Creating sustainable resources through interdisciplinary research based on biology and chemistry

RIKEN Center for Sustainable Resource Science (CSRS)

Since 2013

RIKEN Europe Office Anniversary Symposium

Shaping future society with cutting-edge STI

December 2, 2019

Center Director

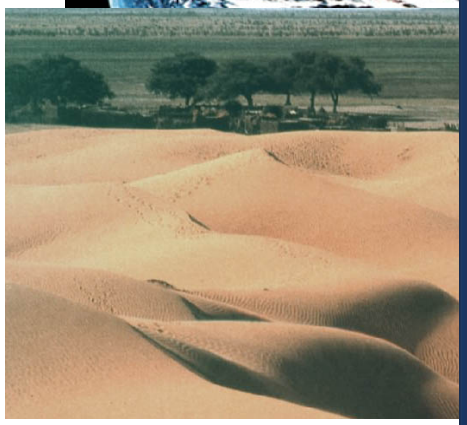
Kazuo Shinozaki

Science and technology contribute to solve global problems.

Global Warming,
Climate change

Increasing Global
Populations

Ocean and soil pollution,
desertification



Desertification

Report of IPCC
October 6, 2018

Importance of science and technology for sustainable development of society.

- Contribution to SDGs
- Breeding of crops and biomass
- Sustainable production of materials
- Carbon capture and utilization

SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD

Paradigm Shift in Social Needs and Technologies

The Sustainable Development Goals (SDGs) , UN 2015.9

COP21 The Paris Agreement 2015.11

Genome Technologies

- Genome sequence technology
- Genome editing technology
- Synthetic Genomics

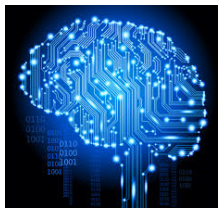
Data Science and Artificial Intelligence

- Data Science
- Artificial Intelligence
- Bioinformatics, Material Informatics,

Society 5.0 for the advancement of smart society

(5th Science and Technology Basic Plan, Japan Cabinet Office, 2016-2020)

- RIKEN started AIP center (AI and data science) in 2015



Introduction of RIKEN CSRS Projects

●Started in 2013 by the reorganization of **Plant Science Center, Chemical Biology, and Catalytic Chemistry Programs** for the contribution to a sustainable production based on biology and chemistry. **Biomass Engineering Program** joined CSRS in 2015.

●Started 5 flagship projects in 2018 for the contribution to **Sustainable Development Goals (SDGs) and Society 5.0**.

Director
Kazuo Shinozaki

Deputy Directors

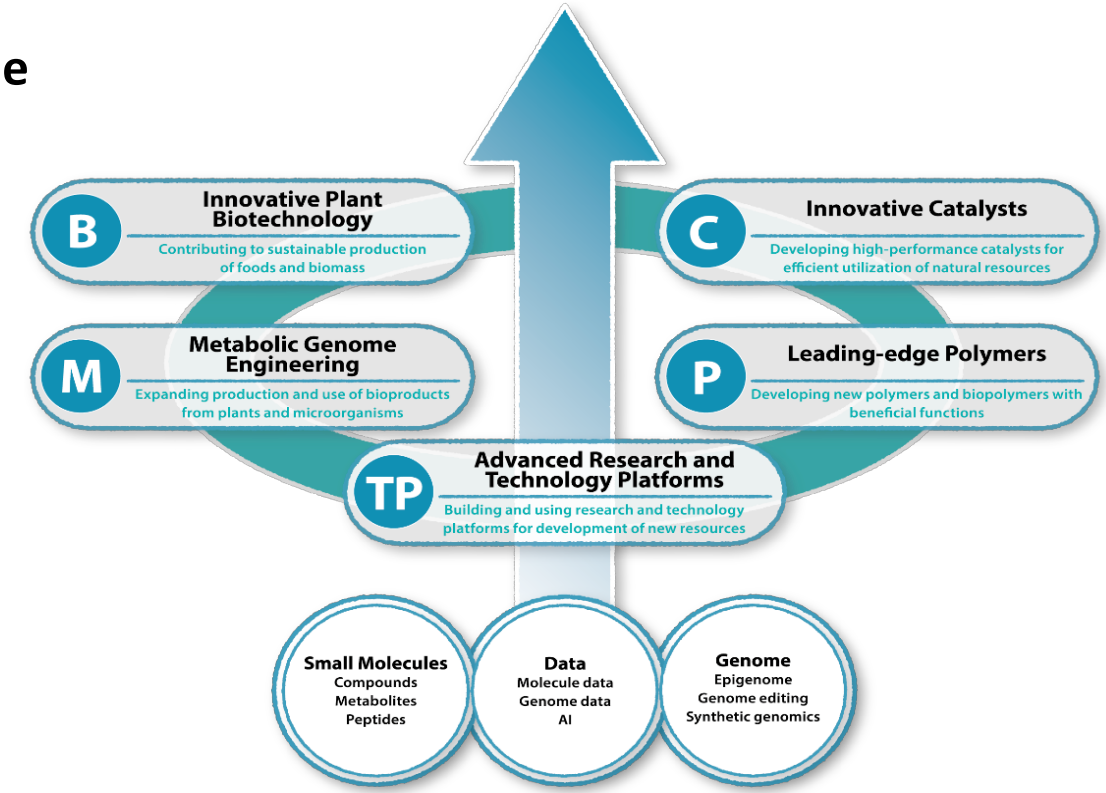
Hiroyuki Osada

Kazuki Saito

Zaomin Hou

Minami Matsui

Creation and Efficient usage of natural resources for sustainable development of humankind



5 Flagship Projects in 4th Midterm Plan

- 5 flagship projects contributing to "Sustainable Development Goals (SDGs)" are promoted to incorporate plant biology, biotechnology, chemical biology, and chemistry.
- Based on results of first phase, R&D on problem-solving is based on sustainable production of useful materials and biomass.
- Establish various types of collaboration

Contributing to sustainable food and biomass production through development of plant trait improvement techniques

Maximizing capacities of plants and microorganisms for chemical synthesis in expanding the production and use of bioproducts

Developing new, highly efficient catalysts that use natural resources

Developing new polymers with beneficial functions improving efficiency in the use of resources and creating new industries

Advancing analytical technology and information platforms and leading innovation as a science and technology hub in Japan

5 Flagship Projects in 4th Midterm Plan

CSRS organization

3 Locations: Yokohama campus, Wako campus, Tsukuba campus

Members: 31 PIs , 150 researchers + postdocs, 100 technical staffs

Center Budgets: 1,820 million yen (15,6 million EUR)

Contributing to sustainable food and biomass production through development of plant trait improvement techniques 10 Labs

Maximizing capacities of plants and microorganisms for chemical synthesis in expanding the production and use of bioproducts 5 Labs

Developing new, highly efficient catalysts that use natural resources 5 Labs

Developing new polymers with beneficial functions improving efficiency in the use of resources and creating new industries 3 Labs

Advancing analytical technology and information platforms and leading innovation as a science and technology hub in Japan 12 Labs

Advanced Research and Technology Platforms

Metabolomics Research Group

- Mass Spectrography (MS) and NMR platform for analyzing plant metabolomes and hormones

Kazuki Saito
Deputy Director

Mass spectroscope and NMR device for analyzing metabolomes / hormones

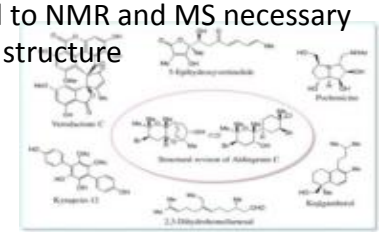
Microscopes for analysis of tissues and cells

Mass Spectrometry and Microscopy Unit

Technology Platform Division

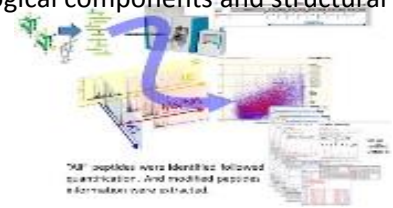
Molecular Structure Characterization Unit

Promotes new methods and technological development related to NMR and MS necessary for determination of structure



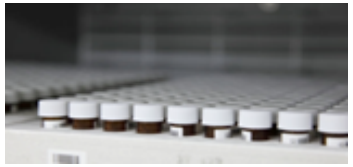
Biomolecular Characterization Unit

Promotes applied research on developing methods to analyze the structure of biological components and structural analysis



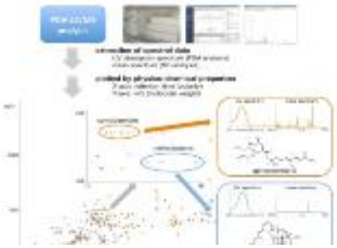
Chemical Biology Research Group

Platform for Chemical libraries and chemical screening

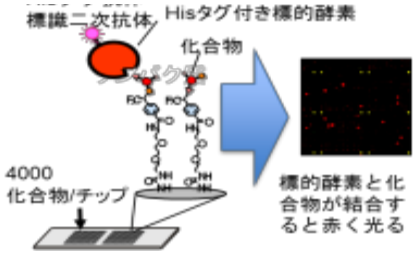


Natural compound library (NPDepo)

Hiroyuki Osada
Deputy Director



Database for metabolites (NPPlot)

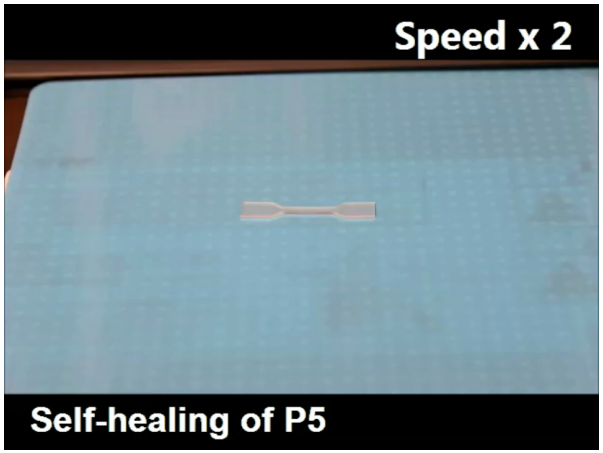


Exploration of chemicals using chemical arrays

Research Achievements 1

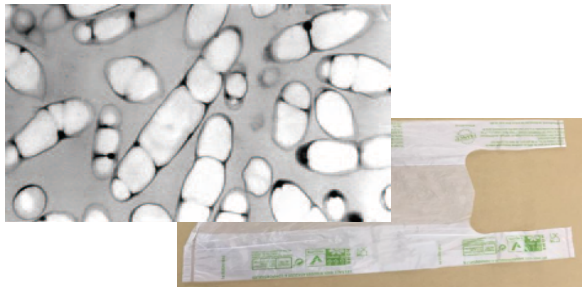
New type of self-healing material

Hou group succeeded in creating new functional polymers with characteristics of self-healing and shape memory under the conditions in not only dry air but also water, and acidic and alkaline aqueous solutions. This research was very unique and visible to attract many companies. (JACS 2019)



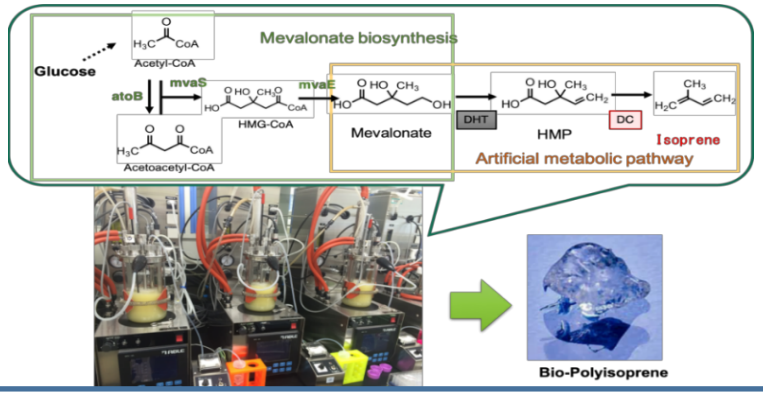
Plant-derived biodegraded polymer

Abe group has collaborated with Kaneka company to develop biodegraded polymer PHA and PHB. Recently, the PHB biopolymer is recognized as useful biodegraded plastics that can solve micro-plastic pollution in ocean.



Isoprene bio-production by designing an artificial metabolic pathway

Kondo group succeeded in constructing an artificial metabolic pathway synthesizing isoprene efficiently in *E. coli*, and collaborated with a rubber company for application.



Research Achievements 2

Development of poisonless potatoes, that can be stored for along time

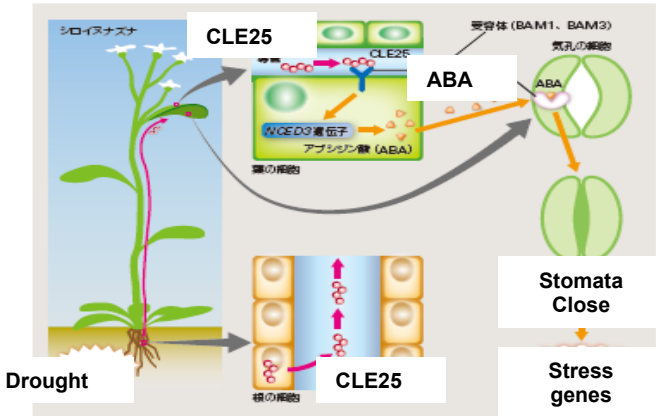
Saito group succeeded to reduce SGA content by suppressing genes that are expressed in shoots and flowers. The yield of potato does not change, and storing without sprouting.
(Plant Cell 2014, Plant Phys. 2016)

Breeding drought tolerant upland rice GM cultivars and their field test

The GolS2 transgenic rice plants are drought tolerant and maintain a high crop yield under dry field of CIAT in Columbia
(Plant Biotech J 2017)

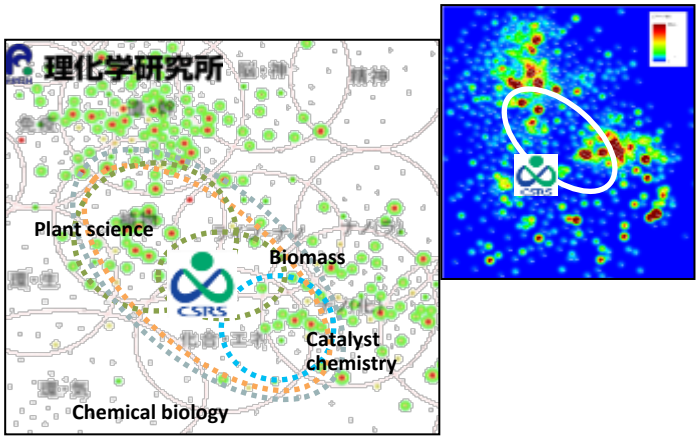
Newly discovered peptide hormone helps keep plants from dehydration

Shinozaki group discovered CLE25 peptide regulating dehydration stress resistance via root-to-shoot long distance signaling. This discovery was unique and visible in plant science.
(Nature 2018)



High-level research: Plant science and chemical biology

Plant Science and Biochemistry are visible research area in RIKEN



Source: Science Map 2014, NISTEP REPORT No.169, September, 2016.
MEXT NISTEP created and processed by RIKEN.

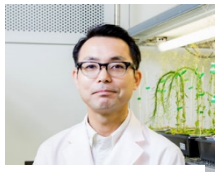
9 researchers from CSRS （6 PIs, and 3 others）selected as "Highly Cited Researchers 2018*" by Clarivate Analytics (formerly Thomson Reuters）
(*Authors whose publications were quoted in the top 1% from 2006 to 2016)

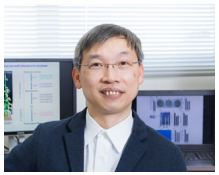
Kazuo Shinozaki

Kazuki Saito

Ken Shirasu

Motoaki Seki


Mitsunori Seo


Lam-Son Phan Tran

※Clarivate Analytics selected 90 researchers from Japan, of 20 researchers were selected in 4 fields from RIKEN.

2016 Person of Cultural Merit / Medal with Purple Ribbon

Plant stress biology, Functional genomics

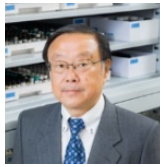
K. Shinozaki

2018 Medal with Purple Ribbon

Plant Metabolomics
Metabolic engineering

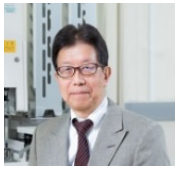
K. Saito

2015 Inhoffen Medal
First Japanese to receive the award


Chemical Biology,
Drug discovery

H. Osada

2018 Japan Medical Research and Development Grand Prize

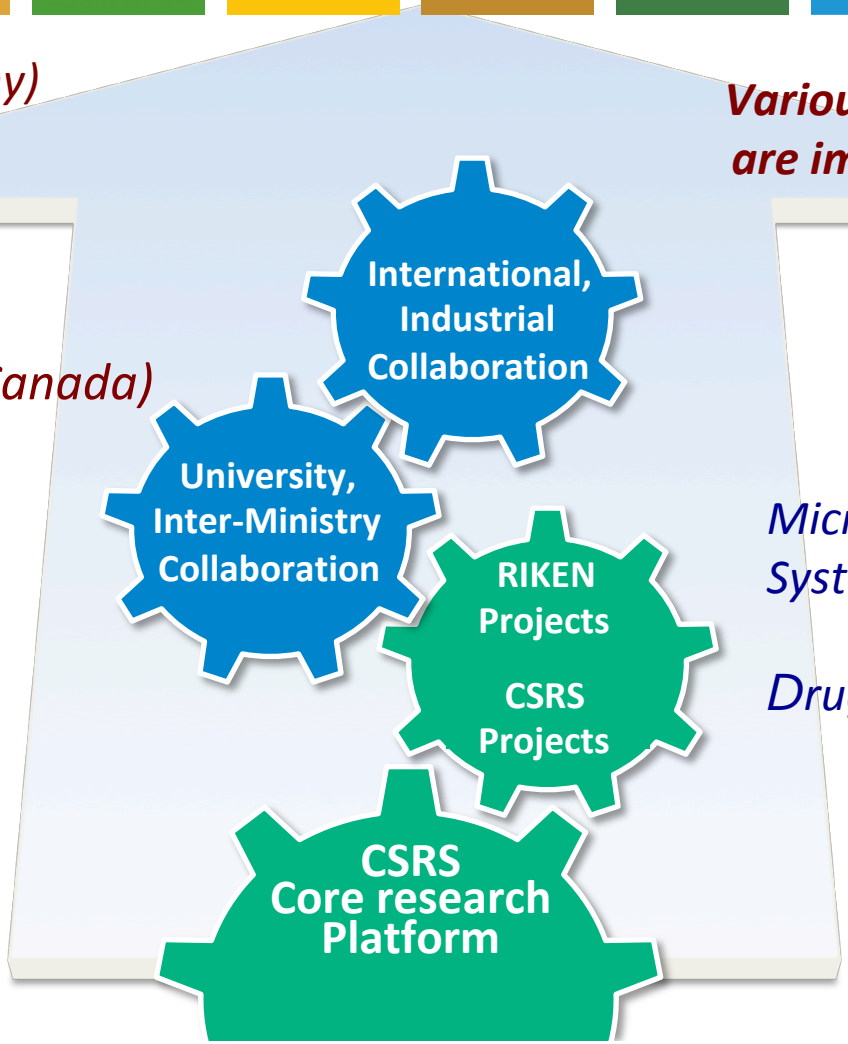

Chemical Biology
Functional genomics

M. Yoshida

Project Management in CSRS

Max Planck Inst. (Germany)
VIB-PSB (Gent, Belgium)
John Innes Institute (UK)
INRA (Paris, France)
Michigan State U. (US)
University of Toronto (Canada)

Various types of collaboration are important for these goals



AIST, NARO,
FFPRI, FRA

Nagoya Univ.
Yokohama City Univ.
Keio Univ.

Microbial – host symbiotic System, iSYM (2017 -)

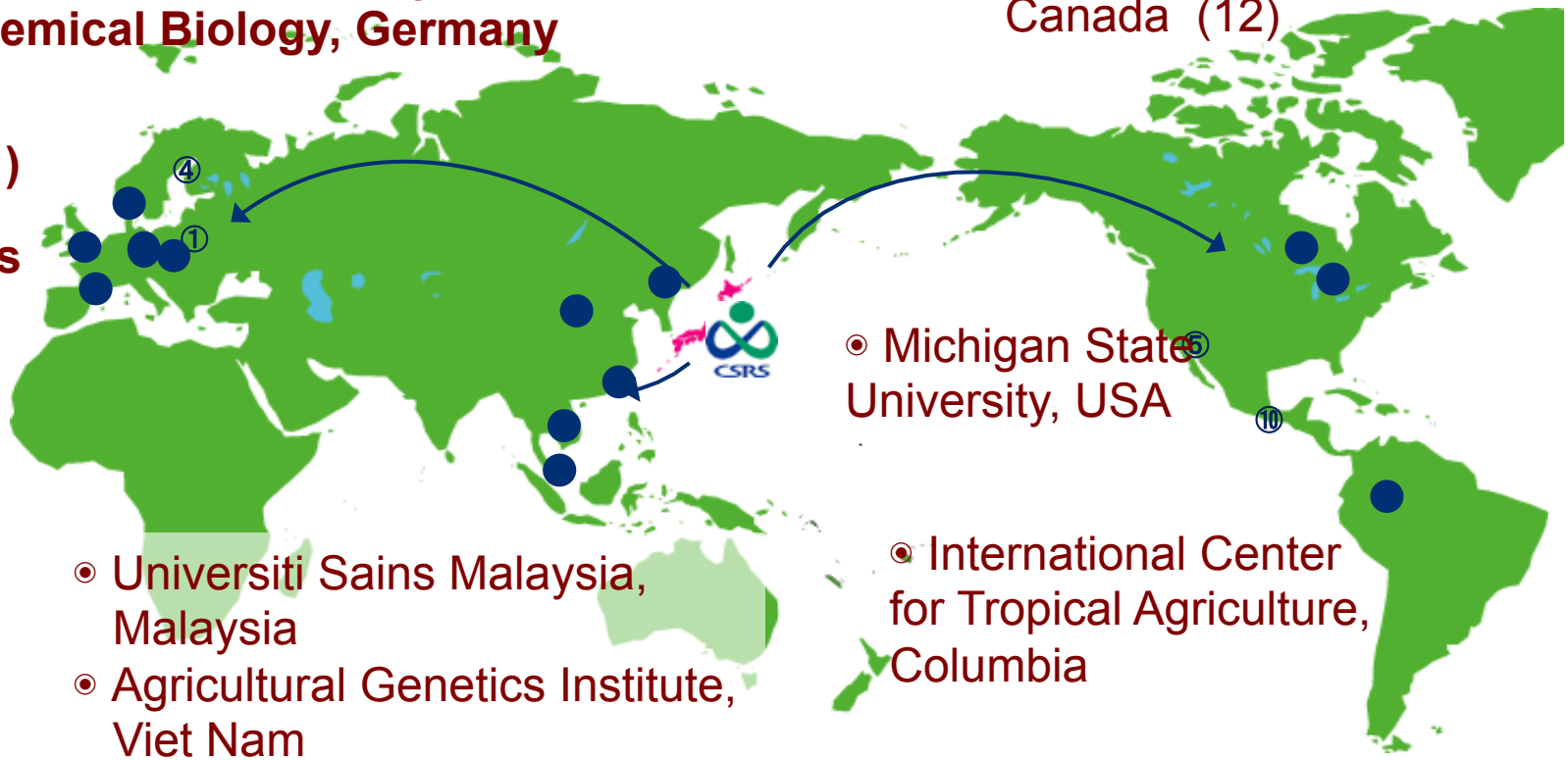
Drug Discovery Platform (2010 –)

International collaborations in CSRS

International Collaboration is important for innovation.

(Joint papers/1311 papers, 2015-2018)

- **Umea Plant Science Center, Sweden**
- **Max Planck Institute of Molecular Plant Physiology, Germany (32)**
- **Max Planck Institute of Systems Chemical Biology, Germany**
- **The Sainsbury Laboratory, UK (11)**
- **VIB-Plant Systems Biology, Belgium**
- **INRA, France**



- University of Toronto, Canada (12)
- Michigan State University, USA
- Universiti Sains Malaysia, Malaysia
- Agricultural Genetics Institute, Viet Nam
- International Center for Tropical Agriculture, Columbia

Collaborations with institutes in EU countries

- We have been collaborating with Institutes in EU countries mainly in plant biology and chemical biology.
- We are planning to promote collaboration with VIB, Belgium.

- Chemical Biology

- Max Planck Institute of Systems Chemical Biology, Germany

- Plant Metabolomics

- Max Planck Institute of Molecular Plant Physiology, Germany
- Umea Plant Science Center, Sweden

- Plant Biology

- John Innes Centre and the Sainsbury Laboratory, UK

- Plant hormone Research

- INRA, France

- Plant Biology

- **VIB-Plant Systems Biology, Gent, Belgium**

Thank you for your attention.

We are planning to promote various types of collaboration with Institutes in EU countries for the contribution to SDGs.

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