岡山大学
OKAYAMA UNIVERSITY

INSTITUTE OF PLANT SCIENCE AND RESOURCES

OKAYAMA
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GLOBAL GATE FOR LEARNING

GUIDE BOOK 2019

Institute of Plant Science and Resources
Okayama University

Always in Kurashiki: History of IPSR

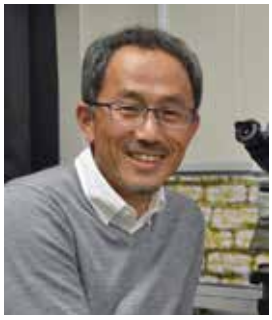
The Institute of Plant Science and Resources (IPSR), the successor to the “Ohara Institute for Agricultural Research”, was established in 1914 by Magosaburo Ohara, the renowned Kurashiki philanthropist. Since its establishment, the institute has remained located in the center of Kurashiki City (Okayama University – Kurashiki Campus), only a short distance on foot from the Ohara Museum of Art and Bikan-chiku (historical quarter) area. After affiliated with Okayama University in 1952, IPSR was reorganized and renamed several times. In spite of changes down through the years, however, the institute has never deviated from its original mission of contributing to basic research in crop science, physiology, pathology, stress responses, and genetics of plants. In April 2010, its last major period of reform, two Research Cores and five Research Units were added, together with the Barley and Wild Plant Resource Center. Three of the units currently specifically examine abiotic, biotic, and soil stress, whereas two units support research on genetic resources and applied genomics. In natural harmony, genetic resources of plants are used to embrace individual groups’ efforts at improvement of plant resilience, sustainable society development, and genomic breeding of future crops. Along with the greenhouse facilities, a 1.5-ha experimental field is attached to the research buildings that host large and diverse arrays of high-tech research equipment. Aside from its research facilities, Kurashiki Campus also accommodates an annex library of the Okayama University and its unique collection of rare books, some of which are from the institute’s founding era (Pfeffer’s collection on plant physiology, and others). As an indispensable affiliate of the Graduate School of Environment and Life Sciences (Plant Stress Science Course), IPSR has already trained numerous young researchers, and annually awards master and doctor degrees to graduate students from all over Japan and overseas.


Experimental field


Graduates


IPSR Branch Library

Message from the Director


Director Wataru Sakamoto

IPSR is one of the 98 research institutions and centers, attached to 30 Japanese National Universities, forming the Council for Research Institutions and Centers. Within this council, IPSR is the only one particularly addressing Plant Science, where it conducts cutting-edge research, and earns its status as a world-leading institution in the Plant Genetic Resources and Stress Science field. Since 2010, IPSR strongly devoted to support of research community in Japan by adopting its role as a national Joint Usage/Research Center. By the end of fiscal year 2018, we had accepted 423 collaborative research programs at IPSR. At present, we aim to extend our collaborations from nationwide to truly international scale, and to contribute to a broad scope of educational and research activities, particularly addressing the support of young researchers and graduate students.

Along with great concerns linked to global warming in the 21st century, we face natural disasters, environmental pollution, and severe shortages of food on a global scale. “Green Revolution” was achieved in the 20th century by the introduction of high-yielding varieties with grain lodging resistance, large-scale irrigation systems, and the use of chemical fertilizers. However, the environmental effects of intensive agriculture have raised severe concerns about sustainability. In the 21st century, implementation of highly productive crops that can grow even at low fertilizer levels, crops with increased photosynthetic efficiency, and crops resistant to temperature fluctuations and so on, are necessary to fuel the next stage of green revolution. To meet these expectations, IPSR’s research goals include improvement of crop resistance to environmental stresses and pests, development of plant-derived chemical compounds for human health, use of bioenergy, and maintenance of biodiversity. Through our research and educational efforts at IPSR, we aim at contributing to sustainable development goals (SDGs) and at future development of human wealth on a global level.

Joint Usage/Research Center Program at IPSR

IPSR is recognized as a Joint Usage/Research Center of "Plant Genetic Resources/Stress Science Research" by the Ministry of Education, Culture, Sports, Science and Technology. Since 2010, we have annually accepted about 50 collaboration projects, supporting them with abundant genetic resources, cultivation facilities, and analytical equipment, all used effectively through joint use and research, and further benefiting from our technical support department, which manages common devices. To date, more than 190 publications have been released through joint research, particularly addressing elucidation of environmental adaptation mechanisms and applications of plant bio-resources. Additionally, we organize an annual symposium on plant science and resources, together with smaller workshops. We share information with the research community via organization of the Plant Stress Science Research Network (PSSnet). Kurashiki Guest House was built to support collaborators who stay on campus, conducting research and scientific discussions, while enjoying the comfort of spacious rooms near Kurashiki historical town.

Guest House


Research Equipment

For more details about our research activities, please visit the IPSR website. ▶▶▶
http://www.rib.okayama-u.ac.jp

Research Core for Plant Stress Science

Atmospheric Stress Unit

Plant Light Acclimation Research Group

Professor Wataru Sakamoto
Associate Professor Ryo Matsushima
Assistant Professor Yusuke Kato

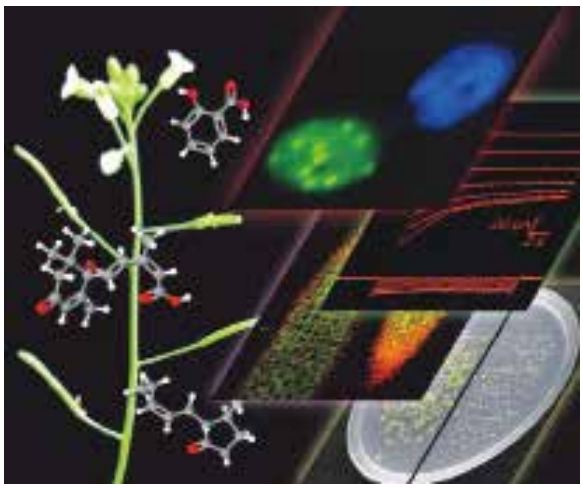
Photosynthesis and chloroplast biogenesis: Understanding to innovation

Our life on earth cannot continue without the atmospheric environment, which is maintained by oxygenic photosynthesis. Plants perform photosynthesis in chloroplasts, where light energy is converted into chemical energy by a series of electrochemical reactions. In contrast, sessile land plants are exposed incessantly to excess light energy or harsh atmospheric environments that engender 'photodamage'. How do plants cope with such photosynthetic inactivation? What are the key elements to maintaining or even maximizing chloroplast functions? Our group studies various aspects of chloroplast development and photosynthesis. Through understanding of the factors involved in photoprotection and chloroplast function, we aim at improving crop productivity against atmospheric stress over the long term.

Atmospheric Stress Unit

Group of Environmental Response Systems

Professor Takashi Hirayama
Associate Professor Izumi Mori
Associate Professor Yoko Ikeda



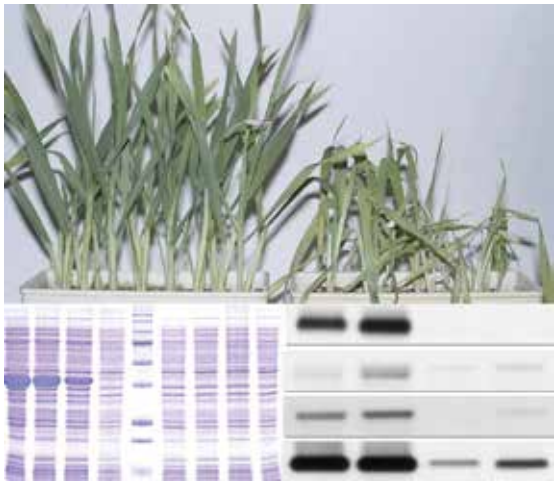
Uncovering secrets of plants: how plants 'know' their surroundings and 'think up' ways to cope with them

Being sessile, plants must adapt to all environmental changes or perish. Plants are already well-known to recognize environmental fluctuations and to respond promptly to such changes. Nevertheless, it remains unclear how plants dissect and integrate environmental signals and make a decision to render an optimal response even with no information-integration systems such as those of our central nervous system. To address this question, our group investigates environmental stress response systems of plants using physiological, molecular biological, and molecular genetic approaches. Among plant stress responses, we emphasize the studies of stress-associated plant hormone signaling and stress-associated chromatin regulation. Our ultimate goal is to take advantage of the research outcomes to create stress-tolerant crops.

Atmospheric Stress Unit

Group of Functional Biomolecular Discovery

Associate Professor Manabu Sugimoto
Assistant Professor Kazuhide Rikiishi



Application of functional biomolecules for developing plants supporting future society

Plants are sensitive to various environmental stimuli. They respond to physical, chemical, and biological stress factors. Consequently, plants can undergo changes in their development, morphology, and physiology during their life cycle. We have used biochemical and molecular biological techniques to elucidate the functions of enzymes, proteins, and gene regulating factors, which are all related to stress tolerance mechanisms of plant cells under environmental stress conditions. Through our research, we aim at developing plants that can adapt well to adverse and extreme environments to resolve difficulties such as food shortages and environmental degradation.

Research Core for Plant Stress Science

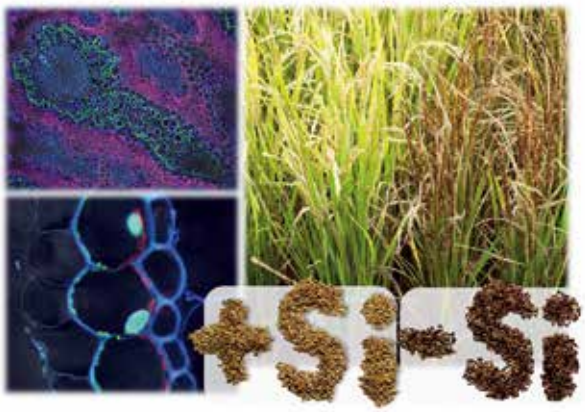
Soil Stress Unit

Group of Plant Stress Physiology

Professor Jian Feng Ma
Associate Professor Naoki Yamaji
Associate Professor Namiki Mitani-Ueno
Assistant Professor Kengo Yokosho

Strategies of plants to overcome mineral stresses

Plants rooting in soil must take up mineral nutrients as well as water for their growth. A deficiency or excess of a mineral element can cause growth inhibition. However, some plant species have developed strategies to overcome mineral stresses. Our group specifically examines the mechanisms of uptake, distribution, and accumulation of mineral elements including essential, beneficial and toxic elements from the intact plant level to the gene level. We aim at making a future contribution to sustainable and safe crop production.



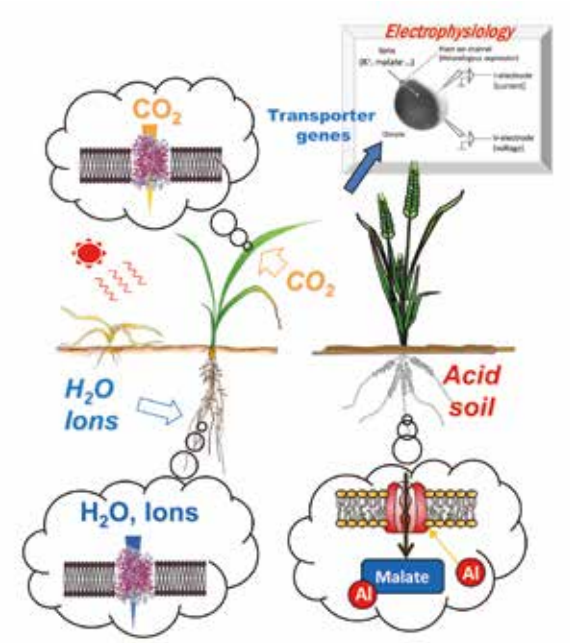
Soil Stress Unit

Group of Plant Molecular Physiology

Professor Maki Katsuhara
Associate Professor Takayuki Sasaki
Assistant Professor Shigeko Utsugi

Mechanisms of water or ion transport under environmental stresses

We have been conducting cellular, membrane-biological, and molecular studies of the responses of plants to soil environmental stresses and plant development. Today, our emphasis is on the function and regulation of aquaporins (water channels) or cation channels in salt/osmotic stress. Furthermore, we have specifically examined aluminum (Al) ion, a major inhibitory factor of plant growth in acidic soils. Moreover, we have been analyzing the mechanisms of Al toxicity and tolerance in plants. We are analyzing a wheat Al-tolerant gene, *ALMT1*, which encodes Al-activated malate transporter, and the diversity of physiological functions for the ALMT1 homologues in several plants.



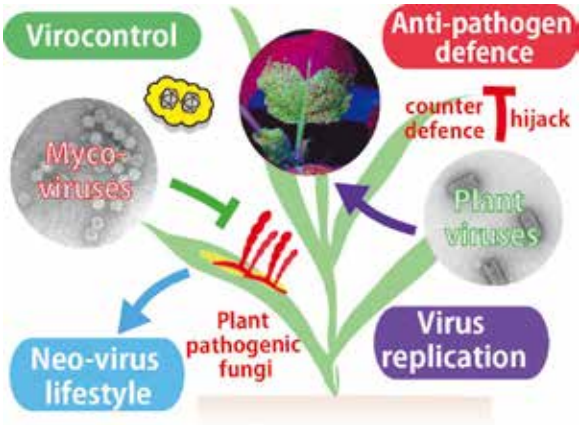
Biotic Stress Unit

Group of Plant-Microbe Interactions

Professor Nobuhiro Suzuki
Associate Professor Hideki Kondo
Assistant Professor Kiwamu Hyodo

Ascertaining the interplay between plants and beneficial and harmful viruses

Plant growth is influenced by interactions between plants and various microorganisms. Viruses, bacteria and fungi pathogenic are threats to plants. By contrast, some viruses infect phytopathogenic fungi and reduce their virulence, thereby having potential as biocontrol agents. This group studies various bipartite (plant - virus) or tripartite (plant - pathogenic fungus - mycovirus) interplays with specific examination of the multifaceted nature of microbes. Our ultimate goal is to contribute to the promotion of healthy growth of crops and other plants.



Research Core for Plant Stress Science

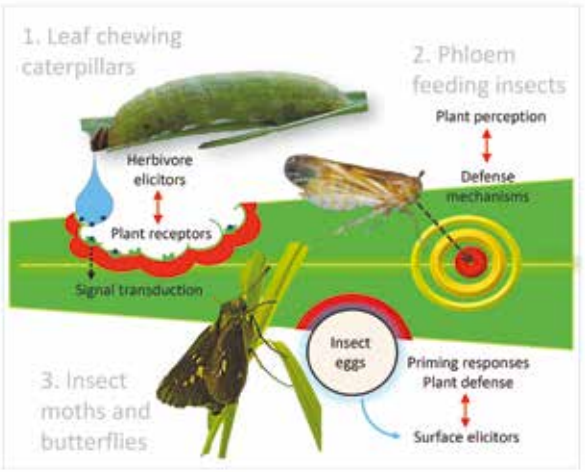
Biotic Stress Unit

Group of Plant-Insect Interactions

Professor Ivan Galis
Associate Professor Tomonori Shinya

Elucidation of plant-insect interactions at molecular level

Establishment of effective plant defense systems against herbivores in natural history reflects the existence of extremely variable interactions between plants and insects, also known as co-evolution process. Our group strives to understand, at molecular level, the mechanisms of activation, signal transduction and metabolic basics of plant defenses triggered after the recognition of insect attack. Furthermore, we target sustainable pest control by the use of natural enemies and their attraction to herbivore-infested plants by the emissions of various volatile organic compounds (VOCs) from plants.



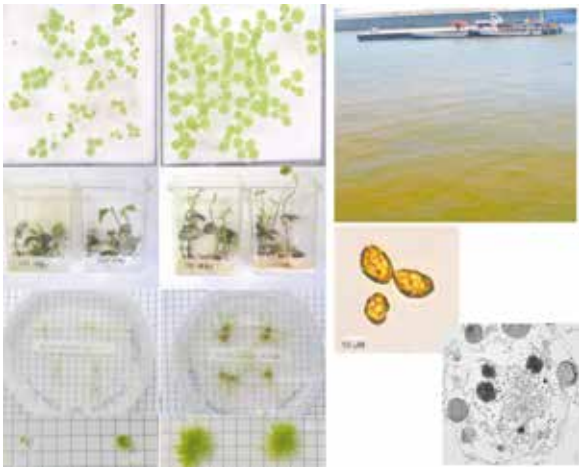
Biotic Stress Unit

Group of Plant-Environmental Microbiology

Associate Professor Akio Tani
Associate Professor Shoko Ueki

Deciphering molecular mechanisms of symbioses among plants, algae, bacteria, and viruses

We study symbiotic bacteria and viruses that affect plants and algae growth. *Methylobacterium* species that use methanol emitted from plants can promote plant growth. We aim to use their function to improve crop plants. They have a novel lanthanide-dependent enzyme involved in their methanol metabolism. Lanthanides have been regarded as non-essential for any kind of life; we ascertain its importance in microorganisms both genetically and biochemically.
Similarly to land plants, algae also interact with various microorganisms. We characterize biotic interactions between a bloom forming algae and marine bacteria or viruses, which shape algal population dynamics in environments. Viruses are known to be bloom terminating factors, whereas recent studies demonstrated that some marine bacteria promote growth of specific algal species. We are trying to decipher these interspecies interactions at the molecular and cellular levels.



Barley and Wild Plant Resource Center

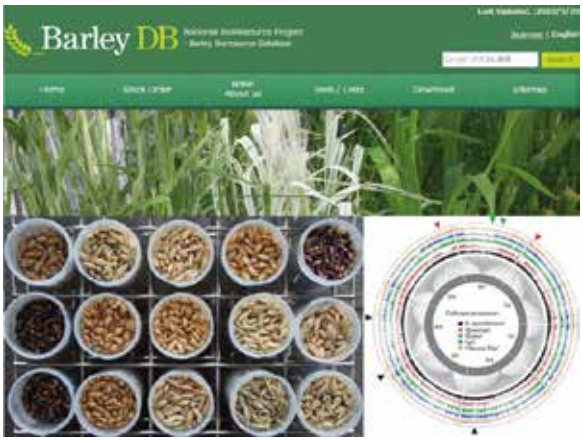
Genetic Resources Unit

Group of Genome Diversity

Professor Kazuhiro Sato
Associate Professor Daisuke Saisho
Associate Professor Hiroshi Hisano

Analysis and application of genome diversity in barley genetic resources

Our group specifically conducts investigation into the analysis and application of barley diversity using ca. 15,000 accessions including landraces, cultivars/breeding lines, experimental lines and wild relatives collected worldwide. Main subjects of our research are (1) Diversity analysis of genetic resources and their genomes, (2) Genome sequencing and generation of genome related resources, and (3) Genetic analysis of traits with industrial importance and their technical applications. Our activities for collection, preservation, and distribution of barley genetic and genomic resources, which are partially supported by the National BioResource Project, MEXT, Japan, contribute to the research community worldwide.



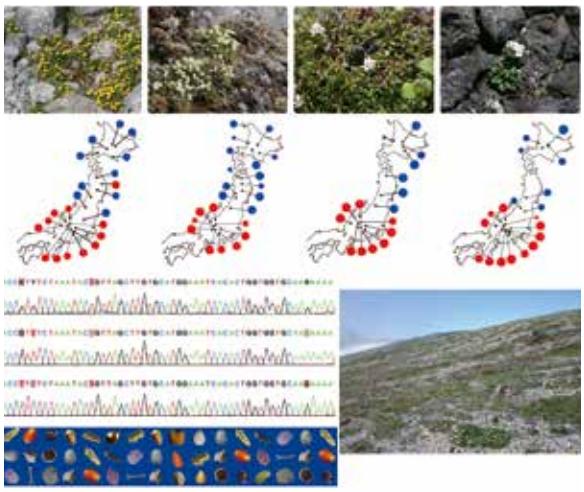
Barley and Wild Plant Resource Center

Genetic Resources Unit
Group of Wild Plant Science

Associate Professor Hajime Ikeda
Assistant Professor Jun Yamashita

Natural variation and evolution of plants

Earth is home to over 300,000 known species of plants. This diversity of plant species has been shaped mainly through adaptive evolution to various environments, including abiotic as well as biotic ones. By particularly addressing evolutionary genomics of wild plants, we attempt to reveal relationship between plant evolution and natural environment and to elucidate mechanisms that shaped plant diversity. In addition to such basic research, we preserve and distribute wild plant seed resources.



Applied Genomics Unit
Group of Genetic Resources and Functions

Professor Shin Taketa

Molecular genetics of barley: seed morphology, and healthy dietary fiber

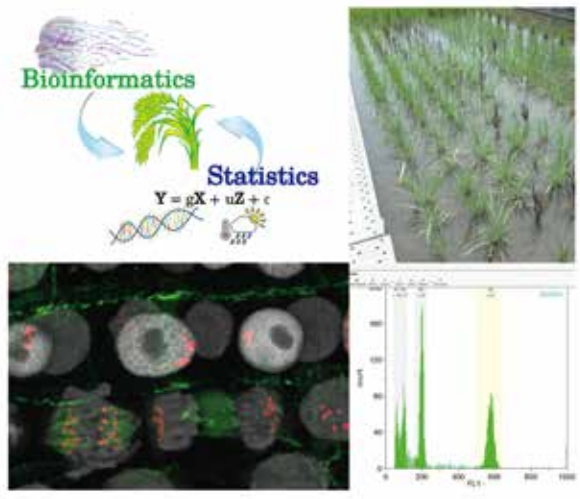
Barley, the fourth most important cereal crop in the world, typically has seeds with adhered hulls. This hulled seed trait is suitable for breweries. Some naked seed mutants with easily separable hulls were generated through spontaneous mutation. They are suitable for food usage. Barley also has photosynthetically active awns on the tip of the spikes. Our current research specifically examines molecular identification and characterization of beneficial genes controlling (1) seed and awn morphology and (2) water soluble healthy dietary fiber, and beta-glucan content. We seek application of our basic findings to practical breeding.

Applied Genomics Unit
Group of Integrated Genomic Breeding

Professor Toshio Yamamoto
Associate Professor Kiyotaka Nagaki
Assistant Professor Tomoyuki Furuta

Understand the genome and chromosome dynamics for future crop breeding

Along with rapid changes in global environments in recent years, agricultural environments are also changing rapidly. To continue food production under these changing circumstances, we must develop varieties that can adapt to those changes more rapidly than ever. Our research group has been investigating the genomic constitution of vast rice genetic resources, which are the driving force of breeding, specifically examining rice productivity and environmental stress tolerance, and developing identification methods for genes (group) capable of responding to various breeding targets. We have also been investigating chromosome dynamics in cross breeding.



Crop Design Research Team

Professor Takashi Hirayama (adjunctive)
Specially Appointed Professor Keiichi Mochida

Technology development to design crops driven by field data

Our group was launched in November 2015 based on an agreement for a cross-appointment between Okayama University and RIKEN. By adopting genetic resources at IPSR and integrating a broad range of data and knowledge related to the physiological responses of the plant to environmental fluctuation, our group aims to accelerate the discovery of genes which contribute to higher crop productivity. Understanding the interactions of genes and environmental changes in plants under field conditions is crucially important. Our group, by integration of various comprehensive analytical techniques, has been promoting research to elucidate the physiological state transitions of crops throughout their life course in field conditions. Furthermore, we have promoted the use of field data for development of analytical methodologies to predict agronomic traits of crops computationally.

Ecophysiology Research Team

Ion Dynamics Section

Associate Professor Izumi Mori (adjunctive)
Professor Maki Katsuhara (adjunctive)
Associate Professor Takayuki Sasaki (adjunctive)

Rhizosphere Microbiome Section

Associate Professor Akio Tani (adjunctive)
Associate Professor Naoki Yamaji (adjunctive)
Associate Professor Daisuke Saisho (adjunctive)
Assistant Professor Jun Yamashita (adjunctive)

Crop Innovation Research Team

Epigenetics Section

Associate Professor Kiyotaka Nagaki (adjunctive)
Associate Professor Naoki Yamaji (adjunctive)
Associate Professor Yoko Ikeda (adjunctive)

Barley Genetic Modification Section

Associate Professor Hiroshi Hisano (adjunctive)
Associate Professor Hideki Kondo (adjunctive)
Associate Professor Ryo Matsushima (adjunctive)
Associate Professor Namiki Mitani-Ueno (adjunctive)

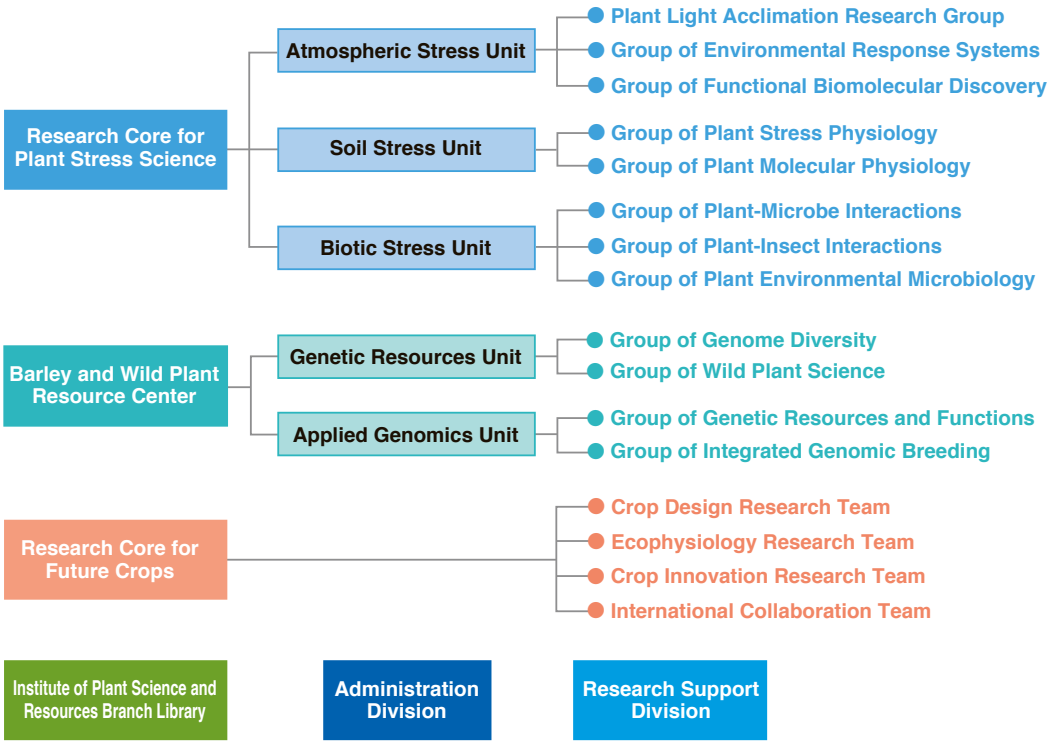
International Collaboration Team

Professor Wataru Sakamoto (adjunctive)
Professor Toshio Yamamoto (adjunctive)
Professor Nobuhiro Suzuki (adjunctive)
Professor Ivan Galis (adjunctive)
Associate Professor Akio Tani (adjunctive)
Professor Yasutaka Kubo (adjunctive)
(Graduate School of Environmental and Life Science)

For innovative and leading plant research in East Africa

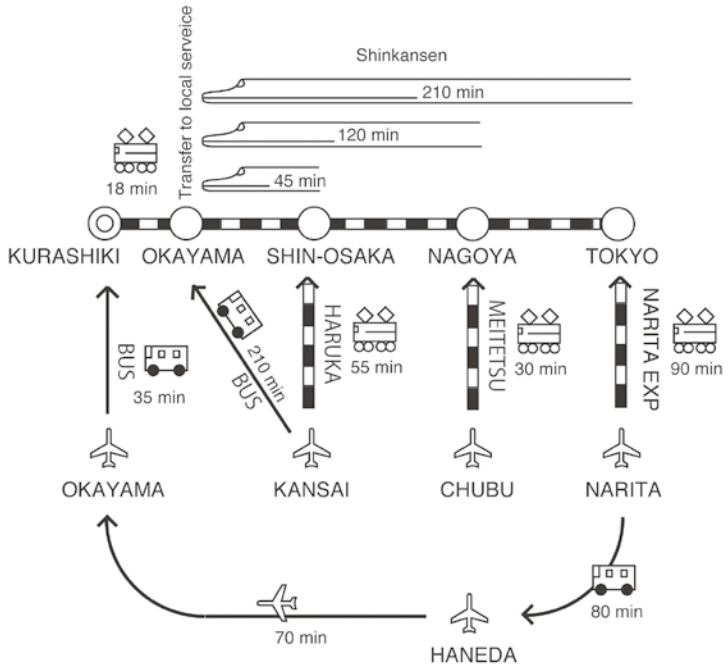
Understanding how plants respond and acclimate themselves to various biotic and abiotic stress conditions is useful to generate future crops endowed with 'stress resistance'. However, the application of stress-resistant crops must be conducted from a global standpoint, which necessitates international collaboration in a timely and strategic manner. Currently, this group aims to develop a research network in east Africa, in collaboration with Jomo Kenyatta University of Agriculture and Technology (JKUAT) in Kenya. Through this research network, our institute accepts graduate students and researchers, who conduct various projects in disciplines related to plant stress science. The group also organizes international meetings, both domestically and abroad, to accelerate networking.

Organization



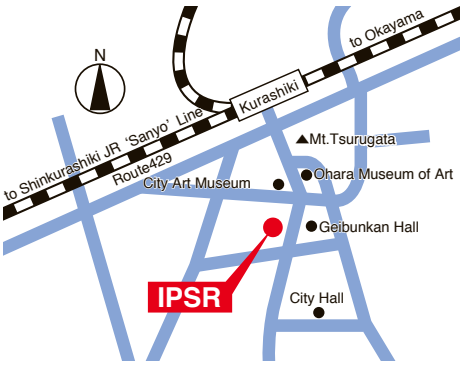
Access & Routes

Domestic Transportations to Kurashiki



IPSR SINCE 1914

SUSTAINABLE DEVELOPMENT GOALS



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University Mark

OKAYAMA UNIVERSITY
INSTITUTE OF PLANT SCIENCE AND RESOURCES

2-20-1 Chuo, Kurashiki 710-0046, Japan
Tel:+81-86-424-1661 Fax:+81-86-434-1249
E-mail:SEE1201@adm.okayama-u.ac.jp

http://www.rib.okayama-u.ac.jp

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