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JIRCAS Newsletter for INTERNATIONAL COLLABORATION

Nigerien farmers transport their cowpea harvest. (Photo by S. Muranaka)

In This Issue

JIRCAS
JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES

Overview of JIRCAS Research for African Agriculture

JIRCAS Newsletter No. 58 (published in July 2010) provided an overview of JIRCAS research activities for African agriculture. As was reported in the newsletter, JIRCAS has established the Africa Liaison Office in Accra, Ghana and strengthened its research activities in the region, taking Japanese governmental policy and trends in international agricultural research into account. The center continues its support of agricultural research in Africa for the third medium term (covering fiscal years 2011-2015) by investing effort and by allocating adequate budget and resources for the planned activities.

Majority of rural people in Africa are engaged in agriculture. However, African farm yields have hardly increased, unlike in other regions. The most effective way for Africa to cope with this situation and improve its agricultural performance would be to enhance technological development and human capacity building through 'agricultural research' (see JIRCAS Newsletter No. 58).

A research study funded by the Ministry of Agriculture, Forestry and Fisheries in 2006-2007, titled "Study on Key Technologies for Innovation of African Agriculture," played an important role towards strengthening JIRCAS' research activities in Africa. Several Japanese researchers who had prior experience in Africa joined this study. The results were edited and published by the JIRCAS Research Strategy Office as a report. The report suggested that Japanese research efforts should concentrate on its strong points or on areas where it has comparative advantage, given its limited experience on international agricultural research compared with other advanced countries.

New research themes like "conservation agriculture," "use of phosphate rock," "yam" and "leguminous crops" were proposed, based on understanding the importance of conserving and utilizing the diversity of local agriculture and resources. This is in line with intensified efforts to achieve the U.N. Millennium Development Goals, which include the eradication of global poverty and hunger. JIRCAS aims to do its part by increasing agricultural productivity in Africa. These proposals have contributed to the creation of new research projects in the present third medium-term plan.

In response to the Yokohama Action Plan at the 2008 Tokyo International Conference on African Development (TICAD IV) to "double African rice production in the next decade," a global initiative − the Coalition for African Rice Development (CARD) − was established to realize that plan. JIRCAS has been part of the Steering Committee since its inception and has been supporting CARD's main target to double rice production in Africa within ten years. In Africa, the volume of rice imports from Asia and North America has increased annually due to the rapid rise of consumption that exceeds production. Meanwhile, local farmers' techniques and knowledge in rice cultivation being deficient and the research and aid system to support such farmers' activities likewise insufficient, technological progress and increase in rice production are not yet assured. Consequently, the flagship project, titled "Development of Rice Production Technologies in Africa" was developed and has since been implemented (**page 3**). This ongoing research is one of the flagship projects of JIRCAS for the third medium-term period.

Tropical field crops which are versatile in their utilization as food, feed, processed food products and industrial raw materials are usually well adapted to local agricultural environments even under adverse conditions. Examining the potential of these versatile crops will help secure the local food supply and safeguard the diversity of each area's agriculture (yam, **page 5**; cowpea, **page 6**).

Burkina Faso and Ghana in the West African savanna are areas characterized by low soil fertility and severe soil erosion as well as erratic rainfall. A project focusing on a method which makes efficient use of water resources and applies soil conservation techniques (conservation agriculture) is being carried out by researchers (**page 7**). On the other hand, large tracts of land in the southern part of Africa have remained unutilized despite its high fertility. JIRCAS will try to develop a commercial agricultural system that maximizes the potential of this savanna (**page 8**).

A model that would help create sustainable rural communities with low GHG emission is being developed in Ethiopia (**page 9**). Carbon sequestration through reforestation and GHG emission reduction through agroforestry in degraded areas are the main activities. These activities are aimed towards formulating a Clean Development Mechanism (CDM) project and funding rural development through monetized carbon credits, after project registration and verification by the Executive Board of CDM, UNFCCC. The basic technology for this research was developed by JIRCAS in Paraguay.

We hope this issue of the newsletter generates strong interest among readers regarding our research activities on African agriculture.

Takeshi Kano
Program Director
Stable Food Production Program
JIRCAS

Development of Rice Production Technologies in Africa

In Africa, delays in economic development and high population growth have given rise to poverty and food shortages. JIRCAS takes action by implementing a research project aimed towards achieving the goal of the Coalition for African Rice Development (CARD) to "double African rice production in the next decade." This flagship project comprises three **research subjects**, as described below:

A) **Development of new breeding lines obtained by evaluating and improving the existing genetic resources of upland and lowland rice that are suitable for African field conditions.** Efforts will be directed at boosting rice production and on reducing the losses caused by phosphate fertilizer deficiency or by rice blast.
B) **Development of a low life cycle cost paddy technology, an Asian-type rice cultivation system, and a paddy field model suitable for African conditions.** Support will be extended to enable local farmers to easily recreate Asian-type irrigated paddy fields (that are bunded, leveled and puddled) and carry out paddy rice cultivation. Technologies will be developed for soil fertility improvement in paddy fields with use of indigenous materials, based on their locality and availability.
C) **Expansion of rice cultivation in areas which used to be flood plains.** JIRCAS will develop a technology for effective rice production in river basins.

Likewise, efforts are underway to build a framework for cooperation or launch a joint research project so that the governments concerned or the international organizations can utilize the outputs of this research with full confidence for their own projects, investigations and extension promotions.

JIRCAS explained the above studies at JIRCAS Symposium 2011 and other seminars in Africa. JIRCAS also published some results in scientific journals and on the JIRCAS website. Three **research highlights** below are part of our study results.

1. Manual for Improving Rice Production in Africa

In Western African countries such as Nigeria and Ghana, a particular way of rice cultivation, called the "Sawah" system, is being practiced on some rice fields. The "Sawah" system is technically defined as rice cultivation on a bunded, (i.e., leveed or embanked) well-leveled rice field with an inlet for irrigation and an outlet for drainage. Based on observations, the system reported remarkable results comparable to traditional rice cultivation (i.e., on rice paddies without levees).

JIRCAS saw the need to develop the inland-valley areas where grassroots support can be readily harnessed and developed for the local farmers to become skilled practitioners of the "Sawah" system. JIRCAS started the study through the Development of Improved Infrastructure and Technologies for Rice Production in Africa (DIITRPA) program in 2008, with financial support provided by the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan. The project was carried out by doing the following: (a) manual construction of the levee or embankment, (b) leveling the land using a power tiller, and (c) delivering irrigation water through man-made canals.

As one of the outputs of the study, a technical manual was published in 2012 on the JIRCAS website (http://www.jircas.affrc.go.jp/english/manual/ricemanual2012/ricemanual2012_index.html). It includes many findings acquired through four years of validation studies in Ghana and Ethiopia, including: (a) site selection, (b) organizing farmers' groups, (c) appropriate use of power-tiller or oxen (**Photo 1**), (d) constructing small-scale irrigation facilities, canals and levees, (e) leveling, puddling and transplanting (**Photo 2**), (f) adequate weeding and fertilizer application, and (g) post-harvesting techniques, among others.

Photo 1. Land leveling by a power tiller (Ghana)

Photo 2. Transplanting (Ghana)

On JIRCAS' recommendation, many charts and illustrations were used to make the manual easier to comprehend and help the target readers, particularly extension officials (EOs) and farmers, digest the contents easily. Any rice producer who uses the manual is expected to easily understand the steps to undertake on the first year and the following years. Usually, the first year is most crucial as it is the time when land is initially developed for rice cultivation, with lighter work expected for the succeeding years.

Some difficulties were encountered during validation studies in Ghana due to the area's natural conditions (i.e., topography and precipitation). To address the issue, JIRCAS recommended and shared the cost of constructing canals on a case-to-case basis to enable conveyance of irrigation water to the field. The availability of several types of irrigation facilities in the capital city of Kumasi in the Ashanti Region allowed the study to overcome such difficulties. The validation studies showed that the proposed techniques are effective on paddy fields of bunded and leveled conditions similar to the traditionally-practiced paddy fields in Japan. In addition, a guide for rehabilitating constructed irrigation facilities such as weirs and canals was also included in the technical manual for the first time--an invaluable information that was not included in previous manuals.

2. Indigenous organic resources for improving soil fertility in rice systems in Sub-Saharan Africa

Low soil fertility in Sub-Saharan Africa (SSA) has

resulted in a decrease in rice production. It was also found that small-scale farmers do not have enough purchasing power to afford sufficient amounts of commercial inorganic fertilizers to replenish soil fertility. Thus, to increase agricultural productivity without spending much on fertilizers, easily obtainable and low-cost indigenous resources were examined.

Surveys implemented in a commissioned study by MAFF, Japan, revealed that various indigenous resources from agricultural wastes such as rice straws and rice husks could be used for rice systems in Ghana, West Africa. These residues were abundant in Northern, Volta, Upper East, Western, and Eastern regions where large amount of rice was produced. Total rice straw and husk produced as waste in Ghanaian rice systems was 430,000 tons. These contained N, P, and K elements with nutrient equivalent (in tons) of 2,530 N, 990 P_2O_5, and 5,460 K_2O, respectively.

Various livestock excreta including dung and urine were also abundant, particularly from cows followed by goats. Amount of excreta differed among regions. Cow and pig excreta were largely produced in Northern, Upper East, and Upper Western regions. Poultry manure was ample in Ashanti, Greater Accra, and in other municipalities and cities. Livestock excreta produced in Ghana were calculated to contain 80,500 N, 44,500 P_2O_5, and 59,200 K_2O (total nutrient equivalent, in tons).

The estimated quantity of indigenous organic resources differed among regions; thus, resources should be optimized for use in the host areas. For example, in the Northern region where rice cultivation is most prominent, adding rice straw into the rice cultivation system would cover approximately 20 percent of N and P, and most K requirement of the soil compared to applied chemical fertilizers. Also, based on total estimated organic resources from livestock, if only 20 percent of these resources were utilized, it could replace the requirement for chemical fertilizer in rice cultivation system for the entire Northern region. Furthermore, development of composting techniques is required for sustainable and effective application of these organic resources. Meanwhile, it has been noted that grazing livestock excreta (dung and urine) were difficult to manage; hence, effective methods for its collection and transportation from the sources should be investigated prior to its use. In addition to the aforementioned observed resources in Ghana, other organic resources such as human excreta, sawdust, and oil palm shells are also available and may prove useful. Therefore, further studies on the abundance and usefulness of these resources should be considered.

3. Simple and rapid measurements of photosynthetic activity in submerged rice by measuring chlorophyll fluorescence emissions

Submerged rice plants experience low oxygen and irradiance underwater, causing severe visible damages and photosynthesis inhibition. In recent years, the measurement of chlorophyll fluorescence emissions using a Pulse Amplitude Modulation (PAM) instrument has become a powerful tool for quick and non-invasive evaluation of the photosynthetic activity and photoinhibition in plants.

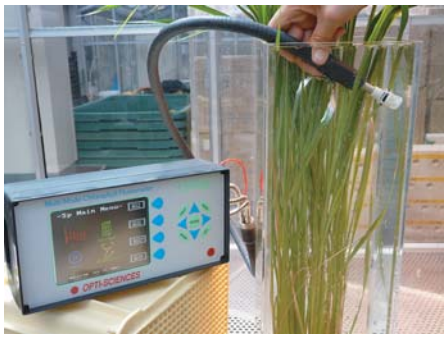

Photo 3. Portable chlorophyll fluorescence meter with a waterproof probe

However, methods for measuring chlorophyll fluorescence in rice underwater have not been developed. Previous studies on photosynthetic activity of submerged rice plants technically involved only numerical values measured above water (i.e. aerobic conditions) as measurements were taken after the removal of plants from submergence instead of measuring it while submerged. By doing so, it discounted the effects of environmental changes from anaerobic to aerobic conditions. The objective of this study is to develop a method for evaluating photodamage directly under water by analyzing chlorophyll fluorescence in leaves using a portable chlorophyll fluorescence meter with a waterproof probe.

Two rice (*Oryza sativa* L.) cultivars differing in their response to submergence were compared, namely: (1) a tolerance cultivar IR 67520-B-14-1-3-2-2 (IR67520), and (2) a susceptible cultivar IR72442-6B-3-2-1-1 (IR72442). Twenty-three-day-old seedlings were submerged in 80-cm-deep water for 14 days. The maximal quantum yield of PSII (Fv/Fm) of the dark-adapted leaves was measured using a portable chlorophyll fluorometer (OS5p; Opti Sciences Inc., USA) with the probe wrapped tightly with polyolefin to become waterproof (**Photo 3**). Dark-adaptation leaf clips were mounted on the leaves before readings were taken. During submergence, Fv/Fm of the submerged leaf decreased earlier in IR72442 than in IR67520 compared to control plant. Fv/Fm showed a significant positive correlation with chlorophyll content during submergence. At 14 days after submergence, the water in the tank was lowered to a 4-cm depth. Although Fv/Fm of the newly developed leaves during submergence in submerged IR 67520 increased substantially from 2 days post-submergence, IR72442's decreased because of leaf chlorosis and all plants eventually died. Therefore, it can be inferred that the tolerance cultivar coped with submergence by inhibiting photodamage and maintaining high chlorophyll content in the leaves.

The chlorophyll fluorescence meter with a waterproof probe can be utilized for the measurement of photochemistry reactions in rice leaves under floodwater. In our method, Fv/Fm can be measured in less than one minute per plant in air and underwater, with the results expected to become valuable screening tools for research and breeding programs for the improvement of submergence resistance in rice.

Naoya Fujimoto
Rural Development Division

Collaborative Research Towards Increasing the Productivity of Yam, a Traditional Food Crop in West Africa

Agricultural development in Africa and locally important crops

Agricultural investments and international agricultural research in Africa focused mostly on the development of major cereals and crops for export. Recently, however, there has been growing recognition that agricultural diversification and innovation should be defined and suited for each location in order to increase productivity and profitability, achieve sustainable food security, and overcome poverty and malnutrition.

Farm households in many African countries subsist on so-called "orphan (or minor) crops," which are regionally or locally important crops traditionally cultivated for nutrition and income. These crops are often under-researched despite their potential to alleviate widespread poverty and hunger; they are nutritious, culturally valuable, adaptable to harsh environments, and help promote diversified regional agriculture systems. Further development and utilization of these regionally important crops is therefore crucial for improving food security and livelihoods in Africa.

Yam, a traditional food crop in West Africa

Root and tuber crops play important roles in African diet. It is reported that average annual consumptions of cereals and roots/tuber crops in Sub-Saharan Africa are 123 and 194 kg/person, respectively, while average world annual consumptions are 171 kg/person for cereals and 69 kg/person for roots and tuber crops. Major root and tuber crops in West Africa include cassava, yam, sweet potato and taro. Among these crops, yam, being West Africa's traditional staple crop, plays a central role in the food culture.

Yam is a multi-species tuber crop that is widely cultivated throughout the humid and sub-humid tropics in Africa, Caribbean and the South Pacific Islands. Global production is estimated to be 50 million metric tonnes annually, 93% of which is produced in West Africa. Yam plays key roles in regional food security and income generation, and is a traditionally important staple crop especially in Benin, Cote d'Ivoire, Ghana, Nigeria and Togo.

JIRCAS collaborative research for promoting genetic improvement of yam

Due to consumer preference for yam over other roots and tubers in the region, greater demand can be expected with increasing populations. However, in the last few decades, farm yields have declined due to low soil fertility, increased pest problems, and the slow pace of getting new technologies to farmers. JIRCAS has recognized the urgent need to invest more in yam, an orphan crop that has suffered from research neglect.

To encourage crop productivity and to enhance income generation of small-scale yam farmers, research-for-development should focus on increasing productivity through adoption of improved production technologies and by providing farmers with improved varieties to meet regional needs.

JIRCAS, together with several Japanese research institutions, has initiated a collaborative research project to promote yam germplasm utilization and genetic improvement for West Africa with the International Institute of Tropical Agriculture (IITA). The project aims to 1) develop and utilize genomic information and molecular techniques to facilitate genetic improvement, 2) improve analysis of the crop biodiversity and identify potentially useful germplasm for yam breeding, and 3) develop efficient protocols to evaluate important agronomic traits for yam breeding.

The outputs of this collaborative research are expected to contribute to the harnessing of yam breeding technologies and the utilization of useful germplasm. Consequently, the development of new yam varieties with increased productivity will provide better food security for the people of West Africa.

Hiroko Takagi
Tropical Agriculture Research Front

Photo 1. Yam field (Nigeria)

Photo 2. Yam market (Ghana)

Photo 3. Yam market (Nigeria)

Improving the Livelihoods of Farmers in Dry Regions of Africa via Development of High-Value Cowpea Varieties

Hidden hunger in Africa

Malnutrition arising from food shortages caused by frequent droughts in Africa has been reported by various media outlets. However, "acute malnutrition" induced by food shortages only covers one third of people categorized as "malnourished" in Africa. The fact is that more Africans suffer from "chronic malnutrition" caused by deficiency in protein and essential minerals over a long period of time. Whereas acute malnutrition leads to wasting or thinness, chronic malnutrition or "hidden hunger" leads to stunting or shortness.

Chronic malnutrition affects 42-50% of Niger Republic's population, according to the 2012 SMART nutrition surveys. This fact indicates that the problem in the regions cannot be solved by food aid within a short period; it can be overcome only by reduction of regional poverty through enhanced income of poor farmers and improved food quality and nutrition.

Realizing this challenge, JIRCAS turned its sights on cowpea (*Vigna unguiculata*), a food legume crop that possesses outstanding tolerance to drought and low soil fertility in the savanna regions of Africa.

Role of cowpea in the regions

Cowpea is an important cash crop for the regions' small-scale farmers, who have limited options for income generation; it generated an estimated 2 billion USD in annual revenue, according to FAO (2007-2009 data). Cowpea also serves as a readily available and cheap protein source for the poor, and its high-protein content helps fulfill the nutritional and dietary requirements of people in the regions.

Our survey results indicate that consumers in the regions can utilize the diverse quality characteristics of cowpea well by selecting cowpea varieties that suit different types of food dishes for their consumption.

Development of value-added cowpea

To sufficiently understand the level of consumer preferences and genetic diversity necessary for the development of new value-added cowpea varieties, JIRCAS started a joint activity with the International Institute of Tropical Agriculture (IITA) to 1) identify consumers' preferences and cowpea characteristics that can be used for value addition, 2) select appropriate parental lines with useful characteristics for further breeding, 3) evaluate environmental factors affecting grain quality and its nutritional values, and 4) develop useful tools for quicker and easier quality evaluations. Results from this joint collaboration will offer more insights/information that will advance "value addition" into cowpea breeding programs in West African countries.

The knowledge gained from this work/collaboration will also boost the development of improved cowpea varieties that meet local preferences and utilization. Developed value-added cowpea will help promote rural livelihood improvement through enhanced income generation, while cowpea consumption will contribute to solving the problem on chronic malnutrition, especially among poor farm households in the regions.

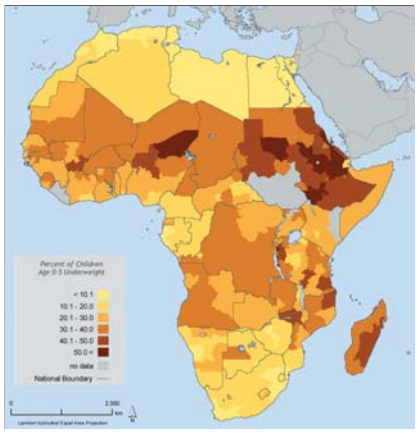

Figure 1. Child malnutrition levels in Africa. Darker shades indicate higher percentage of underweight children aged 0-5 years. (Source: http://sedac.ciesin.columbia.edu/data/collection/povmap)

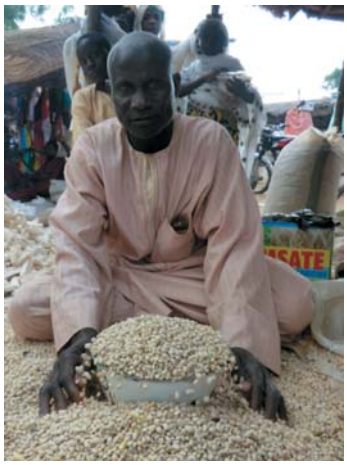

Figure 2. A farmer sells his harvested cowpea at the local market. (Kano, Nigeria)

Satoru Muranaka
Tropical Agriculture Research Front

Development of a Conservation Agriculture-based Cropping System in West Africa

Rainfed upland cropping is a major agricultural production system widely practiced by farmers around the world. However, crop yield varies according to rainfall; therefore, cropping techniques that can overcome unstable rainfall conditions are highly necessary. In view of the situation, the Food and Agriculture Organization of the United Nations (FAO) and several other international agricultural research organizations strive to promote conservation agriculture (CA) in developing countries.

According to FAO, CA is a concept for achieving sustainable and profitable agriculture through efficient use of rainfall and soil conservation. It has three key principles: 1) cropping under non-till or minimum tillage to achieve minimum soil disturbance, 2) mulching the soil surface with crop residue or organic materials, and 3) diversifying cropping pattern by intercropping, crop rotation, or relay cropping.

JIRCAS has launched a project that will pursue the development and evaluation of CA-based cropping systems in the savannas of West Africa. However, instead of introducing a new cropping system, we will integrate several CA techniques with existing cropping systems towards realization of soil conservation and increased agricultural productivity.

We have investigated the cropping systems of eight different regions from Burkina Faso to Ghana (annual rainfall: 600 to 1500 mm). The results revealed that each region has its own specific limiting factor preventing the introduction of CA-based cropping systems.

Farmers cultivate crops and raise livestock, with crop residues used mostly for livestock feed, especially in regions where annual rainfall is less than 1000 mm. Therefore, we need to integrate crop production with animal husbandry. Even though the residues are left on the farms, they are consumed by animals during dry season in many regions. To overcome this problem, we are investigating the possibility of enclosing the farms with live fences; we are also considering reaching agreements with the communities to conserve crop residues in the farms.

We are concurrently conducting several experiments on six sites. We have installed runoff plots in three of the six sites to monitor soil erosion, water runoff, and soil moisture under different treatments. Based on the results of investigations and experiments, we will promote an improved cropping system to the farmers, examine the factors that influence adoption by the farmers, and evaluate the effect of the improved system adoption on farmers' economy. In addition, we will conduct zoning of possible CA-based cropping systems for both Ghana and Burkina Faso using remotely sensed data and by geographic information system analysis. Furthermore, we will try to simulate the effect of CA promotion on national agricultural production and economy.

Despite our initial struggles, we will proceed and work hard so that we can propose and establish an improved cropping system that will be welcomed by farmers.

Fujio Nagumo
Crop, Livestock and Environment Division

Photo 1. Cropping survey in the village

Photo 2. Experimental plots for monitoring soil erosion and water runoff

Construction of Commercial Agricultural Systems in the Tropical Savanna of Southern Africa

The Nacala Corridor refers to a road across northern Mozambique, from the Nacala port facing the Indian Ocean in the east, passing through Nampula Province and further to its western border. This corridor is a key distribution route for goods coming from and going to southern African inland countries like Malawi and Zambia.

Along the Nacala Corridor, the vastly spreading tropical savannas exhibit relatively high agricultural potential. Though the agricultural environments and socio-economic conditions are varied, increased agricultural productivity and expansion of agricultural land areas in the surrounding areas of Nacala Corridor are expected through introduction of appropriate agricultural technologies and infusion of capital investments. With the active participation of small-scale farmers, Mozambique expects the agricultural sector to improve and achieve economic development. Moreover, introduction of cash crops will increase export earnings from agricultural products and expand the acquisition of foreign currency for Mozambique.

The Cerrado, a tropical ecosystem of Brazil characterized by shrubby vegetation and a sterile substrate, used to be an unproductive area for agriculture. However, a Japan-Brazil agricultural development program implemented in the 1970s has since converted the Cerrado into one of the world's most enormous food baskets. Drawing inspiration from the Japan-Brazil partnership, a similar concept, called the triangular ProSAVANA-JBM (Japan-Brazil-Mozambique) Agricultural Development Program in Southern Africa, was launched in 2011. It targeted the Nacala Corridor area of Mozambique between 13° to 17° south latitude, same as the Cerrado of Brazil. The first phase of the ProSAVANA program aims to strengthen the research capacity of the Mozambique Agricultural Research Institute (IIAM) and its staff to promote agricultural development and adopt new technologies. JIRCAS, as one of the consultants appointed by JICA, participates in the first phase of the ProSAVANA program by dispatching expert scientists to facilitate the implementation of the collaborative research in coordination with Brazilian experts from the Brazilian Agricultural Research Corporation (Embrapa).

The first stage of the project involves improving the research capacity of IIAM through the introduction of necessary techniques for agricultural research, e.g., measuring climate and soil properties, implementing surveys on socio-economic conditions of farmers and villages, planning and management of field experiments in regional centers and branches of IIAM, and estimating crop growth and yield, among others.

Because of the highly diversified agricultural environment of the Nacala Corridor area, it is necessary to select cropping systems and agricultural technologies suitable for the region. A "Decision Support Model" for agricultural development will be used as a tool for farmers and extension workers to know the best options. Multi-location field trials are being conducted on staple food crops (maize and cassava) in combination with cash crops/ value-added products (soybean) under different environmental conditions. The effects of environmental resources (light, water, nitrogen, etc.) and agricultural technologies on dry matter production and yield are being investigated.

Preliminary results have shown that late-maturity soybean intercropped with maize (**Photo 1**) would give the most effective use of land area on a yield basis. These agronomic data will be combined with socio-economic data to construct the "Decision Support Model," which will provide the best-suited and most sustainable cropping system and agricultural technologies for each region. This model will be put into practice in pilot demonstration farms. Agricultural technologies will be applied and IIAM's research capacity will be enhanced through technology transfer.

Photo 1. Multi-location field trial plot with intercropped maize and soybean. (Photo taken at the IIAM Mutequlese station in the northernmost part of Zambezia Province, Mozambique)

Photo 2. Analysis of canopy structure using digital photography. (Photo taken at the IIAM Mutuali station, westernmost part of Nampula Province, Mozambique)

Satoshi Tobita
Crop, Livestock and Environment Division

Establishment of a Rural Society with Low Emission in Ethiopia

Tigray Region in the northern part of Ethiopia has been frequently plagued by droughts, exposing people to threats of starvation.

The Tigray people cultivate wheat, teff (a food grain native to the Ethiopian highlands) and legumes in steep, mountainous lands during the rainy season from June to September. They also grow grains and beans somewhere during a light rainy period from March to May, supplemented by limited irrigation water. Rainfall intensities are strong, though the average annual precipitation (less than 700mm/year) is low and erratic overall. This unstable rainfall condition causes soil erosion and degradation, leaving the region highly vulnerable to climate change.

JIRCAS has undertaken a research project in Tigray Region to establish a technology platform to recover and enhance natural resources (land, water, soil and vegetation) in rural areas, and promote sequestration of greenhouse gases (GHGs), particularly carbon dioxide, within trees and soil. These goals will be achieved by disseminating technologies through a Clean Development Mechanism (CDM) project that contributes to the stability of agricultural and livestock production.

The target technologies for development and dissemination are 1) agro-forestry, an integrated practice that combines agriculture and forestry, 2) reforestation, 3) improved soil fertility management practices, including soil and water conservation, and 4) formulation of CDM project methodology and establishment of an MRV (monitoring, reporting and verification) system for carbon sequestration.

Agro-forestry and soil fertility improvements will be applied on farmer-owned lands, while agro-forestry and reforestation will be employed on inefficient or "useless" communal lands. With the help of improved technology, the increased quantity of carbon held in soil and vegetation (estimated as the difference in carbon stock between baseline and ex-post monitoring result) will be converted to carbon credit if a CDM project is developed, and the revenue from carbon credits sold will be brought back to the community.

A low-income village with an area of 4,000 ha and population of 6,000 has been selected for the study. Various surveys have been conducted, covering 400 farm households and 1,400 ha of communal lands as well as 44 sampling points for quarterly soil carbon analysis. Workshops were performed on all communities belonging to the village to solicit participants' ideas and opinions for making plans for the use of communal lands.

Soil and water conservation studies were conducted in four select watersheds in advanced districts. Moreover, a 1.6-ha demonstration farm has been established on a communal land. It was subdivided into three experimental plots, namely, soil fertility improvement, agro-forestry, and reforestation. Initial experimental activities and technology demonstrations have since been carried out.

As of this moment, household surveys, sample data collection and early experiments have shown that 1) there is a large seasonal variation in soil carbon accumulations, 2) landholdings average 0.5 ha per farm household, 3) agro-forestry is not practiced, 4) there is potential in using green manure (leguminous cover crops) as a method for improving soil fertility, 5) *Eucalyptus globules* and *Cordia africana* are desirable tree species, 6) the number of livestock is large compared to grazing lands, and 7) collaborative work exists within the community.

Restoration and growth of local resources will be achieved through land use changes in accordance with the CDM project methodology, as shown in **Figure 1**. A rural development model that enables the reduction of GHG emission and sequestration of carbon will be formulated for Tigray Region in Ethiopia. This ongoing project will be realized by promoting activities in the demonstration farm, by disseminating appropriate technologies, and by developing a forest type CDM project.

Eiji Matsubara
Rural Development Division

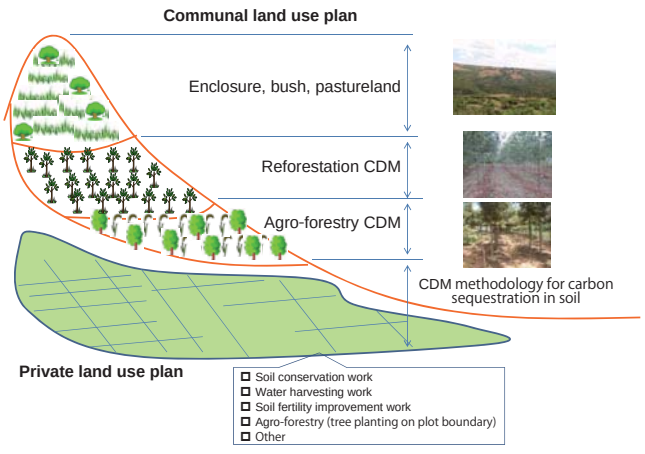

Figure 1. Land use changes and CDM project activities at the project site

Figure 2. Preparation of tree planting pits at the agro-forestry demonstration plot

JIRCAS TODAY

○2012 Japan International Award for Young Agricultural Researchers

The commendation ceremony of the 2012 Japan International Award for Young Agricultural Researchers was held at Tsukuba International Congress Center Epochal, Tsukuba City, Japan on November 28. The ceremony was attended by many participants, including members of the selection committee.

Awardees, members of the selection committee and other officials

2012 commendation ceremony awardees and participants

This is the sixth time that the award was presented by the chairman of the Agriculture, Forestry and Fisheries Research Council to young foreign researchers with outstanding achievements to promote research and development of agricultural, forestry, fishery and other related industries in developing regions. This year's recipients of the award and their research achievements are as follows.

Dr. Sudisha Jogaiah

Nationality: Republic of India

Institute: University of Mysore

Research achievement: Antimildew compounds from wood rot fungi and sequence characterized amplified region markers associated with downy mildew disease resistance in pearl millet

Ms. Kanokwan Srirattana

Nationality: Kingdom of Thailand

Institute: Suranaree University of Technology

Research achievement: Improvement of reproductive biotechnology techniques for livestock and endangered species

Dr. Lijun Yin

Nationality: People's Republic of China

Institute: China Agricultural University

Research achievement: Development of technology for quality and functionality improvement of traditional foods, and application of novel emulsifying technology for new processing system

○JIRCAS International Symposium 2012

The 2012 JIRCAS International Symposium was held at the Tsukuba International Congress Center (Epochal), Tsukuba City, Japan on November 28-29 with the theme, "Resilient Food Production Systems: The Role of Agricultural Technology Development in Developing Regions." It was attended by 152 guests and participants, and was organized by JIRCAS under the auspices of the Agriculture, Forestry and Fisheries Research Council (AFFRC) Secretariat of the Ministry of Agriculture, Forestry and Fisheries (MAFF), National Agriculture and Food Research Organization (NARO), Japan International Cooperation Agency (JICA), International Food Policy Research Institute (IFPRI), Food and Agriculture Organization (FAO) of the United Nations - Japan Office, and Japan Forum on International Agricultural Research for Sustainable Development (J-FARD).

2012 JIRCAS International Symposium Opening Session

Dr. Masa Iwanaga, President of JIRCAS, opened the symposium. He stated the background and objectives, briefly discussed the symposium's theme, and gave remarks on the future direction of resilient food production systems.

Mr. Masamichi Saigo, Research Councilor of the AFFRC Secretariat, MAFF, welcomed the participants. He named population growth and crop failure due to global warming as contributors to food insecurity and emphasized the significance of exchanging information on the topic of resilience.

Two keynote speeches were delivered: Dr. Shenggen Fan of the International Food Policy Research Institute (IFPRI) presented "Building Resilient Food Systems: Policies and Technologies," while Prof. Chieko Umetsu of Nagasaki University discussed "Resilience of Social-Ecological Systems for Food Security."

Four thematic sessions followed wherein researchers and experts from various organizations shared their experiences and opinions on resilient food production systems:

In Session 1 (Resilience in the Livestock Sector), resilience to livestock damage due to cold and snow disasters (*Dzud*) in northeast Asia and droughts in the Horn of Africa were discussed. Measures to protect pastoralists from livestock losses were also presented.

In Session 2 (Resilience in Upland Crop Production), speakers and participants reported on and discussed conservation agriculture in Africa and China. The extent and countermeasures to drought and salt damage in Uzbekistan were also explained.

In Session 3 (Resilience in Paddy Rice Production), the following topics were discussed: "The impact of cyclone 'Aila' on the livelihood of the coastal people of Bangladesh," "Weather Index Insurance for Agriculture (WIIA) in Thailand," and "Adaptation and coexistence in high-flood rice area in the Mekong Delta."

In Session 4 (Risk Recognition and Monitoring System), the presentations focused on the Mauritanian experience on desert locust pest control, migration prediction and insecticide resistance monitoring for rice planthoppers, and the development of an early-warning system against cool-weather damage in rice production.

During panel discussion, titled "Role of Technological Development and Japan's Contribution," the four panelists expressed their ideas and gave comments from the standpoint of soil, weather, farm management, and biodiversity.

The discussion was concluded by acknowledging the need of dynamic diversity which considers profitability, and that the symposium would have served its purpose if it contributes to further deepen agricultural research on issues related to resilience.

JIRCAS International Symposium participants

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