Agrobiotechnological Direct Air Capture Towards Carbon Circulation Society

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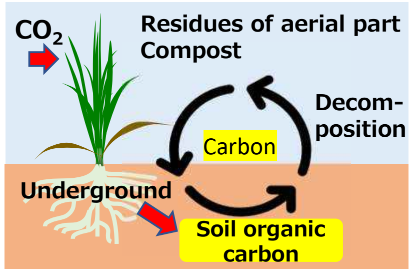
PJ Participating Institutions:
National Agriculture and Food Research Organization (NARO), The Tokyo University of Agriculture and Technology (TUAT), Nagoya University, The University of Tokyo, Kyoto University, Shinshu University, The University of Shiga Prefecture, Saitama University

Negative emission technology in agriculture, forestry and fisheries

Utilization of photosynthesis（CO_2 absorption）

・**Super Crop**
Development of crops with high photosynthesis capacity

・**Biochar**
Agricultural land application of rice husk and wood



・**Soil carbon storage**
Agricultural land application of organic matter

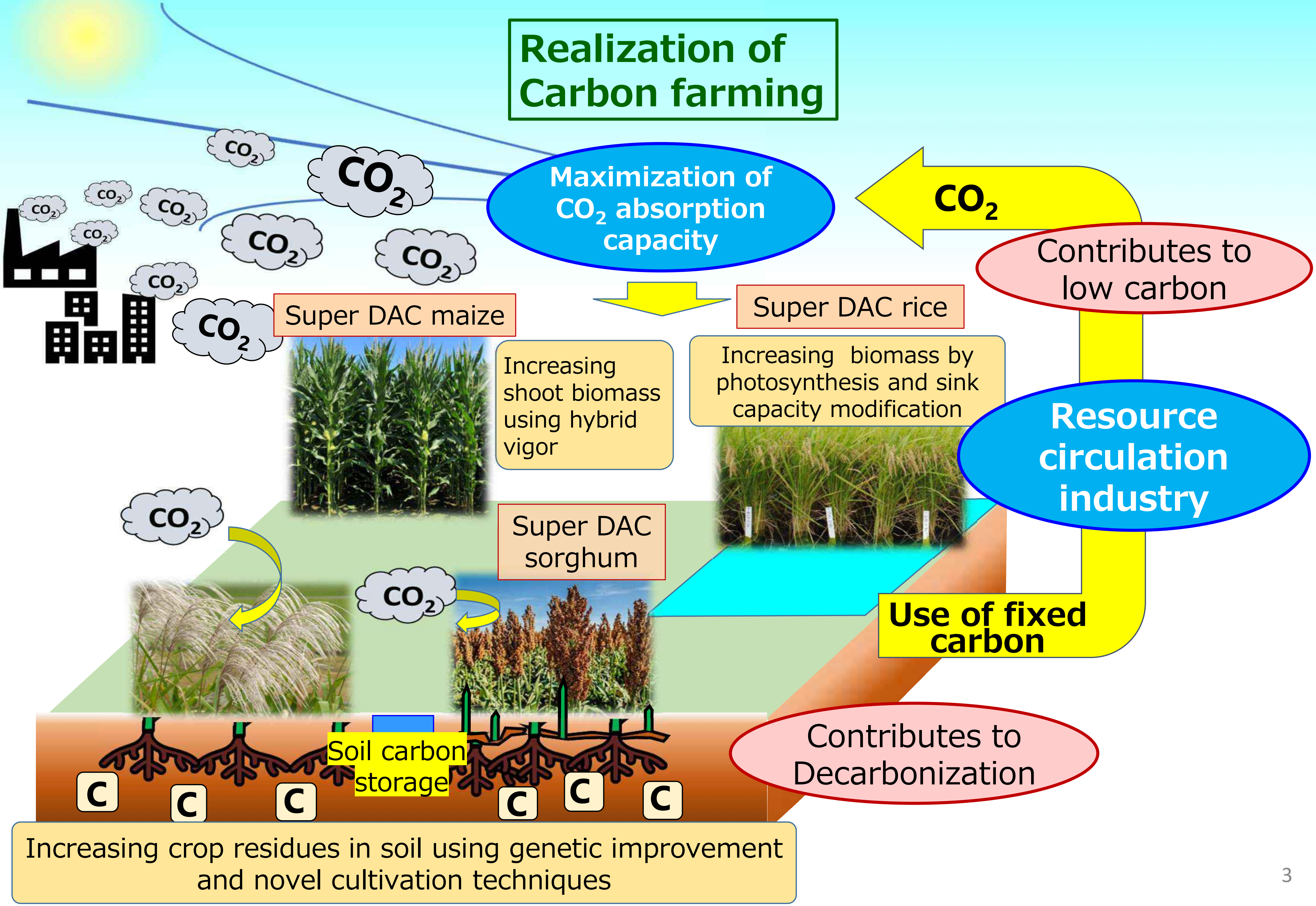
・**Material conversion**
Bioethanol and bioplastics

・**Reforestation and forest regeneration**
Elite tree and
new materials derived from wood

・**Blue Carbon**
Carbon storage by algae bed

Source : "Negative emission technology (NETs)"
(NEDO Technology Strategy Center)

Image of DAC agriculture in 2050



Potential of CO_2 absorption/fixation of crops

Assumption: 10t/ha biomass increase

<Present>

Average crop yield
10t/ha/year
CO_2 absorption/Fixation

1.5 kg- CO_2/m²/year

world arable land:1500 M ha
→22.5 Gt CO_2 Fixation

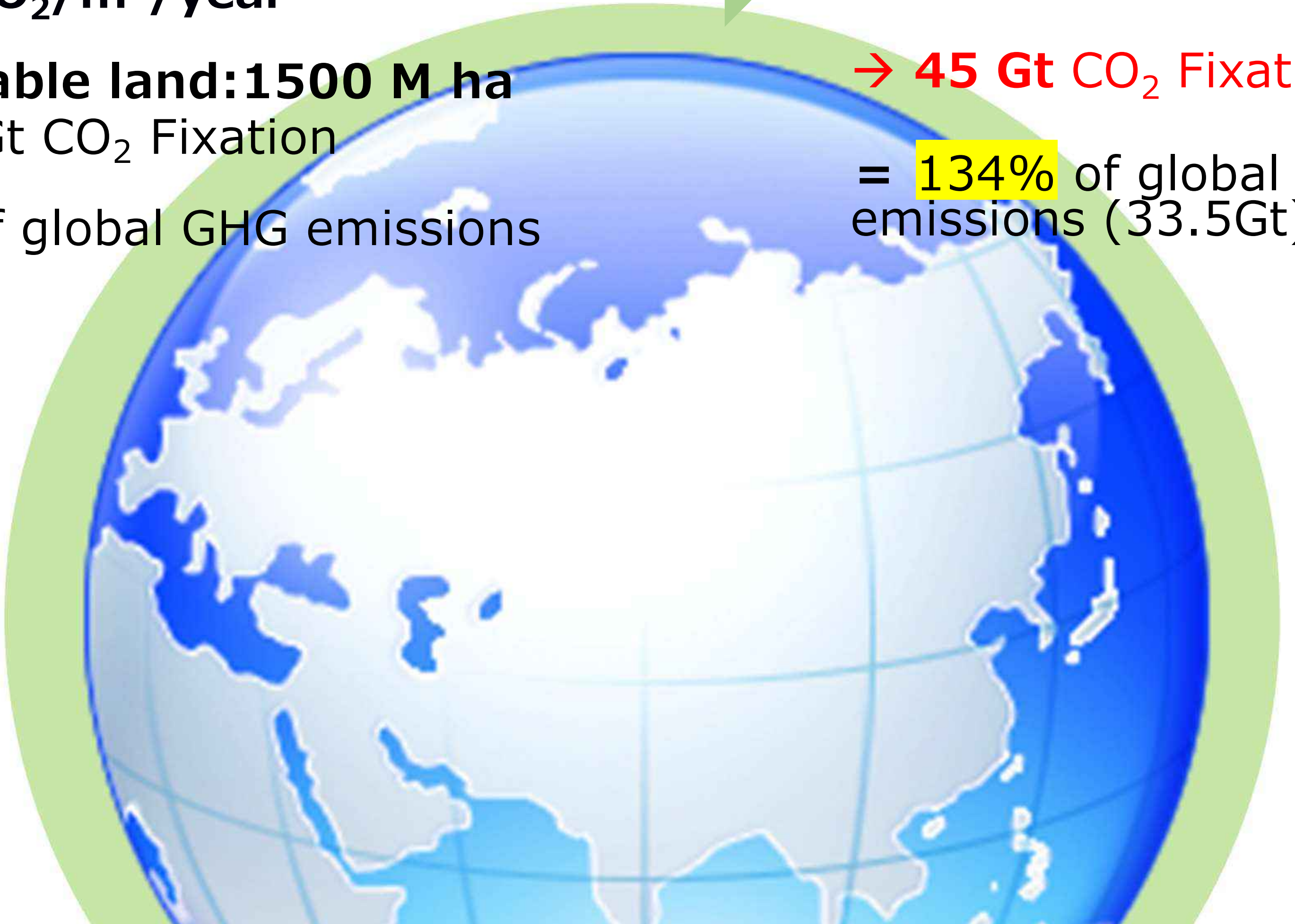
= 67% of global GHG emissions (33.5Gt)

<2050>

20t/ha/year
3.0 kg- CO_2/m²/year

→ **45 Gt** CO_2 Fixation

= 134% of global GHG emissions (33.5Gt)



Challenges, Goals, and Research theme

Technical challenges	Achievement goal	Research theme
Doubling CO_2 fixation ability of crops 1	**Development of Super DAC crops** Rice grain : 50%↑ Maize shoot : 100%↑	● Theme I Development of Super DAC Rice by increasing CO_2 absorption/ fixation ability ● Theme II Research on carbon fixation by increasing crop biomass
Biomass storage in soil 2	**Increase in underground biomass and soil carbon assessment.** Sorghum root, rhizome : 100%↑	● Theme II Research on carbon fixation by increasing crop biomass
Circular utilization of above-ground biomass 3	**Research and analysis of breakthrough(s) in resource circulation** by Super DAC crops	● Theme Ⅲ : Economic value and life cycle assessments of processes for resource utilization in DAC agriculture

Representative institution : National Agriculture and Food Research Organization (NARO)
Participating institutions:

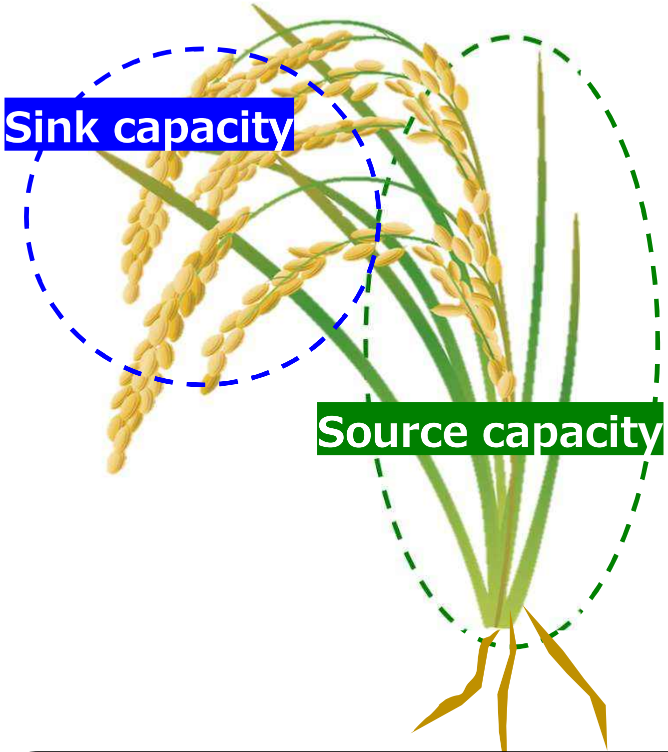
Theme I (Tokyo Univ. Agr. Tech., NARO, Nagoya U., UTokyo, Kyoto U.)
Theme Ⅱ (NARO, Nagoya U., Tokyo Univ. Agr. Tech., Shinshu U.)
Theme Ⅲ (NARO, UTokyo, The University of Shiga Prefecture, Saitama U.)

Theme I： Development of Super DAC Rice

Rice yield is determined by sink and source capacity

Sink capacity : seed number per panicle, seed size

Source capacity : photosynthesis and nutrient absorption capacity



Simultaneous improvements of source and sink capabilities

Breakthrough of rice yield limit

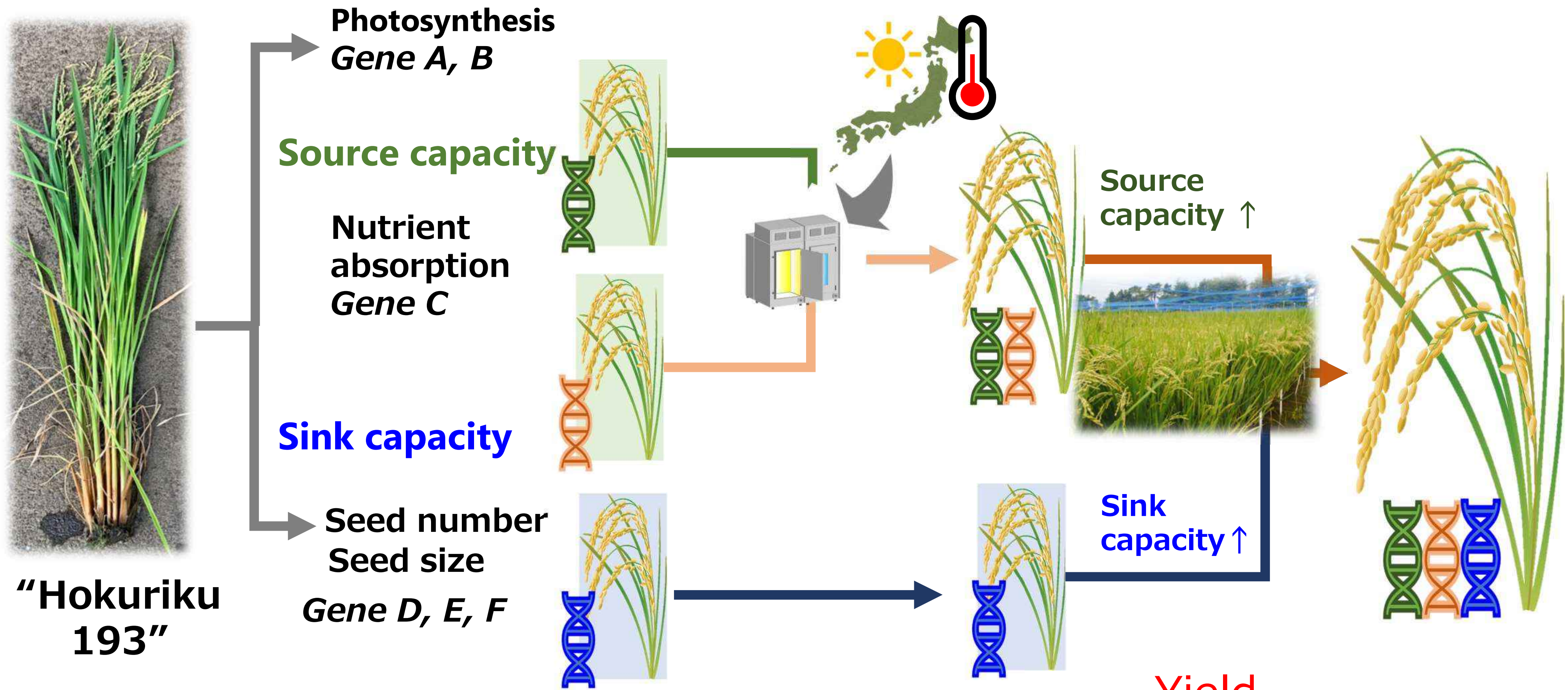
Photosynthesis capacity (Source) (10%↑)
Nutrient absorption capacity (Source) (10%↑)
Seed number and seed size (sink) (15%↑)

Theme I： Development of Super DAC Rice

(Present) (2022-2024 : FS stage) (2025-2030)

(2022-2024 : FS stage)
- ✓ Development of breeding material by genome editing
- ✓ Evaluation under growth chamber

(2025-2030)
- ✓ Staking of genes by generation acceleration
- ✓ Evaluation under field condition



Yield

1.5 times that of "Hokuriku 193“
More than twice as much as "Koshihikari"

Theme Ⅱ : Development of Super DAC maize

(Present) | **(2022-2024 : FS stage)** | **(2025-2030)**

Mi29 *Zea nicaraguensis*

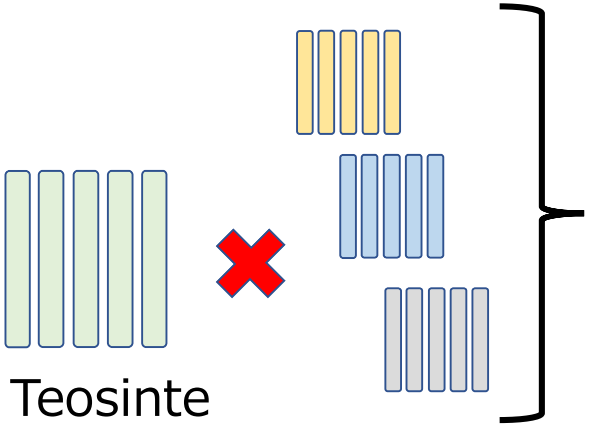
Maize is susceptible to wet soils.

A maize relative with moisture tolerance, Teosinte

Dozens of maize Inbred lines

F1 hybrid between maize x teosinte

2 times that of maize (shoot biomass)



Teosinte line

Dozens of Maize inbred lines

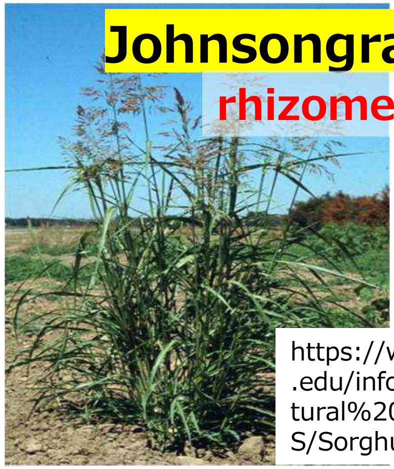
Identification of genomic regions controlling “hybrid vigor”

Evaluation of lodging resistance

Theme Ⅱ： Increase in underground biomass and soil carbon assessment

(Present) (2022-2024 : FS stage) (2025-2030)

Sorghum



https://wric.ucdavis.edu/information/natural%20areas/wr_S/Sorghum.pdf

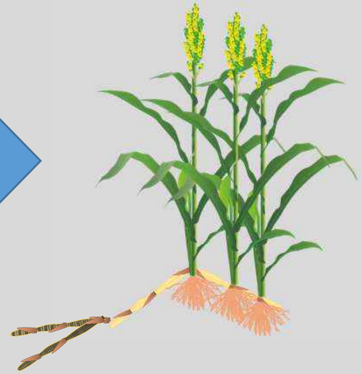
A sorghum relative with rhizome, johnsongrass

Collect and Select

No rhizomes

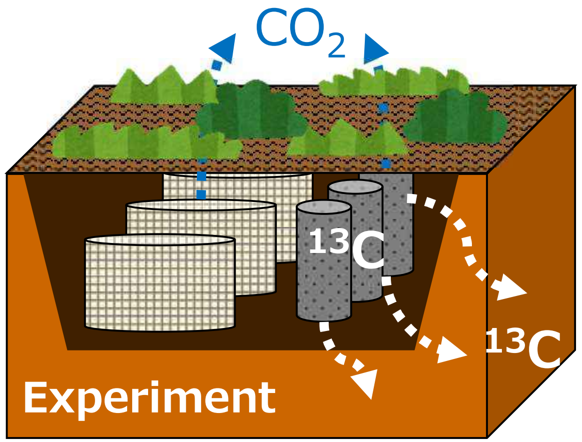
Sorghum

After 2025



Hybrid between sorghum and "elite johnsongrass"

2 times that of sorghum (underground biomass)



Assessment of soil carbon storage

Model estimation

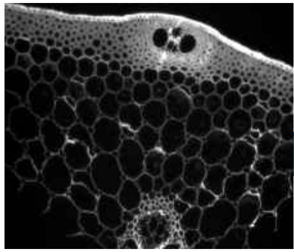
Basic data for negative emission of CO_2 with Soil carbon storage

Characterization of crop traits related to increased soil carbon storage

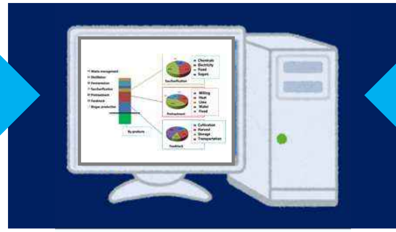
Theme Ⅲ： Economic value and life cycle assessments of processes for resource utilization in DAC agriculture

Crop cultivation — Harvest, collection, transportation, and storage — Recovery and production of valuables — Selling and consumption





Production/preparation of biomass (research and analysis)



Components, structures, and conversion efficiencies (research and analysis)

(2022-2024 : FS stage)

Evaluation of material characteristics and conversion properties of crop biomass
Proposal of scenarios for foundation of novel businesses by resource circulation

(2025-2030)

Demonstration of technologies for utilization of resources from Super DAC crops

Image of DAC agriculture in 2050