maximize output; Theme 2: Development of breeding materials for rice and vegetables that contribute to increased food production and improved nutrition in Africa; and Theme 3: Development and impact assessment of cultivation technologies and production systems with excellent resource utilization that lead to improved nutrition and higher income.

Under Theme 1, we will increase rice production and water use efficiency by developing and combining simple water utilization facilities, rice and vegetable/legume cultivation, and water distribution suited to the topography and cropping system. Under Theme 2, we will develop breeding materials for rice with stable productivity even under water-scarce and nutrient-poor conditions and in problematic soils such as those with excess iron, as well as rice, tomato, and amaranthus with enhanced nutrition and marketability. In addition, we will verify the effectiveness of the breeding materials developed in the local production environment. Under Theme 3, we will develop and disseminate technologies that can increase rice production with less fertilizer use by integrating field-specific fertilization methods and breeding materials. In addition, we will introduce vegetable and legume cultivation, microbiological functions, and paddy-fish farming to establish a rice farming system that excels in nutrient utilization and leads to improved nutrition for people.

This project has been supported through external funding provided by the SATREPS (Science and Technology Research Partnership for Sustainable Development) program and subsidies from the Ministry of Agriculture, Forestry and Fisheries. So far, we have achieved various and practical research outputs toward increasing rice production and food security in SSA such as the publication of a technical manual for efficient use of water resources in irrigation schemes in Africa, the release of new lowland rice varieties in Madagascar, and the development and dissemination of an efficient, localized phosphorus application technique (called P-dipping) in Madagascar. Among these outputs, the release of new lowland rice varieties in Madagascar is a recent highlight. These new varieties, named FyVary32 and FyVary85, have relatively high productivity even under low fertilizer inputs and poor soil fertility conditions. Repeated production tests and taste tests (Photo 1) have confirmed that these new varieties have consistently higher yields and equivalent tasting quality relative to X265, one of the main high-yielding varieties in Madagascar. The news was captured by various media outlets and in May 2022, we even had a chance to introduce these new varieties to the president of Madagascar (Photo 2). We will further collaborate with policy makers, development and aid agencies, and seed production sectors to disseminate the new varieties and contribute toward increasing rice production in the region.

TSUJIMOTO Yasuhiro
Crop, Livestock and Environment Division

Photo 1. Taste testing of new varieties

Photo 2. Explaining the new rice varieties using a pamphlet
(From far right: A representative of JICA Madagascar Office, the President of Madagascar, the Ambassador of Japan to Madagascar, and the Minister of Agriculture and Livestock of Madagascar. *Reprinted from the official Facebook page of the Ministry of Agriculture and Livestock of Madagascar*)

Improvement of Crop Farming Systems in the Savanna Region of Africa

Africa's population is expected to grow rapidly, and food production to support this population has become an important issue. However, especially in arid regions, recent climate change has caused frequent extreme weather events and soil degradation, making stable food production difficult. On the other hand, the savanna regions of Africa are among the areas expected to improve agricultural production, with the Food and Agriculture Organization (FAO) of the United Nations calling them "sleeping giants." Therefore, JIRCAS is currently implementing the "Development of soil and crop management technologies to stabilize upland farming systems of African smallholder farmers【Africa upland farming system】" project for the savanna regions of Africa.

The savanna regions in Africa can be divided into wet savanna, where there is relatively high rainfall and many feasible technology options, and dry savanna, where rainfall is low and soil degradation is severe. Even in the same savanna region, these differences in regional characteristics are expected to affect the feasibility of technology adoption by farmers. Therefore, this project aims to develop suitable soil and cultivation management technologies and dissemination methods for both the wet savanna in northern Ghana and the dry savanna in Burkina Faso.

In the northern region of Ghana, which is a wet savanna, we are developing technologies to support small-scale field crop farmers in their selection of technologies that will help them improve their profitability, reflecting the relatively high agricultural production potential of the area (Photo 1). Specifically, we are examining various crop cultivation methods, such as intercropping and relay cropping, adoption of improved varieties, agricultural machinery, and irrigation technologies in the wet savannas, and creation of models that will enable farmers to make the best choices for their specific circumstances when introducing these technologies. In addition, to ensure that the choice of technology does not lead to future deterioration of soil fertility, we are evaluating the impact of each technology on the soil and are studying a system that allows farmers to choose from among technologies that can maintain soil fertility.

In Burkina Faso, a dry savanna, we are developing cultivation management practices to minimize risks during frequent extreme weather events, in addition to improving soil conservation technologies developed so far to minimize soil degradation and evaluating them for developing soil conservation standards (Photo 2). The activities in the dry savanna will offer small-scale field farmers, who are exposed to diverse soil and weather risks, ways to minimize risks with techniques that farmers can implement.

We also believe that the conditions and methods for the local application of these technologies differ from region to region. Therefore, we will summarize the factors and conditions necessary for the adoption of the developed technologies in both wet and dry savannas, and propose methods of technology dissemination according to the region.

Through these activities, we hope to improve the productivity, profitability, and sustainability of smallholders in the savanna regions of Africa and realize stable food production.

NAKAMURA Satoshi
Crop, Livestock and Environment Division

Photo 1. Preparation of soybean cultivation field trial area in wet savanna, Ghana

Photo 2. Topsoil removal trial to elucidate the effect of cumulative erosion on crop yield in dry savanna, Burkina Faso

Toward “Local Production for Local Consumption”: Aiming at Production and Distribution of Fertilizers Manufactured from African Indigenous Phosphate Rock

Today, there are concerns about food shortages around the world, especially in developing countries, due to Russia’s invasion of Ukraine. In addition, there are fears that the soaring price of fertilizer triggered by the spread of the new coronavirus infection will also cause serious damage to agricultural production. For example, Burkina Faso in West Africa, one of the poorest countries in the world (Human Development Index in 2019: 182nd out of 189 countries), relies entirely on imports for fertilizers. In 2019, before the pandemic, the price of nitrogen-phosphate-potash compound fertilizer was 7,000 yen /100 kg, but now it is about 13,000 yen/100 kg (March 2022). This price is equivalent to 45 days’ wages for local day laborers, and there are concerns that the situation will be further aggravated as the required amount could not be purchased due to the high price.

Under these circumstances, the Burkina Faso government aims to manufacture and sell compound fertilizers stably by producing phosphorus fertilizer utilizing domestic phosphate rock resources (with ore reserves equivalent to 100 million tons) and blending it with other fertilizer raw materials. To contribute to this goal, JIRCAS is implementing the SATREPS (Science and Technology Research Partnership for Sustainable Development) project called “Establishment of the model for fertilization cultivation promotion using Burkina Faso phosphate rock” (2017-2022). We first introduced the progress of the project in JIRCAS Newsletter No. 89 (October 2020) pp. 4-5.

Some of the results achieved so far are as follows:

1) We have clarified the chemical and physical properties of three types of phosphate fertilizers, including raw phosphate rock powder, and their fertilizing effects (Fig. 1), and demonstrated that prototype phosphate fertilizers can be substituted for imported ones.

2) We have demonstrated that fertilizer production is possible with a test equipment installed on site. In addition, based on the estimated cost of constructing a practical-scale phosphorus fertilizer plant, we estimated that the selling price of compound fertilizer could be produced at 70% of the market price (compared to the price before the surge in fertilizer prices).

3) Phosphate rock-enriched compost produced by adding phosphate rock powder has been practiced till now. We have demonstrated that when soil is added to it, phosphorus in the compost is solubilized, and that the compost can be used more effectively for crops.

We have also been actively engaged in public relations activities. In 2021, we made presentations at three international symposia and forums held in the capital Ouagadougou and set up a booth to introduce the fertilizer manufacturing process (Photo 1). The project will be completed soon, and we expect that the project goals will be mostly achieved. However, in order for the results to be utilized and the production and dissemination of domestic fertilizers to be realized, we believe that further support is necessary, and the Burkina Faso side also strongly hopes for this. We are currently considering what kind of support is possible, and we will propose it by the end of the project.

The soaring price of fertilizer has made me realize again that fertilizer is an internationally traded commodity. In many African countries, fertilizer self-sufficiency rates remain extremely low. We believe that it is necessary to diversify and stabilize fertilizer procurement sources through domestic production of fertilizer using various resources available, including unused phosphorus resources distributed in many countries. Whether or not this project has been able to show the pathways depends on its future social implementation in Burkina Faso.

NAGUMO Fujio
Crop, Livestock and Environment Division

Targeted P fertilizers

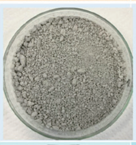
Type	Appearance	Manufacturing method	merit	Demerit
Phosphate rock (PR) Powder		- Crush PR	- less expensive	- Slow-acting - Low-grade
Partially-acidulated PR (PAPR)		- React PR with sulfuric acid	- rich in water soluble, and immediate effect - possible to supply S nutrient	- Risk of acidification of soils - Difficult to remove heavy metals in case
Calcinated PR		- Calcinate PR with high temperature together with carbonates（K, Ca, Mg)	- No risk of acidification - Possible to remove heavy metals	- Some carbonates are highly expensive

Fig. 1. Manufacturing methods and characteristics of various fertilizers manufactured from domestic phosphate rock

Photo 1. Presenting the project at the 13th National Forum on Scientific Research and Technology Innovation held in Ouagadougou in October 2021

Efforts to Improve the Efficiency of Use of Limited Agricultural Water Resources in Africa

According to FAO (2020), 3.2 billion people all over the world live in agricultural areas with high or very high levels of water scarcity, including 1.2 billion people or one-sixth of the world's population in extremely water-constrained areas. The United Nations' Sustainable Development Goal (SDG) 6 aims to "ensure availability and sustainable management of water and sanitation for all". Since irrigation increases agricultural productivity by about 50% (You, 2008), increasing the efficiency of use of limited water resources and providing more water for irrigation is necessary to increase agricultural productivity and alleviate poverty.

Thus, with subsidy from the Ministry of Agriculture, Forestry and Fisheries, JIRCAS conducted research and studies in Ghana and Tanzania to promote the efficient use of limited agricultural water resources.

The study in Ghana was conducted in the northern region. The northern region belongs to the savanna climate zone, with a rainy season generally from April to October and a dry season from November to February with almost no rainfall. For this reason, many reservoirs called dugouts were constructed to provide water for domestic use and deliver drinking water to livestock during the dry season. The water in dugouts overflows during the rainy season and flows into rivers without being used. Therefore, using this water for irrigation improves the efficiency of water resource use.

Specifically, a sub-pond is constructed to temporarily store water overflowing from the dugout (main pond), which is then used as supplemental irrigation water for downstream rain-fed paddies (paddies where rice is cultivated using only rainfall) (Pair Pond System: Photo 1).

The pair pond system increased the yield of rice compared to rainfed fields (40% increase in yield in the test field). After being used as supplemental irrigation water, the surplus water was also used for vegetable cultivation during the dry season, helping to increase farmers' income and improve nutrition.

To determine the size of the sub-pond, we have to estimate how much water will overflow from the dugout. In addition, the estimation method must be simple to use for local engineers. For this reason, we have developed a method that improves on the curve number method, which requires fewer types of data to be used in the calculation.

Meanwhile. the study in Tanzania was conducted in an irrigation scheme in the Kilimanjaro Region. This irrigation scheme does not irrigate the planned area.

The amount of water taken from rivers for irrigation (water withdrawal) and the amount of irrigation water consumed in paddy fields were measured (Photo 2).

The results showed that the amount of water irrigated to the paddy field far exceeded the amount of water required for rice cultivation, thus water use efficiency was very low.

Measures to prevent canal leakage and improve water flow of canal, as well as measures against plot leakage and water-saving cultivation methods (thereby saving irrigation water volume) were implemented to improve water use efficiency, and the effects of these measures were verified in the field.

The irrigable area is determined by the amount of water that can be taken from the river. Since the possible amount of water intake is determined by the river discharge, it is necessary to predict the river discharge during the irrigation period prior to the start of puddling in order to determine the irrigable area. The results of the study showed that the tank model can be used to predict the river flow rate.

These techniques have been compiled into manuals, and these reference materials are available on the JIRCAS website. We hope that the technologies introduced here will help in cultivating paddy fields efficiently using limited water resources.

HIROUCHI Shinji
Rural Development Division

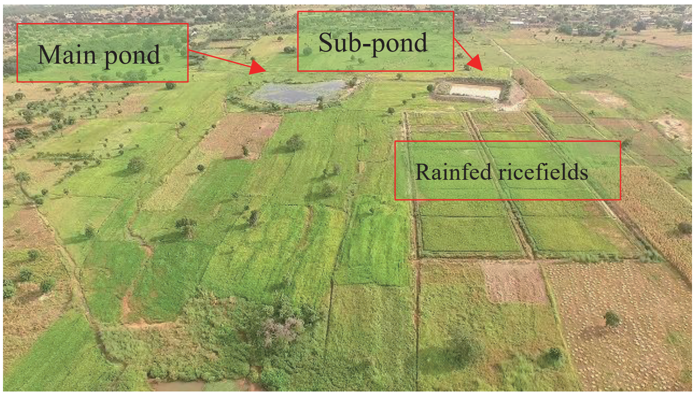


Photo 1. Pair Pond System (Ghana)

Photo 2. Canal flow measurement (Tanzania)

Measuring Household Water Use in Rural Ghana

Rice is one of the staple foods in Ghana, along with maize, yam, and plantains. As irrigation facilities are not common, rice is grown in lowlands and wet areas. Even in such places, rice fields easily suffer from water shortages due to erratic rainfall patterns. For this reason, JIRCAS conducted research on the introduction of small reservoirs (a subsidized project by the Ministry of Agriculture, Forestry and Fisheries of Japan) to enable areas suffering from water shortages to harvest more rice. The research found that farmers can increase their yields through collective irrigation in accordance with the rules, and that they highly appreciate the inclusion of penalties among the rules. Furthermore, we found that surplus water could be used to grow leafy vegetables during the dry season when cultivation is usually not possible. The harvested vegetables can be sold for a good price as well as consumed at home, where they are much appreciated as a colorful and tasty addition to daily dishes.

We had planned to have this reservoir used exclusively for agricultural purposes and managed mainly by farmers. However, to our dismay, many people came to the reservoir to fetch water for domestic uses such as drinking, cooking, cleaning, washing clothes, bathing, processing agricultural products, etc (Photo 1), causing water shortage in the area. Since the water supply is often cut off during the dry season, it is inappropriate to prohibit fetching of water for their daily needs. On the other hand, it is a problem for farming activities if water for irrigation runs out during cultivation. Thus, we need to know how much water can be used for agriculture while securing demand for domestic use to make a rational farming and irrigation plan without waste. And so, how much water is needed for domestic use? Since it was unknown, we decided to measure the amount of water used in homes in rural villages.

Photo 1. Fetching water from an agricultural reservoir

Most houses where the study was conducted do not have running water. Water fetched from a reservoir or a communal water supply or water collected on the rooftop is stored in containers for household use (Photo 2). Sensors were installed in these containers to measure changes in the amount of water. The amount of water used per person per day every month was calculated using the measurement results and other data. The result ranged from a few liters to 30 liters depending on the household and the time of year. This amount is minimal compared to the 214 liters* per person per day of water used at a typical home in Tokyo. Perhaps more water is needed to have a more hygienic and prosperous life in rural Ghana. How can we balance water use to enrich lives and increase agricultural production? Should we use no more than we do now for domestic use, should we build a more extensive reservoir, or should we give up vegetables in the dry season until a water supply system is built? I believe the answer is that local people must decide for themselves and manage their water use. I will try to carry out research that will help people who use water understand their own water use and help them decide how to use water through discussions.

* Bureau of Waterworks, Tokyo Metropolitan Government (https://www.waterworks.metro.tokyo.lg.jp/faq/qa-14.html#2)

OKA Naoko
Rural Development Division

Photo 2. Collecting rainwater from a rooftop into a container

A New Breeze for Traditional Cropping in West Africa Using Unutilized Genetic Resources

When we say "yam" in Japan, most of us think of "jinenjo/Japanese yam" or "nagaimo/Chinese yam," which are grown mainly in the northern parts of the country like Hokkaido where the average temperature is relatively lower than in other areas. On the other hand, in the coastal region of West Africa called "Guinea Savanna" including Nigeria and Ghana, "yam" means "white guinea yam," which is adapted to tropical climate. It is widely grown throughout the region as a staple and soul food of the people. In late November, yam markets start to open everywhere (Photo 1), with the bigger and good-shaped yams trading at higher prices. They are typically served as "fufu," which is made by pounding boiled yam, and "amara," which is made from dried yam flour.

Nigeria is one of the centers of population explosion in Africa and the largest consumer of yam, thus, demand for yam is expected to increase around urban areas that have been showing remarkable population growth. However, the country's yam production (yield per unit area of land) has been stagnant for decades because most of its yams are cultivated by traditional methods that require much time, labor, and land area, thereby imposing a huge burden on farmers. To address the future increase in demand for yam, JIRCAS is currently developing time- and labor-saving, high-yield yam cultivation techniques. Our target is yam tubers that are not for direct selling in local markets but for processing and consumption in urban areas. Processed yam flour sold in supermarkets is easier to cook compared to yam tubers, and thus is widely used by urban families and in restaurants.

Unlike traditionally grown tubers, which need to be large-sized for them to fetch a high price in the yam market, the size of tubers produced for processing does not matter. Based on this, JIRCAS and the International Institute of Tropical Agriculture (IITA, Nigeria) have been exploiting yam genetic resources to obtain suitable accessions for processing. After identifying multi-stemmed lines from among thousands of yam accessions stored in IITA, we found yam accessions that produce a few small tubers like potatoes instead of one big tuber generally observed in commercial varieties (Photo 2). These accessions had long been considered as useless for the purpose of producing large tubers.

However, viewed from a different perspective, this means that interplant space can be reduced compared with that in traditional cropping (1 plant m^{-2}), and thus small-tuber accessions are suitable in high-density cropping as they enhance land use efficiency. In addition, other labor-saving and high-yielding options, such as non-staking cultivation, mixed cropping with legumes, and using chemical fertilizers and plant growth regulators, are also easy to apply in high-density cropping. We have started evaluating these cropping options to improve tuber yields using small-tuber accessions. The study is being implemented under the "Indigenous Crops and Foods Design Project" of JIRCAS in the 5th Medium to Long-Term Plan which started in 2021. Thus far, the JIRCAS-IITA collaborative studies have produced several research outputs that have been well utilized.

Although yam is an important crop that feeds 270 million people living in Guinea Savanna, research on yam cultivation techniques and variety development has been lagging far behind those seen in major crops like maize and rice. Our goal is to make innovations in traditional yam cropping systems by applying a new cultivation technique that utilizes small-tuber accessions, thereby improving not only yam yields and farmers' income but also food security in the region.

ISEKI Kohtaro
Biological Resources and Post-harvest Division

Photo 1. The yam market bustles with activity during harvest season in November

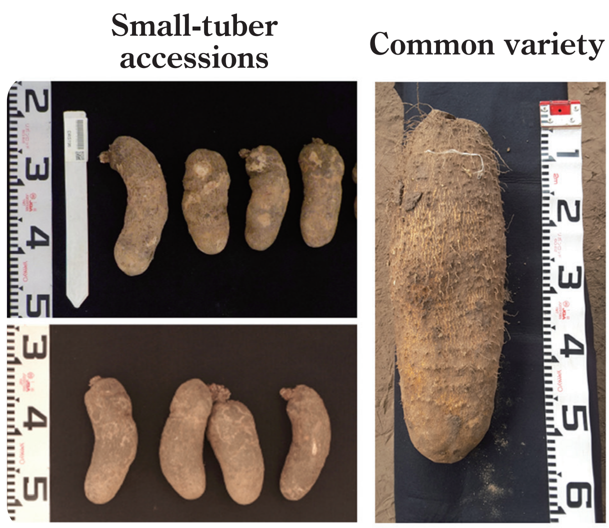


Photo 2. Small-tuber accessions (left) and a common variety (right)

Africa and Nutrition

According to "The State of Food Security and Nutrition in the World 2022 (FAO, IFAD, UNICEF, WFP and WHO 2022)" report released this July, between 702 and 828 million people were affected by hunger in 2021. The Sustainable Development Goals (SDGs) set the goal of achieving zero hunger by 2030; however, the number of people facing hunger has grown by about 150 million since the outbreak of the COVID-19 pandemic. Combined with the situation in Ukraine and climate change, these recent challenges have unfortunately reversed SDG progress in the last few years.

Of the hungry population, 424 million are in Asia and 278 million are in Africa. In terms of regional population ratios, Asia and Africa account for 9.1% and 20.2%, respectively. Africa thus bears the heaviest burden, and is the region where both the population and hunger rate have been increasing the most since 2019. As a result, tackling malnutrition, which includes not only hunger (undernourishment) but also micronutrient (vitamin and mineral) deficiencies and overnutrition (obesity and overweight), has become more important than ever in Africa. It is also for this reason that the African Union has designated 2022 as the "African Year of Nutrition" to encourage leaders in each country to strengthen their nutritional improvement measures.

Photo 1. Market survey

What then can be done to improve nutrition? Food shortages require more food production for sure, but there are many other factors involved, including geographic conditions, income, nutritional knowledge, preferences, and food loss. Africa is not small and has a wide range of climates, soils, ethnic groups, and cultures. The staple food alone can be diverse, including maize, rice, wheat, potatoes, and legumes, and there are also differences between urban and rural areas. We need to understand the local context to develop effective nutritional improvement measures.

We have been conducting interviews with farmers in Africa to collect information on their dietary habits and nutritional status (Photos). We are generally targeting poor farmers living in rural areas, many of whom do not eat three meals a day. They often eat only one type of dish such as boiled beans or rice, the same food in the morning and evening. Basically, they can eat something they have, but they cannot buy something they do not have.

In such cases, they can increase the amount of food by increasing the production of crops that they grow. Cultivating various crops can also lead to variety in the diet and improve nutritional balance. Selling crops at markets can increase income and improve nutrition. In addition, improving the preservation method of harvested products could reduce losses and stabilize food security and income. Knowing about nutritious foods and crop utilization (e.g., eating not only the main product but also sub-products such as leaves, using them as baby food, etc.) also contributes to improving nutrition. We will continue our research on what can done to ensure that everyone has access to a healthy diet.

SHIRATORI Sakiko
Information and Public Relations Office

Photo 2. Household survey

Towards Improved Farm Management of Smallholder Farmers in Africa

Most farmers in Sub-Saharan Africa are smallholders. This condition threatens food security in the region as smallholders cultivate only a few hectares of farmlands and face constraints on income generation. Although there is a strong focus on new agricultural technologies, only a few have shed light on the development of methods to efficiently support smallholder farmers' decision-making, including technology adoption. Therefore, we have decided to develop a new farm management planning model that is effective in supporting decision-making by smallholder farmers, and to use it in the field.

The model can identify the optimal crop and technology choices along with the optimal scales of introducing these crops and technologies to maximize the total household income, based on the following conditions: ensuring the area to produce enough subsistence crops for home consumption, mixed cropping and intercropping as smallholders' coping strategies to production and marketing risks, and ensuring non-farm income and labor distribution of farm and non-farm activities. This allows us to propose improved farming plans that meet farmers' dietary demands, risk dispersion, and off-farm activity needs.

To date, we have used the model in research projects targeting upland crop, rice, and livestock production in various regions of Africa. In northern Mozambique, the model was used in several upland farming areas to identify optimal cropping systems for improving food self-sufficiency and income of smallholder farmers. In southern Mozambique, we also focused on improving nutrition through the use of dairy products and developed an integrated crop-livestock farm management model to facilitate farmers' introduction of dairy farming and integration with cropping activities. In northern Ghana, we used the model to identify a plan for introducing rice production technology using a small reservoir that will allow farmers to improve not only food self-sufficiency and income but also adaptation to climate change.

In order to expand the use of the model and contribute to decision-making support for a large number of smallholder farmers, we also developed a simple-to-use program to run the model. The program was developed in English, French, and Portuguese, the official languages of African countries, to facilitate the development of optimal plans for cropping and technology introduction by local extension workers and others (Photo 1). In Mozambique, the program has provided alternative farming plans to hundreds of smallholder farmers (Photo 2), greatly improving the incomes of the farmers who referred to the plan, and providing an opportunity to introduce new crops and technologies.

Given these results, we are currently conducting research activities to propose sustainable and profitable farming plans that effectively combine multiple cropping and soil management technologies in smallholder production systems in Africa. In response to soaring international fertilizer prices and the depletion of phosphorus resources, we are also conducting research on the feasibility of a newly developed fertilization technology based on indigenous phosphorus rock, and on how to improve smallholder farmers' food and income security using this technology. Through these activities, we will contribute to sustainable food production and poverty reduction in Africa.

KOIDE Junji
Social Sciences Division

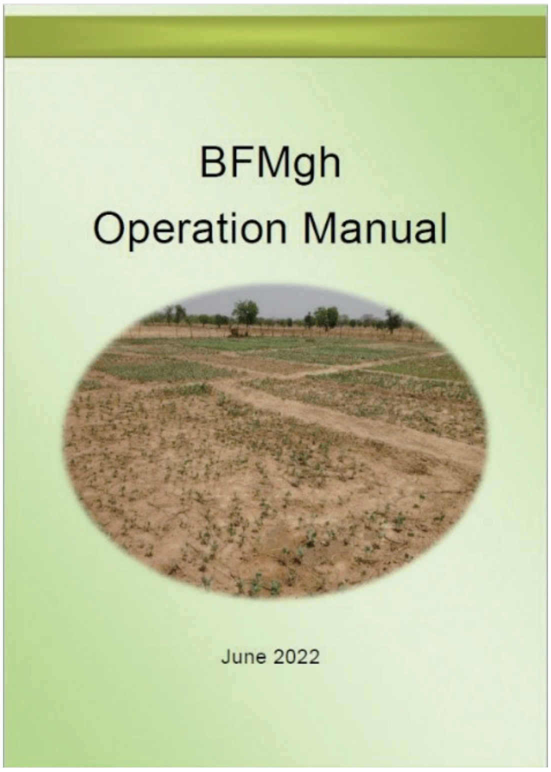


Photo 1: Operation manual of the developed program

Photo 2: Explanation of farming plans to local farmers

JIRCAS TODAY

【Research Highlights】

Development of Cellulose Saccharification Technology Using Microorganism Culture Only —Microbial saccharification method reduces the cost of saccharification enzymes to zero—

A joint research collaboration between JIRCAS and King Mongkut's University of Technology Thonburi (KMUTT), Thailand, has developed a "microbial saccharification" technology that does not require at all the addition of cellulase enzyme when converting cellulose-based biomass into fermentable carbohydrates.

This research achievement eliminates the need to purchase cellulase enzymes, which had been a cause of high costs, because cellulose fiber can be saccharified only by coculturing microorganisms (*Clostridium hermocellum* and *Thermobrachium celere* strain A9). Furthermore, since these microorganisms can be cultured repeatedly, this next-generation saccharification technology is inexpensive and efficient, and will contribute to the promotion of decarbonization and reduction of environmental load in resource and energy procurement under the "Strategy MeaDRI (Measures for the achievement of Decarbonization and Resilience with Innovation)" being promoted by the Ministry of Agriculture, Forestry and Fisheries (MAFF).

The results of this study have been published in the online edition of the scientific journal *Applied Microbiology and Biotechnology* (February 14, 2022 JST).

Year-round Intermittent Irrigation Improves Farmers' Profits and Reduces Greenhouse Gas Emissions —LCA evaluation of the benefits of alternate wetting and drying technology in the Mekong Delta—

JIRCAS conducted an evaluation of the benefits to farmers and reductions in greenhouse gas (GHG) emissions from implementing alternate wetting and drying (AWD) technology in rural areas of the Mekong Delta, Vietnam.

The results of this study showed farmers who implemented AWD increased their profits by 14% for early wet season crops, 3% for late wet season crops, 1% for dry season crops, and 6% throughout the year as compared to farmers who did not implement AWD. The GHG emissions based on life cycle assessment (LCA) also revealed that farmers implementing AWD could reduce GHG emissions by 40% for early wet season crops, 37% for late wet season crops, 35% for dry season crops, and 38% for the entire year. Even taking into account the differences in farmland management by cropping season, AWD farmers were able to demonstrate the benefits of implementing AWD throughout the year, enabling a significant reduction of GHG emissions while gaining benefits in terms of profits, as compared to non-AWD farmers.

The implementation of year-round AWD is an agricultural system with co-benefit that both increases farmers' profits and reduces environmental impacts from agriculture, and is expected to be a promising mitigation and adaptation measure for climate change in the Asia-Monsoon region.

The results of this research have been published in the online edition of *Journal of Cleaner Production*, an international, transdisciplinary journal focusing on cleaner production, environmental, and sustainability research and practice (April 4, 2022 JST).

JIRCAS Mail Magazine (English) Registration Guidance

JIRCAS Mail Magazine, the online quarterly publication of JIRCAS, provides information on the latest topics, events, seminars and workshops, as well as new technologies, research highlights, and guidance publications. To subscribe online, please use the following link. Thank you very much in advance.

https://www.jircas.go.jp/en/public_relations/jircas_mailmagazine

JIRCAS Newsletter No.93

November 2022
Information and Public Relations Office
1-1 Ohwashi, Tsukuba, Ibaraki 305-8686, JAPAN
Phone: +81-29-838-6313 Fax: +81-29-838-6316

https://www.jircas.go.jp/