

Advancement of Tropical Crop Genetic Resources Utilization through the Development of Database, Technologies and Research Networking

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Dr. Shinsuke Yamanaka is the Director of Tropical Agriculture Research Front (TARF) and the Project Leader of the “Tropical crop genetic resources: Advancement of tropical crop genetic resources utilization through the development of database, technologies, and research networking” project at JIRCAS. He graduated from the Department of Applied Physics, Faculty of Science and Engineering, Waseda University. He changed research fields and graduated from the United Graduate School of Agricultural Science, Gifu University with a Ph.D. After working as a postdoctoral fellow at the University of Tsukuba and the National Institute of Agrobiological Sciences (NIAS) Genebank, he joined JIRCAS-TARF as a senior researcher in 2008. His area of expertise is plant genetic resources, an area he has been studying continuously since graduate school. He is currently conducting research on the diversity and utilization of tropical crop genetic resources, including tropical fruits.

Abstracts

JIRCAS maintains diverse genetic resources of sugarcane, indica rice, tropical fruit trees, and *Urochloa* (tropical grass) at the Tropical Agriculture Research Front (TARF) in Ishigaki Island, Okinawa Prefecture. These tropical crops play an important role as sources of food, energy (biofuel), calories, nutrients, cash crops, and fodder in production areas. Amid concerns about global climate change, the sustainable and stable production of these crops is an urgent issue. The introduction of tropical crops and their cultivation and dissemination technologies is expected to be one of the measures to combat global warming in Japan, and will contribute to the expansion of production areas and diversification of food and nutrient sources.

TARF has climatic and geographical conditions similar to those of the experimental fields used in JIRCAS's overseas research. The research environment is suitable for conducting detailed basic experiments, along with demonstration research in tropical crop growing environments, which can contribute to close cooperative partnerships with developing regions and to agriculture in the Southwest (Nansei) Islands of Japan.

The ongoing JIRCAS project “Advancement of tropical crop genetic resources utilization through the development of database, technologies and research networking” (Tropical crop genetic resources project) based at TARF aims to create a shared resource of information, technology, and materials, and contribute to the promotion of sustainable production under unstable environmental conditions, as well as their production and utilization in Japan. This will be achieved through research networking on tropical crop genetic resources to address issues with overseas and domestic organizations, as well as through the development of varieties and technologies that take advantage of this diversity.

In this project, we have developed strategic genetic resource information^[1-2], breeding technologies^[3], varieties and materials, and cultivation and dissemination technologies^[4], taking advantage of the diverse and abundant genetic resources maintained at TARF and the geographical location of the facility, based on international and domestic issues and needs that must be addressed. Through the sharing of information, materials, and technologies, we aim to strengthen collaborations with domestic and overseas research institutions for the advancement of tropical crop genetic resource utilization.

[1] JIRCAS Mango Genetic Resources Site:

<https://www.jircas.go.jp/en/database/mango/mango-top>

[2] JIRCAS-*Erianthus* Database:

<https://www.jircas.go.jp/en/database/erianthus>

[3] JIRCAS Research Highlights (2023):

https://www.jircas.go.jp/en/publication/research_results/2023_c02

[4] JIRCAS Research Highlights (2021):


https://www.jircas.go.jp/en/publication/research_results/2021_c02

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Tropical Agriculture Research Front (TARF),
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Japan International Research Center for Agricultural Sciences

JIRCAS Headquarters (Tsukuba, Ibaraki)



TARF (Ishigaki, Okinawa)



● 1,952 km to Tokyo, 411 km to Naha
● 277 km to Taipei
● 1057 km to Manila
● 1604 km to Hanoi
● 2741 km to Bangkok
● Average Temperature: 24.3°C
● Annual Rainfall: 2107 mm

Main entrance Main building

Location of JIRCAS

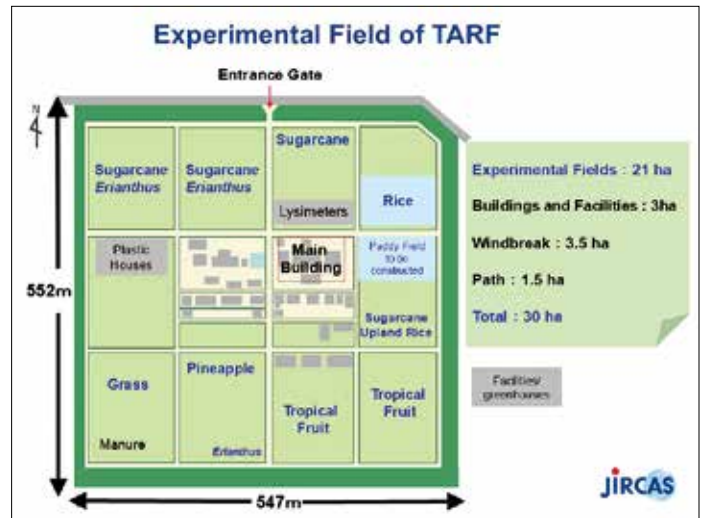


★ JIRCAS-HQ (Tsukuba)

★ JIRCAS-TARF (Ishigaki)

JIRCAS conducts research activities in main research campus with HQ office in Tsukuba and at the branch station, Tropical Agriculture Research Front (TARF) in the Ishigaki Island, Okinawa.

Experimental Field of TARF



Entrance Gate

552m

547m

Experimental Fields : 21 ha
Buildings and Facilities : 3ha
Windbreak : 3.5 ha
Path : 1.5 ha
Total : 30 ha

Facilities: greenhouses

JIRCAS

Facilities at TARF



- Greenhouses
 - Greenhouses for sugarcane view
 - For tropical fruits
 - For sugarcane
 - Contained greenhouse
- Open Laboratory
 - Outdoor lysimeter (standard)
 - Artificial lysimeter
 - Outdoor lysimeter
 - Indoor lysimeter
- Experimental Fields
 - Upland fields
 - Paddy fields

Research Contribution in TARF

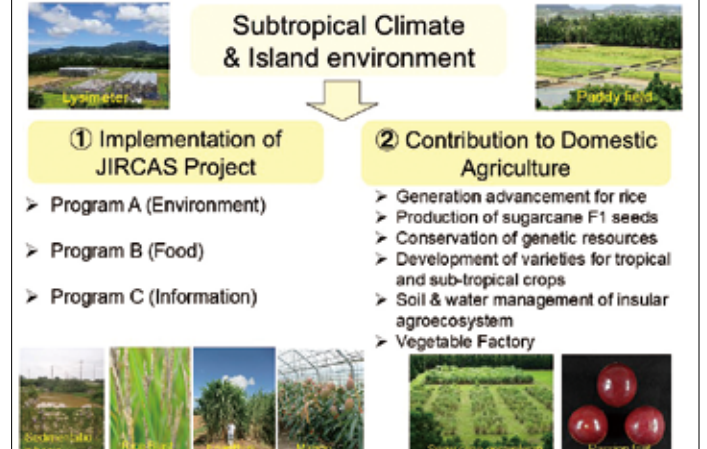
Subtropical Climate & Island environment

① Implementation of JIRCAS Project

- Program A (Environment)
- Program B (Food)
- Program C (Information)

② Contribution to Domestic Agriculture

- Generation advancement for rice
- Production of sugarcane F1 seeds
- Conservation of genetic resources
- Development of varieties for tropical and sub-tropical crops
- Soil & water management of insular agroecosystem
- Vegetable Factory



Advancement of tropical crop genetic resources utilization through the development of database, technologies and research networking (Tropical crop genetic resources)

Background of the project

JIRCAS maintains diverse genetic resources of sugarcane, rice, citrus, banana, and other tropical crops of the tropical agriculture research zone (TAR) in Kirishita Island, a subtropical island. These tropical crops play important roles in food, energy production, and natural resources, such as fuel, and have in the production area potential to develop eco-friendliness. Many countries around the globe demand sugarcane, sustainable and stable production of these crops is an urgent issue.

Also, the introduction of tropical crops, and their cultivation and dissemination technologies is expected to be one of the mainstays to create global centers in Asia and Oceania in the expansion of production area and dissemination of food and nutrition security.

Research objectives of the project

TARF is a division of JIRCAS in Kirishita City with research focus on Kirishita Island, a subtropical island in Okinawa Prefecture. The site has unique climatic and geographical conditions similar to those of the tropics. Research conducted by JIRCAS focuses on the research advancement in terms of conducting detailed basic experiments, along with demonstration research in tropical crop growing environments, which can contribute to other cooperative partnerships with developing regions and to agriculture in the southeast islands in Japan.

Research themes of the project

In this project, we will develop strategic genetic resource utilization, breeding technologies, genetic and materials, and database and dissemination technologies, taking advantage of the diverse and abundant genetic resources, morphology and geographical location at TARF, based on the scientific and technical methods to be advanced through the sharing of information, materials and technologies. We aim to strengthen collaborations with domestic and overseas research institutions for the advancement of tropical crop genetic resource utilization.

Research Themes

1. Information and networking of genetic resources
2. Evaluation of genetic resources and development tools
3. Utilization of genetic resources for new breeding materials and cultivation technologies
4. Domestic research collaboration through utilization of genetic resources

Assessment of utilization of genetic resources

JIRCAS

Background of the project

Tropical Crop Genetic Resources at JIRCAS

Sugarcane Indica rice Tropical Fruits Urochloa

Genetic Resource Utilization Technology

Hybridization Evaluation of useful genes Cultivation Utilization and dissemination

Crossing Control of flowering Genetic recombination Stable flowering Virus-free culture

JIRCAS

Background of the project

Supporting the mission of JIRCAS in tropical crop genetic resources research

JIRCAS Mission

Solving global issues

Lead in the world's research and development

International + domestic contribution Network / Cooperation

Research on Genetic Resources at TARF-JIRCAS

Development of technologies and materials

Environment, genetic resources, fields - facilities

Overseas and domestic hubs

JIRCAS

Objective of the project

Sharing of issues to be solved with domestic and international organizations

Develop varieties and technologies that take advantage of diversity

Research Networking

Sharing information, technology, and materials

Sustainable production under unstable environmental conditions

Promotion of domestic production and utilization

Hub for genetic resources research (center function)

JIRCAS

Research themes of the project

[Research Themes]

1. Information and networking of genetic resources
 - Diversity information for advanced utilization of genetic resources
 - Sharing information, technologies and materials by research networking
2. Evaluation of genetic resources and development tools
 - Evaluation of agronomic traits and environmental stress tolerance
 - Development of evaluation methodologies and tools
 - Genetic analysis and functional analysis of genes for important traits
3. Utilization of genetic resources for new breeding materials and cultivation technologies
 - Development of new varieties for unstable environments
 - Development of cultural practice techniques based on variety and environment
4. Domestic research collaboration through utilization of genetic resources
 - Development of materials and technologies for domestic needs (variety diversification, stable production)
 - Cooperation for measures of global farming and breeding program in Japan
 - External cooperation through providing materials and technologies

JIRCAS

Outline of the activities

Advancement of utilization of tropical crop genetic resources

Strengthening of genetic resource utilization


- Accumulation and integration of information
- Evaluation and utilization technology development
- Development of materials and cultivation technology

Advancement of genetic resource utilization through external collaboration


- Sharing of information, technology, and materials through research networking
- Domestic contribution through the use of genetic resources

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Background: global climate change



High temperature at flowering time (rice) Drought Unseasonable weather at heading period (rice)




Miyako Is., Okinawa


Annual rainfall (mm) Phenology Number (°Cd)

Warming temperature affects flower initiation and production (mango)

Varieties and/or cultivation methods for mitigation of effects by climate change




Background: adverse agricultural environment

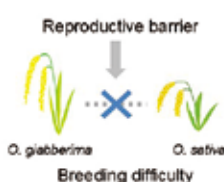


Salinity Acidic soil Sugarcane White Leaf Disease

Tolerance for biotic and abiotic stress conditions
Environmentally harmonized cultivation




Background: underutilized genetic resources




Reproductive barrier

O. glaberrima *O. sativa*

Breeding difficulty



Native (local) varieties




Related species Wild relatives

Underutilized

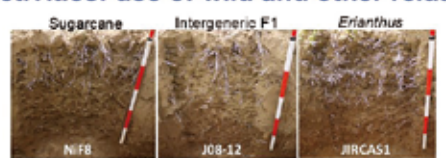
Narrow genetic background of existing varieties

Broaden genetic basis of breeding materials

Revisit the genetic resources underutilized (native, related, wild)



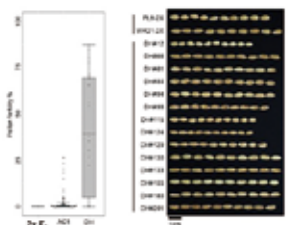
Activities: use of wild and other relatives



Sugarcane Intergenic F1 *Erianthus*

NiFB J08-12 JIRCAS1

Improvement of root systems of sugarcane using *Erianthus* genetic resources (Terajima et al. 2024)




Root length (cm)

Za F1 A04 Dh1

Development of hybrid breeding technology for use of related species (*O. glaberrima* and *O. sativa*)

DH lines showed sufficient pollen fertility and obtained seeds (Kuriyoshi et al. 2024)



Activities: new varieties, on-site trials



KK4 KK3 existing variety

Sugarcane variety KK4 has been adopted as recommended variety in Thailand (2023)




Urochloa variety Isan has been registered in Thailand (2024)



On-site trial of rice breeding materials in Indonesia (evaluation of 'Ciharang' based lines improved for AWD)



Activities: From genetic resources to information resources




Databases of *Erianthus* and Mango genetic resources (2023)

<https://www.jircas.go.jp/en/database/erianthus>

<https://www.jircas.go.jp/en/database/mango/mango-top>

Sugarcane wild relatives and tropical rice will be published (FY2024 and 2025, respectively)



Activities: research networking



Thailand (DOA) **Philippines (SRA)**

JIRCAS
Germpiasm utilization
Linking the exchange information, technology, and

FIJI (SRFI?) **Indonesia (BRIN)**

Sugarcane research network for genetic resource utilization in APO

Tropical fruit consortium organized by FFTC
Core members: Indonesia, Japan, Korea, Malaysia, New Zealand, Philippines, Thailand, Taiwan





Network to share the information and materials on rice research in the project



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Activities: Contribution and collaboration for domestic

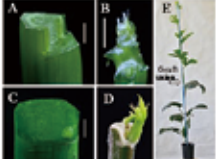



Materials


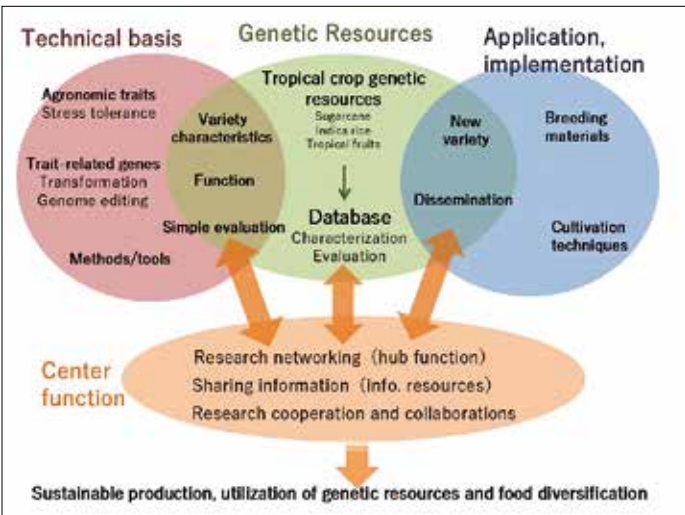
Crossing facility

Cooperation with NARO and Okinawa Pref. for National breeding program of sugarcane

Transformation and genome editing technology to collaborate with other projects



Simple method for virus-free seedlings of passion fruit for SE Japan

Acknowledgements



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Thank you for your attention



www.jircas.go.jp