

## Development of Next-Generation CO<sub>2</sub>-Fixing Plant Through the Gene Optimization, Distant Hybrid, and Microbial Symbiosis

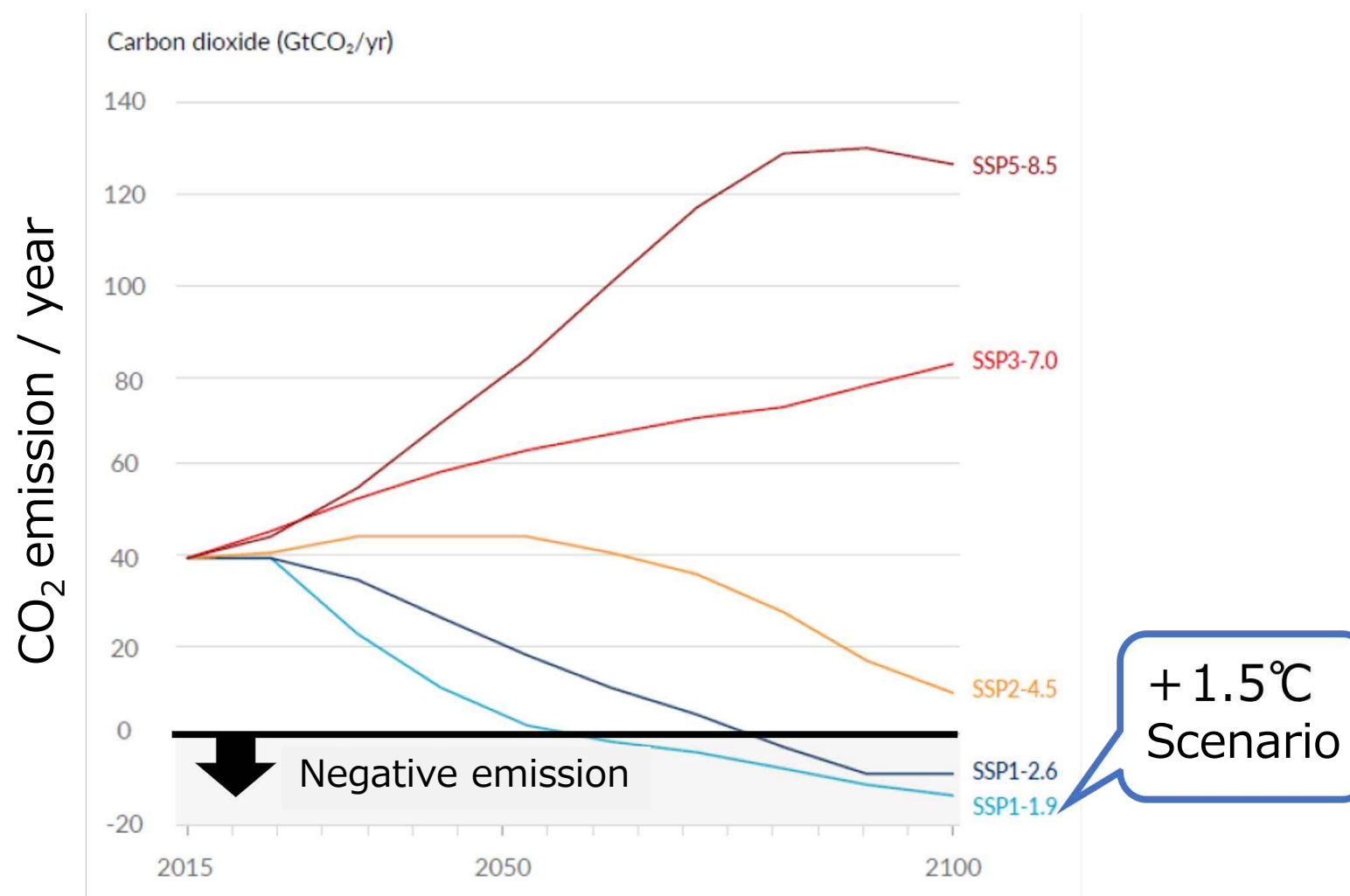


PM : Nobutaka MITSUDA  
Natl. Inst. Adv. Ind. Sci. Tech. (AIST)  
PJ member : AIST, Tokyo Metropolitan Univ.,  
Sumitomo Forestry Co., Ltd.

# Background

- To stop global warming...

Five scenarios about transition of CO<sub>2</sub> emission (IPCC AR6)

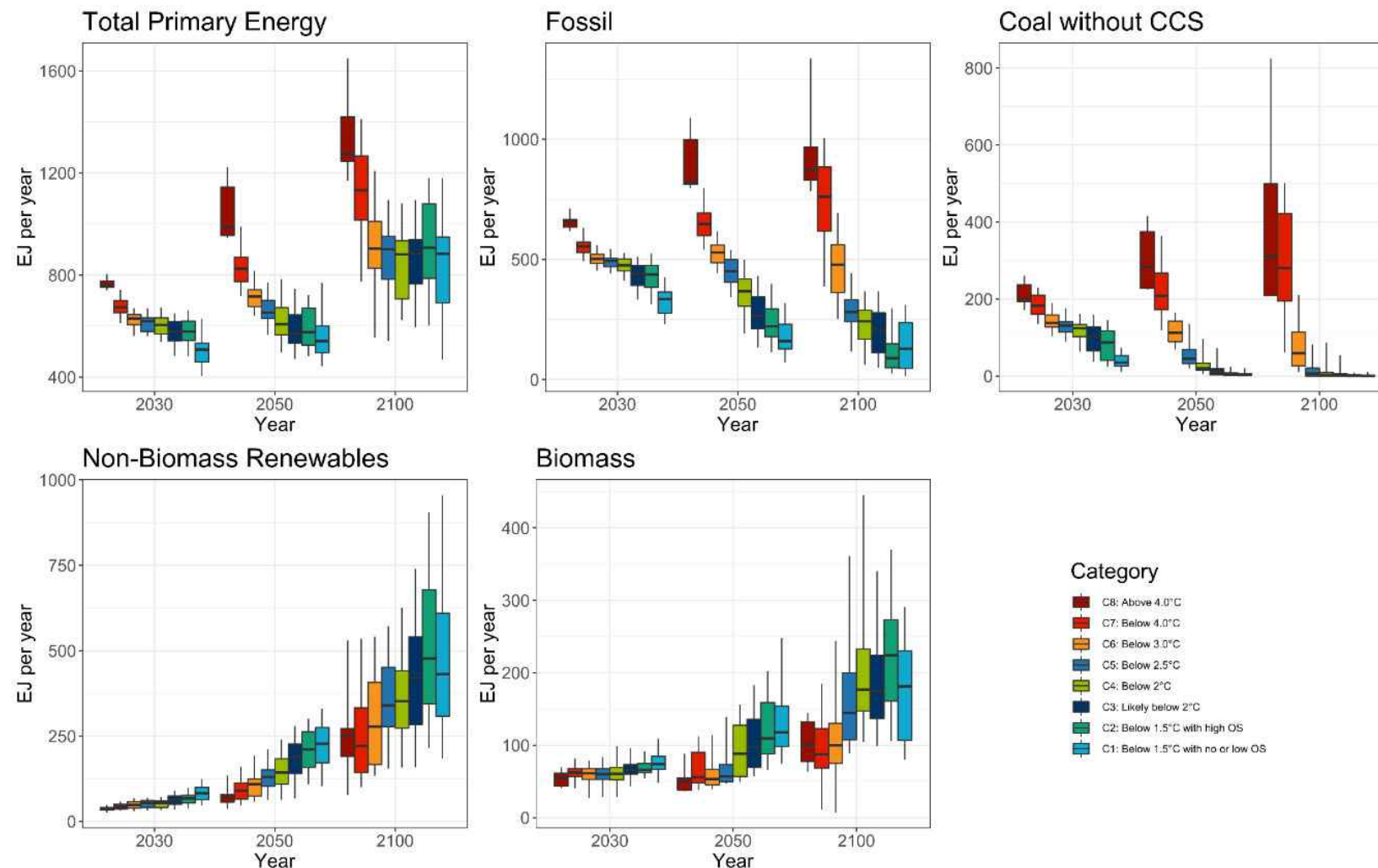


- To achieve the +1.5°C scenario, CO<sub>2</sub> emissions in NET must be reduced even from 2023, and negative emissions in NET must be achieved around 2055

# Background

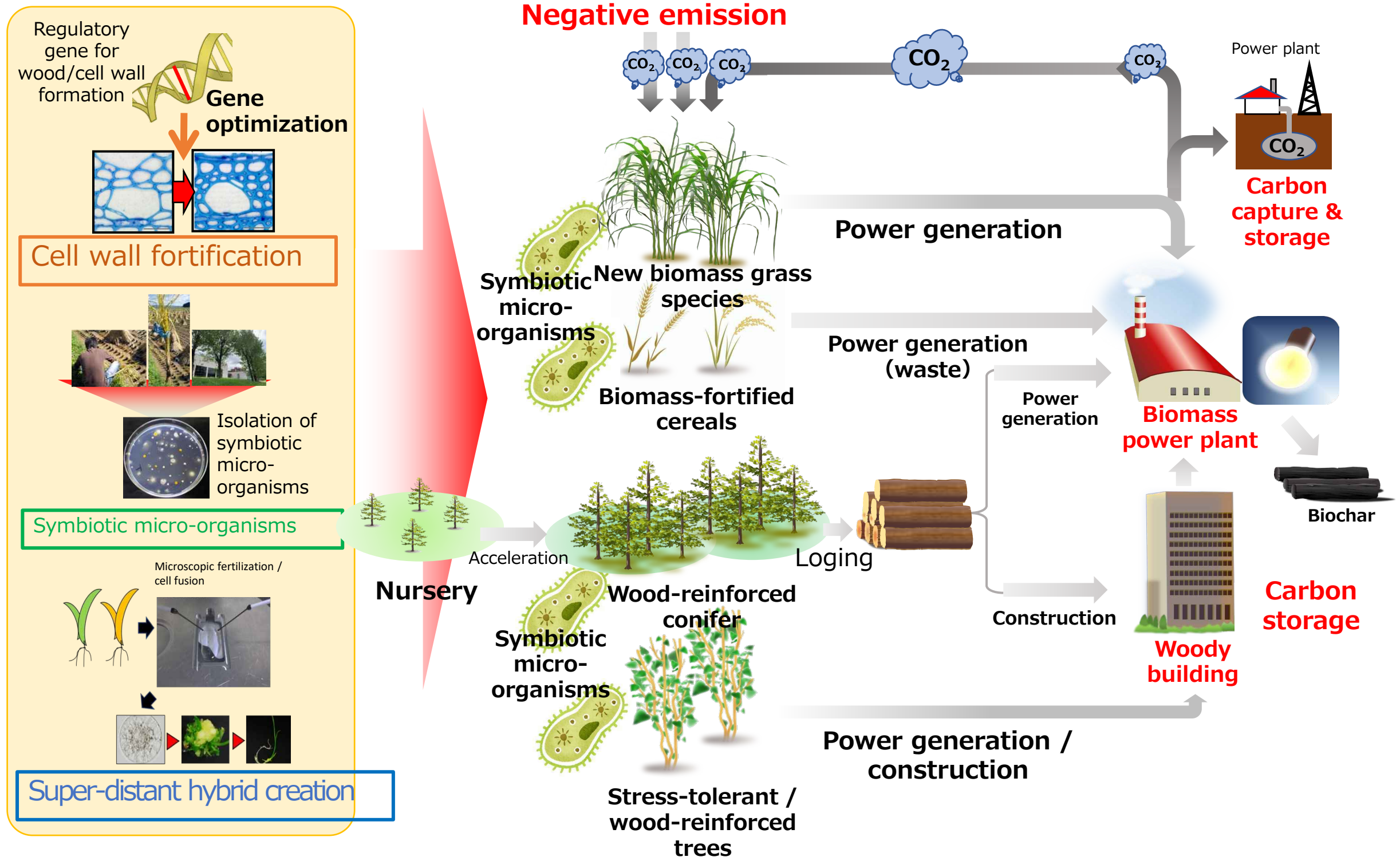
- To achieve +1.5°C scenario ...

Energy source transition in each scenario (IPCC AR6)

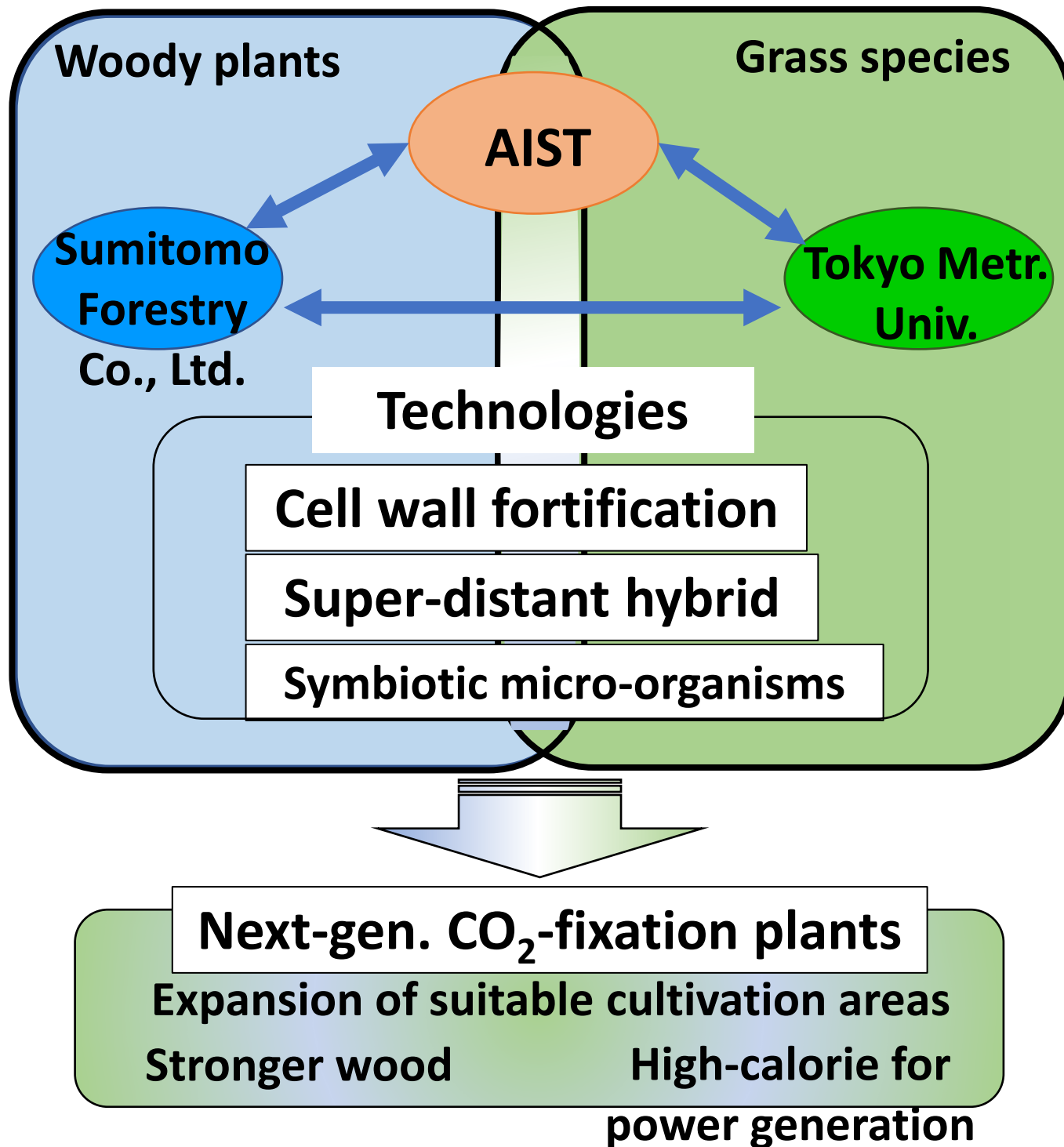


- For +1.5°C scenario, about a quarter of all energy consumption must come from biomass in 2100
- High expectations for biomass, not only for energy

# Graphical abstract



# Team building · Goals



- Aiming to improve biomass productivity by 30% compared to conventional methods for genetic optimization, hyper distantly related hybrids, and symbiotic microorganism optimization, respectively.
  - Results can be used in combination with conventional breeding
- Using the optimization of symbiotic micro-organisms as a hub, combined with super distantly related hybrids in the short term and genetic optimization in the long term, aim to increase biomass productivity by 50% compared to conventional methods.

# Three major technologies

- Gene optimization
- Super-distant hybrids
- Symbiotic micro-organisms

# Three major technologies

- Gene optimization
- Super-distant hybrids
- Symbiotic micro-organisms



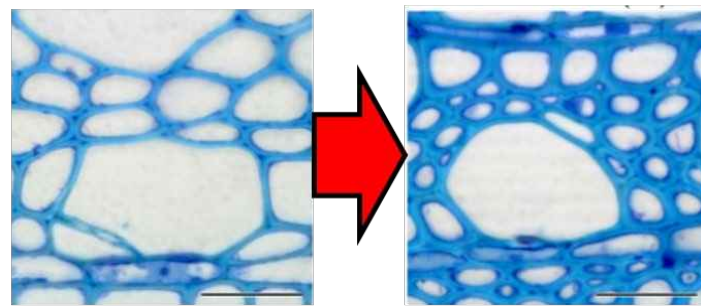
## Research topic 1.

# Biomass fortification by gene optimization

### ◆ Three strategies

Based on gene edit technology

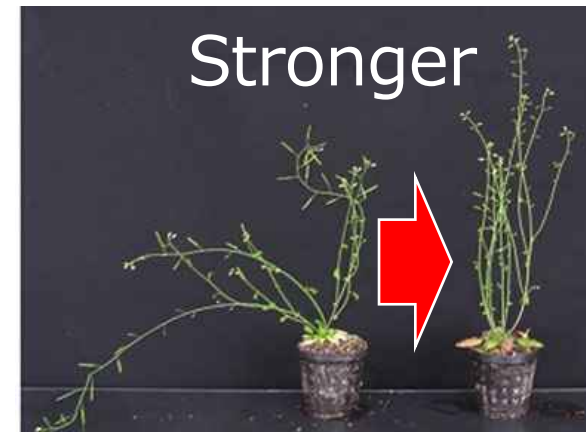
1. Wood reinforcement



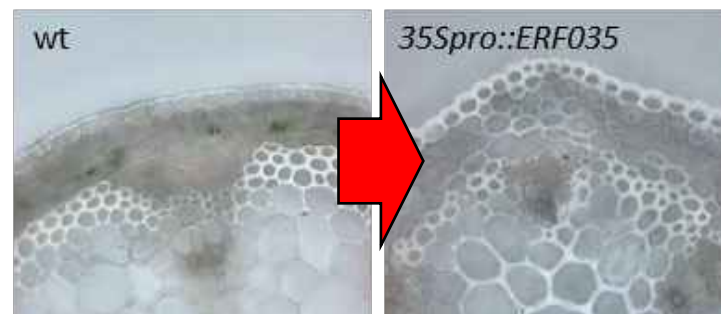
Wood reinforcement

2. Increased strength

- Beneficial trait in addition to higher wood productivity



3. Primary cell wall enhancement (only for grass)



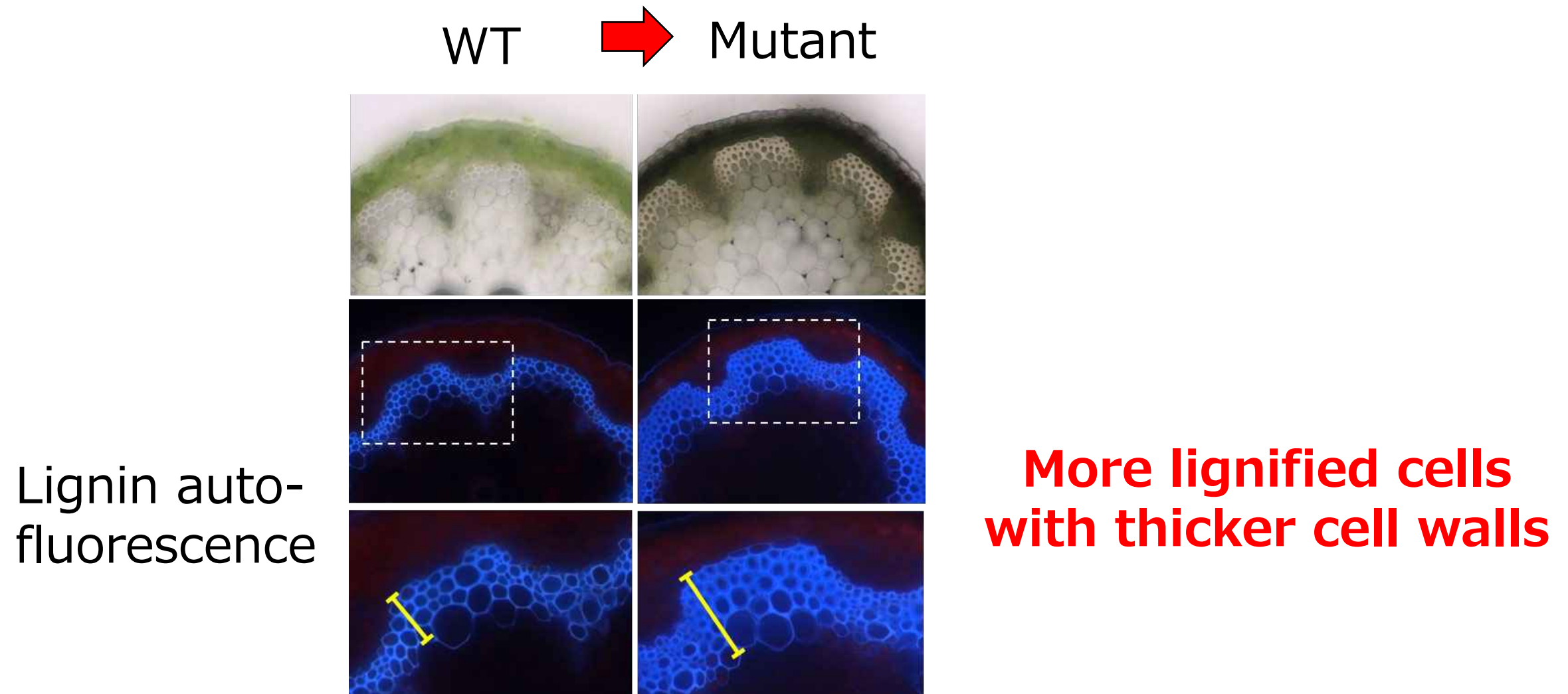
PCW enhancement



Research topic 1-1-2.

# Wood reinforcement by NST upregulation

## ◆ Knocking-out a negative regulator of NST



We have already identified novel negative regulators of NST

→ Developing a technology to apply the gene edit in practical plants

# Three major technologies

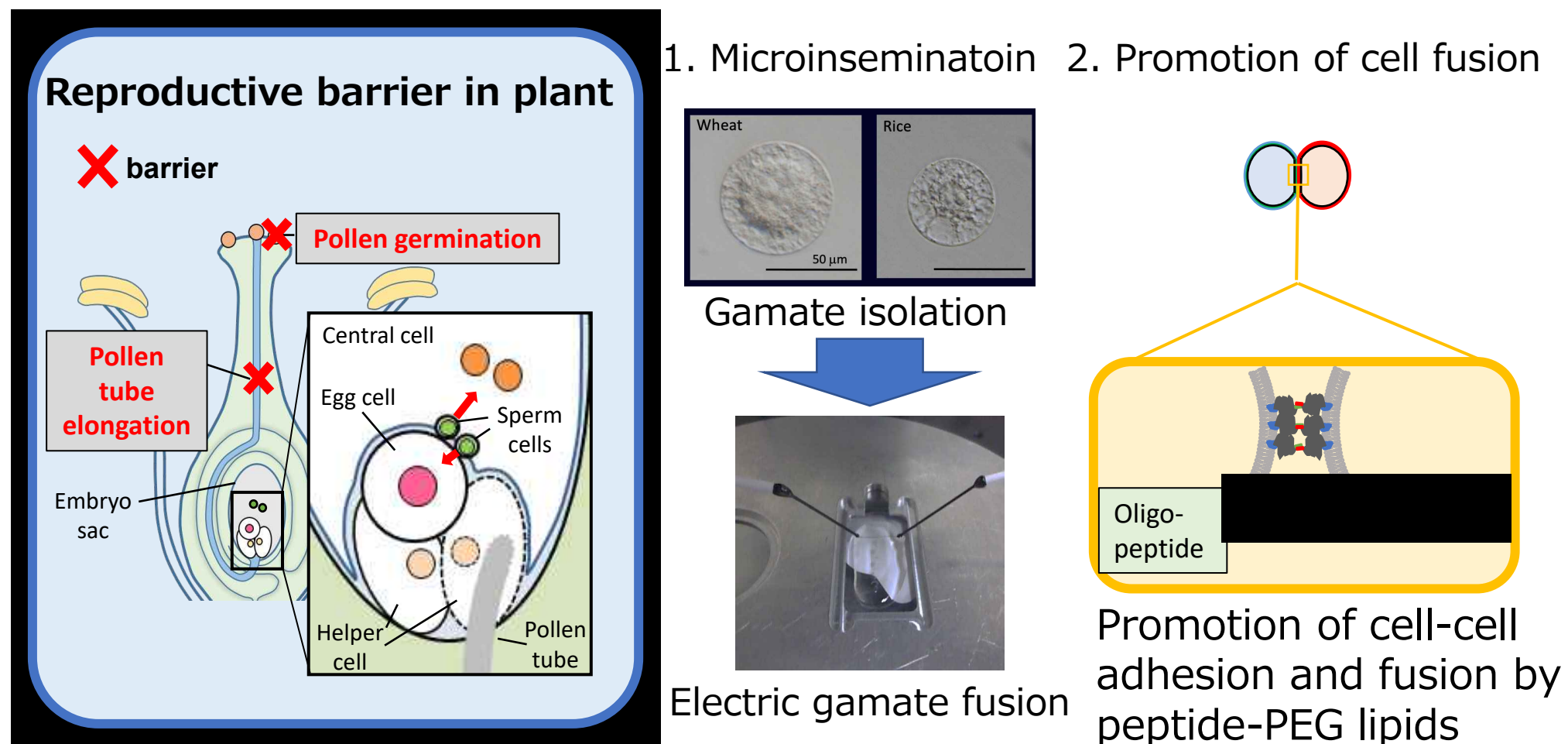
- Gene optimization
- Super-distant hybrids
- Symbiotic micro-organisms

## Research topic 2.

# Creation of new biomass plant by super-distant hybrid creation technology

## ◆ Super-distant hybrid creation technology

Technology to overcome reproductive barrier between different species through "microinsemination" or "cell fusion".



➤ Towards higher biomass production and/or expansion of suitable cultivation areas

# Creation of new biomass plant by super-distant hybrid creation technology

## ◆ New crop by the hybrid of rice / wheat and rice family plants

Rice / wheat



Rice family plant



New rice / wheat



→ Screening of high biomass hybrid

## ◆ New biomass plant by the hybrid of Eryanthus and rice family plants

Eryanthus



Rice family plant



Sterilized Eryanthus

Cold tolerant Eryanthus

High sugar Eryanthus

Cold tolerance High sugar yield

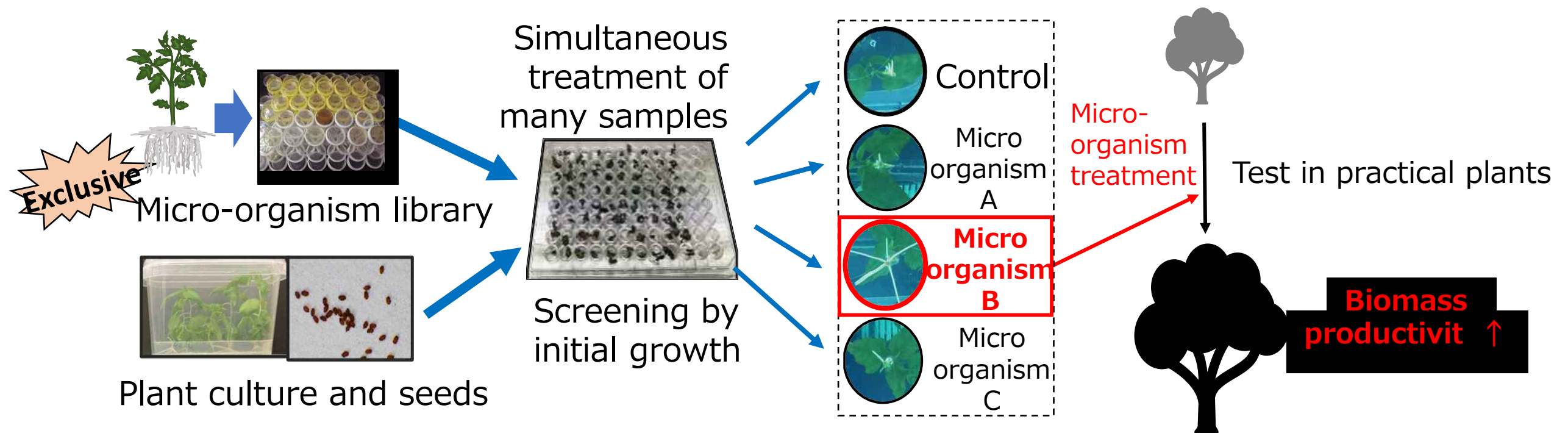
# Three major technologies

- Gene optimization
- Super-distant hybrids
- **Symbiotic micro-organisms**



# Research topic 3. Optimization of symbiotic micro-organisms

## ◆ Finding symbiotic micro-organisms to promote plant growth



Searching symbiotic micro-organisms that promote plant growth from our own micro-organism library and newly acquired microorganisms

# R&D schedule

	2022~2023FY	2024FY
1. Establishment of biomass enhancement strategy by gene optimization	Wood reinforcement in woody and herbaceous plants by NST hyperactivation	
	Examination of primary cell wall enhancement strategy in grass species	
2. Establishment of new biomass plant creation method by super-distant hybrid creation technology	Development of enhanced cell fusion system	
	Creation of new biomass plants by super-distant hybrid creation technology	
		Evaluation of newly created plants
3. Establishment of plant growth promotion system by symbiotic micro-organism	Exploration of symbiotic micro-organisms promoting plant growth	
	Evaluation of the effect of symbiotic micro-organisms on plant growth	