Research activities

Tropical Bioresources Lab.

International Sago Palm Project for food security improvement

Agricultural food production must increase by 70% globally to feed the world's population that is projected to reach 9 billion by 2050. Faced with increasingly serious challenges to food security, including climate change and diminishing underground resources such as oil and phosphorus, it is more important than ever to improve agricultural production and productivity in a sustainable manner while minimizing post-harvest biomass losses. Our research group is focusing on sago palms that grow naturally in the Southeast Asian and South Pacific regions.

This palm adapts well to infertile, acid soils or brackish-water regions that are generally unsuited for crop cultivation. Additionally, it can store about 300 kg of starch in its trunk. Sago is a staple food for local residents, and is also used in food products like biscuits and noodles. In Japan, sago starch is used for dusting when making udon, as an ingredient in allergen-free or hypoallergenic foods, and as a substance capable of suppressing post-meal glucose spikes. With only 10% of wild and semi-cultivated sago palm stands currently harvested, there is significant potential for further exploitation of this economically valuable plant.

Our laboratory is committed to developing stable cultivation techniques for sago palm by elucidating the mechanisms underlying its environmental stress tolerance, enabling efficient seedling production, and utilizing useful microorganisms such as nitrogen-fixing fungi and mycorrhizal fungi.

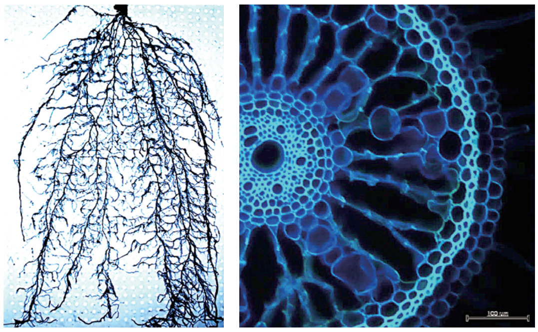
(Hiroshi EHAHRA)

Survey conducted at the Sago Palm Pilot Farm located in Southeast Sulawesi, Indonesia.

Evaluation of root adaption to soil environments with water and nutrient stress in rice

To establish stable and sustainable crop production under unfavorable soil environments is an important issue. As a trait related to crop stress tolerance, in recent years attention has been focused on root traits, which have been retrenched requiring a great deal of time and effort. The root system architecture and anatomy change in response to changing soil environments. We are undertaking research on root system structure and its physiological function for adaption to soil environmental stress such as drought and nitrogen deficiency, mainly focusing on rice. We are also investigating the methods for evaluating root traits from hydroponic conditions to soil culture conditions using root box and tubes.

(Mana KANO-NAKATA)

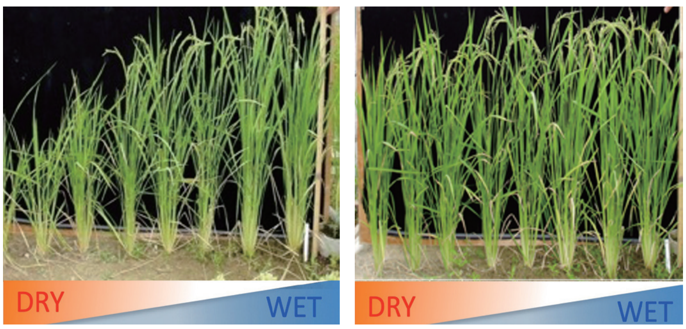


Overall view of the rice plant's root structure (left) and microscopic view of the transverse section of a rice plant's root.

Genetic Information for Bioresources Lab.

Elucidating the environmental stress avoidance mechanism in plants

Under drought stress conditions, plants expand their root zones to increase water absorption in an attempt to maintain their above-ground growth. However, the capability to maintain the above-ground growth in drought conditions varies significantly across different plant varieties. For example, some rice varieties experience significantly compromised growth, while others maintain relatively better growth of their above-ground parts, as shown in the photographs to the right. We have initiated research to elucidate the genetic mechanisms underlying the variation in drought avoidance capabilities among different rice varieties and are, albeit gradually, beginning to discover some of the loci that may be key to developing drought-resistant varieties.



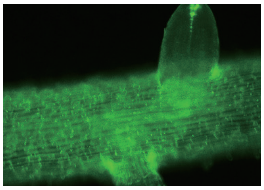
Differing drought avoidance capabilities observed in different rice varieties.
(Left) Variety with lower drought avoidance capability,
(Right) Variety with higher drought avoidance capability.

Genetic improvement of rice to secure stable rice production in unfavorable environments.

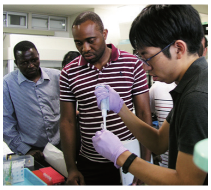
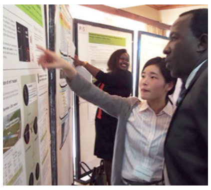
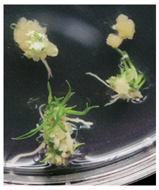
In addition to the conventional cross breeding and mutation breeding technologies, novel breeding techniques, such as quantitative trait locus (QTL) analysis (which identifies QTLs associated with stress tolerance) and marker-assisted selection (MAS) (which can quickly and accurately identify the presence of a specific quantitative trait locus) are now available to breed improved rice varieties with a greater efficiency, thanks to the recent research advancements in the field of agricultural sciences. Novel techniques, such as next generation sequencing (NGS) (which quickly and inexpensively provides genome-wide genetic information on living organisms) and new plant breeding techniques (NBT) (new approach to genome editing) have also been developed. We are using these technologies to achieve genetic improvement of rice with the goal of securing stable rice production in unfavorable environments.

(Yoshiaki INUKAI)






Growth inhibition of rice under unfavorable environments


Research activities for development of new rice varieties with tolerance to environmental stresses

Practical Studies in Africa Lab.

Improvement of rice productivity under environmental stress conditions in Africa

In many sub-Saharan African countries, it is fundamental to boost rice production because the increased rice consumption exceeds the growth in domestic rice production. However, rice yields in sub-Saharan Africa have remained low due to various biotic and abiotic stresses. The Laboratory of Practical Studies in Africa is making comprehensive efforts to increase and stabilize rice yield under such unfavorable environments. Our research activities include development of new varieties suitable for the local environments, evaluation of gene-expression and local adaptability of rice varieties carrying useful genes/QTL, development of cultivation technologies to maximize the potential of rice varieties, elucidation of socio-economic conditions for technology dissemination.
https://rice-africa.agr.nagoya-u.ac.jp/

Cold weather damage onrice panicles (Mwea, Kenya)

Photosynthesis measurement in a paddy field (Mwea, Kenya)

Combatting root-parasitic weed Striga using suicide germination stimulant in Africa

The root-parasitic weed Striga hermonthica has been causing huge problems on cereal production in sub-Saharan Africa. Striga seeds germinate in response to plant hormones called strigolactones released from the roots of host plants, and then infest the host. In the absence of host plants, Striga dies within 4 days after germination. Recently, our collaborators developed a Striga-selective suicide germination stimulant called Sphinolactone-7 (SPL7). It can induce germination of Striga without host plants. The Laboratory of Practical Studies in Africa is working with researchers inside and outside our university to develop a Striga control method using SPL7. Our research activities include verification of the effects of SPL7, evaluation of the genetic diversity of Stiga, and elucidation of socio-economic conditions for technology dissemination.

(Daigo MAKIHARA)

Maize infested with Striga
(a plant with purple flowers) in Kenya