2024 NORTH AMERICAN BIOCHAR CONFERENCE

— USBI —

CALIFORNIA, USA

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2024 NORTH AMERICAN BIOCHAR CONFERENCE — USBI — CALIFORNIA, USA

TOWING

Adding an additional functional layer to biochar using microorganisms

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CTO, TOWING Co., Ltd.

Contents

My presentation consists of 6 parts

- Company profile
- World Agricultural Issues
- Core technology ‘SORATAN 宙炭’
- Recent progress
- Business model & team
- Conclusion

Company profile

We are a ag/bio-tech company tackling the issue of climate and food security

TOWING

- Spin-off from **Nagoya university** in Japan founded in 2020, comprised of 50 members of soil scientists and project developers
- Creating a soil amendment material based on **microorganism and biochar technology** for agriculture
- Our vision is to create a **circular and sustainable agricultural practice** in the earth and in the space, in order tackle imminent climate and food security issue
- Raised **7 mil USD in series A**
- Awarded from several accelerators/pitch program including Plug & Play (Top 5 startups in the 2023 pitch competition), Google accelerator and EQT (2nd place in the impact pitch night competition in 2023)

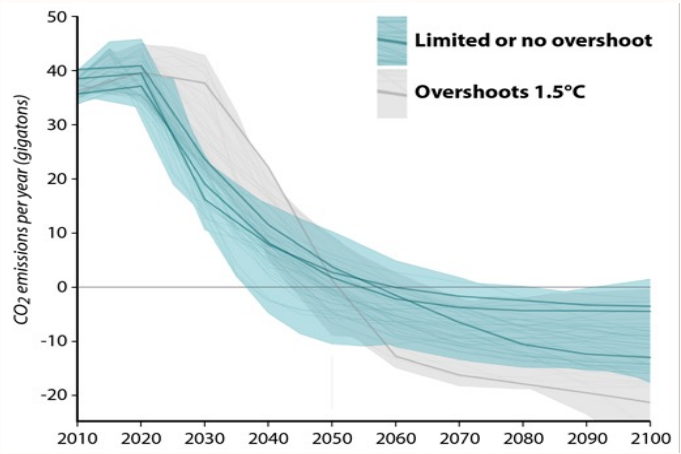
Global agenda humanity is facing

The world has to solve problems while increasing the productivity of food production

Soil degradation

- 23% of the soil in earth is degraded, and 90% could be degraded by 2020 (UN estimation)

Global warming



- Humanity has to achieve net zero carbon emission in order to avoid more than 1.5°C global warming

Food production

- We must increase our food production while tackling problem of climate change and biodiversity loss

Source: United Nations, IPCC, Global plan of action

Challenges the agriculture industry is facing

… and unsustainable practice of agriculture is part of the reason of arising problem. Transition towards sustainable agriculture(Regenerative, Local circulation, Carbon Capturing) is imminently required

Dependence on limited resources

- Chemical fertilizer for Nitrogen, Phosphorus, and Potassium are dependent on finite resources

Overuse of chemicals

- Chemical fertilizer or pesticides is reducing the soil microorganism and causing part of the soil degradation

CO_2 emission from soil

- Various agricultural practices (i.e. tillage, heavy machinery usage) are causing around 20% of world global CO_2 emission

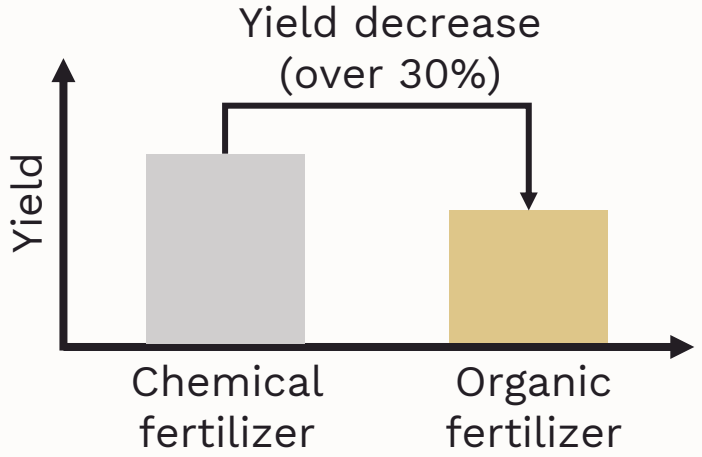
Source: New Indian Express, Global plan of action, World Atlas

Problems of utilizing organic fertilizer

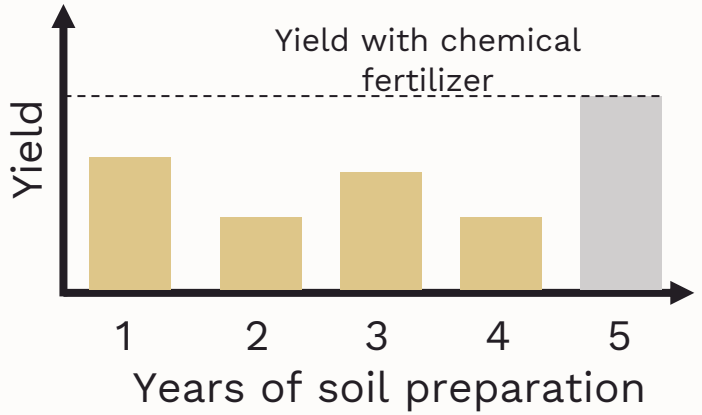
Yield decreases when switching to organic fertilizers. It also takes 5 years to return to the original yield. This will also increase GHG emissions per unit yield.

Yield decrease & Long soil Preparation[1)]

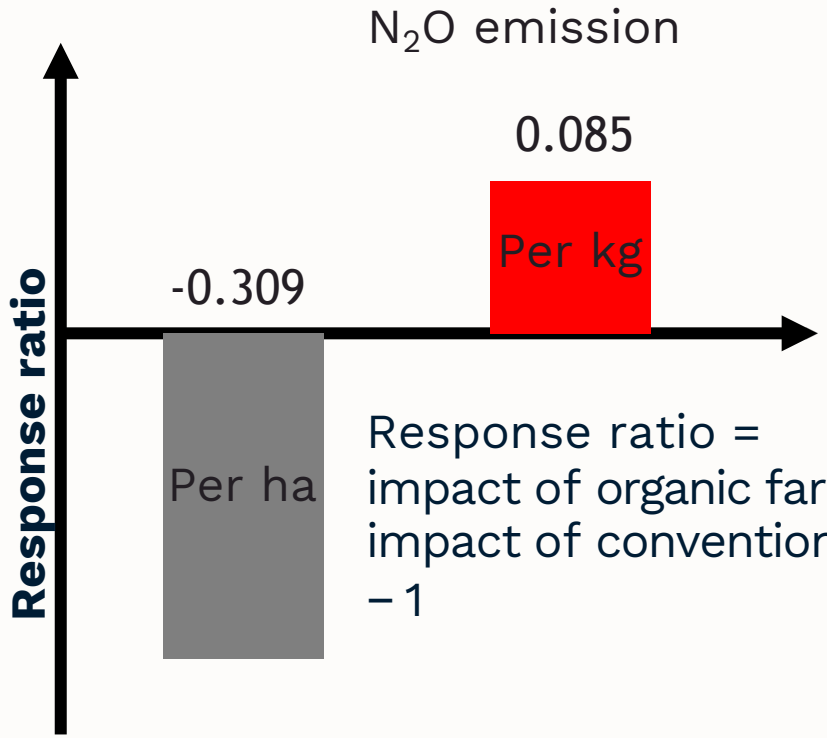
Yield decrease



Long soil Preparation



GHG emission[2)]

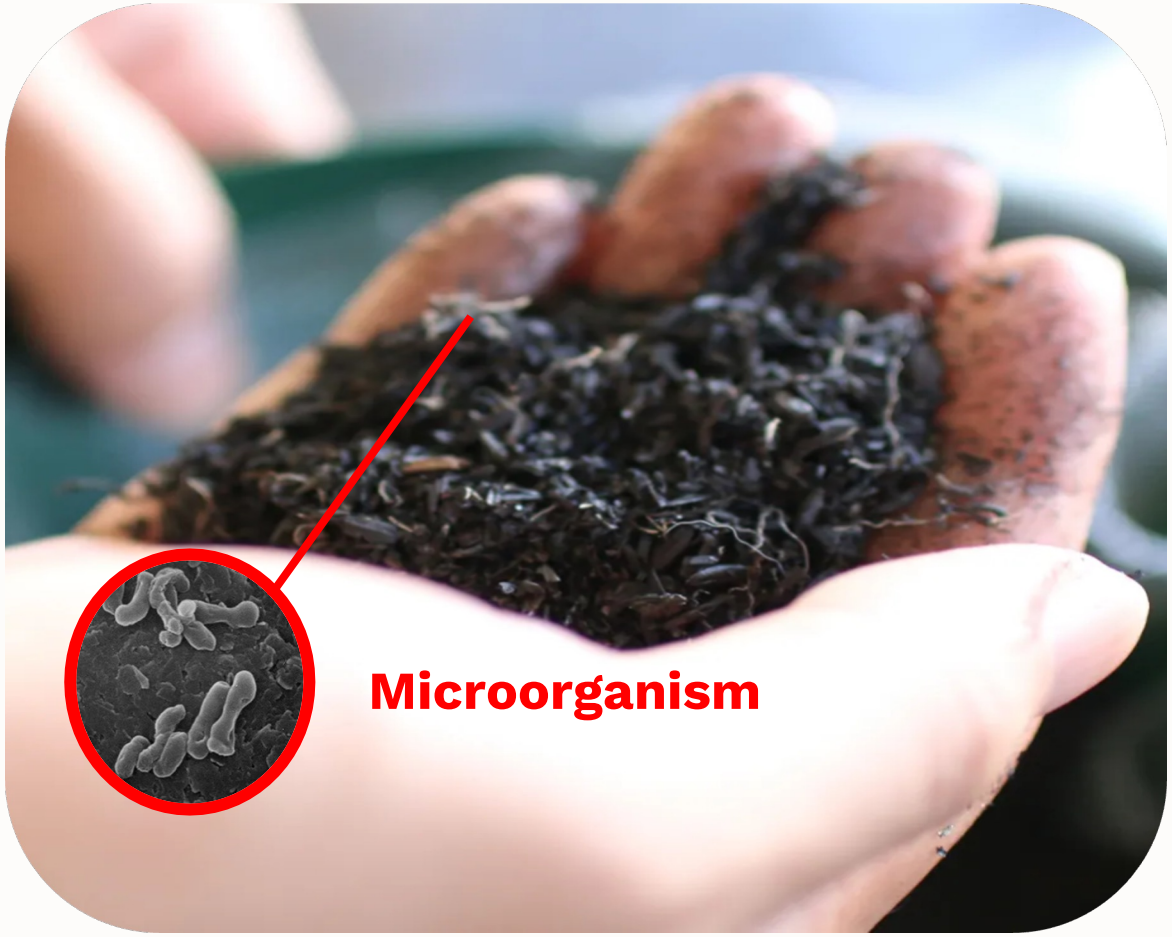


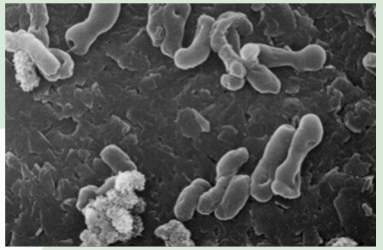
Response ratio =
impact of organic farming /
impact of conventional farming
– 1

1)Seufert, V. *et al.*, Comparing the yields of organic and conventional agriculture. *Nature* 485, 229–232 (2012).
2)Tuomisto, H.L., *et al.*,Does organic farming reduce environmental impacts? – A meta-analysis of European research. J. Environ. Manage 112, 309-320 (2012)

SORATAN 宙炭

TOWING is developing a microorganism based super functional soil amendment material called “SORATAN”





Soil derived microorganism

(e.g. Nitrifying bacteria)

Biochar

(e.g. Rice husk, livestock manure)

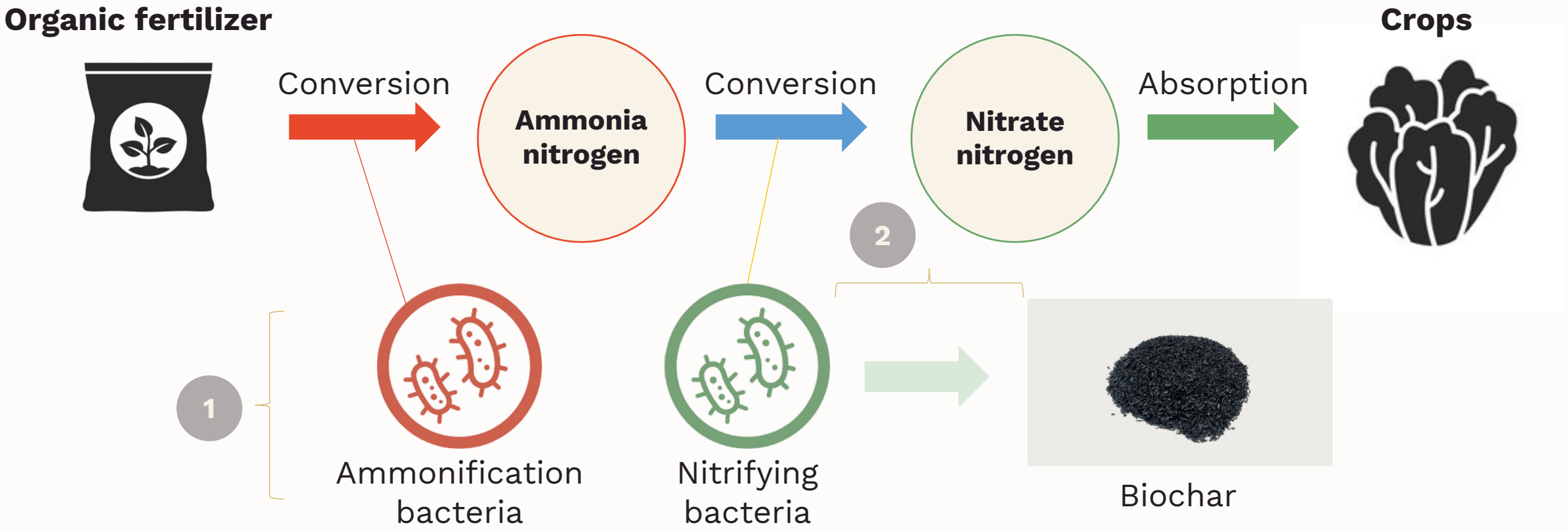
Organic fertilizer

(e.g. Chicken manure, fish powder)

※It is approved in Green food system strategy by the Japanese ministry of agriculture, forestry and fisheries.

Microorganism cultivation technology

Combining several patented technologies to maintain the balance of certain bacteria within a soil, and to attach them into biochar based on fermentation technique of Japanese Sake.

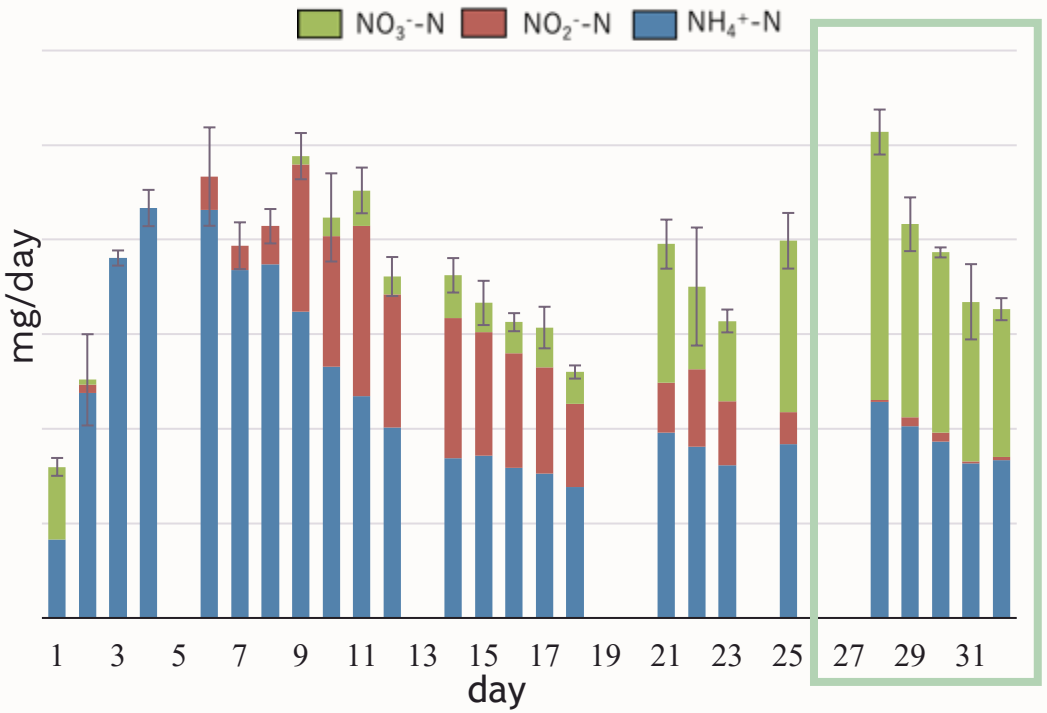


Realized by NARO's development technology and TOWING's unique biochar processing and microbial culture technology

Effects of microorganism in biochar

After 4 weeks of microbial culture, the level of nitrate production stabilizes. After that, SORATAN alone has soil functionality and allows plants to grow healthily with the use of organic fertilizers.

Generation rate of inorganic nitrogen [mg/day]*



Uses of SORATAN

Seedling soil

SOARTAN Control

Soil amendment

Generation of nitrate nitrogen from organic nitrogen stabilizes in around 4 weeks

Combines carbon fixation and improved microbial function

* Meeboon, J., Nishida, R.,. *et al.* Development of soil-less substrates capable of degrading organic nitrogen into nitrate as in natural soils. *Sci Rep* 12, 785 (2022).

Concept of our solution

We utilize local resources (biomass, organic fertilizer, microorganism) and bring them back into local soil

Utilize local resources as an alternative to finite resources

Bring back microorganism into soil to restore soil health

Store CO_2 in the agricultural farmland

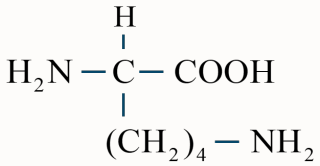
Our R&D activity

Create a platform of high functioning biochar suitable for local materials, functioning for organic conversion, disease suppression, yield increase and GHG reduction

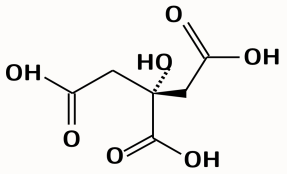
Update the functionality of SORATAN

③Control from biomes

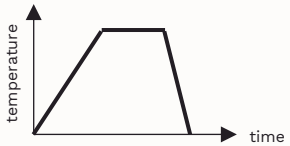
②Control from biomass



④Control from Acid

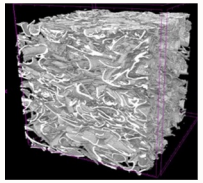


①Control from the pyrolysis



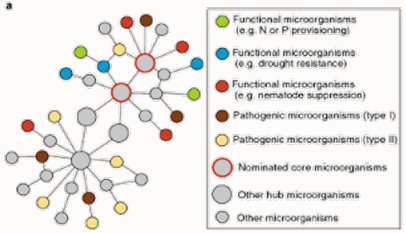
High functioning biochar

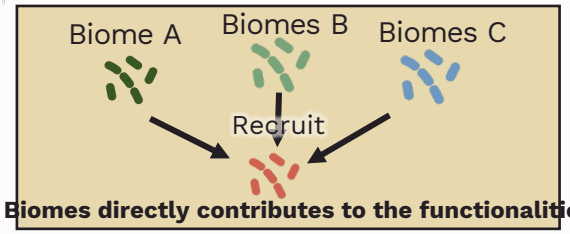
⑤Control from structure



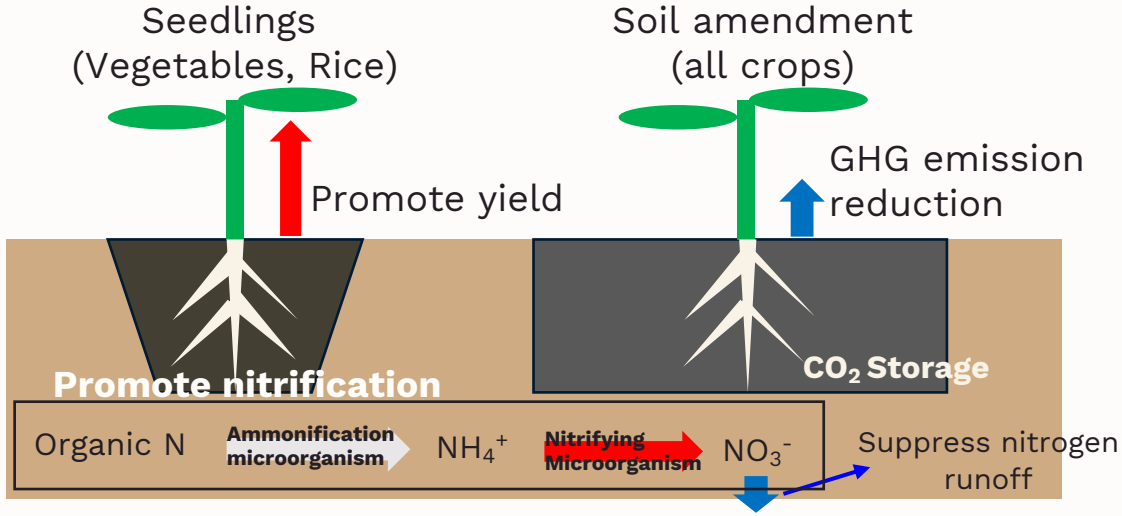
Explore the core biomes through bacterial flora and fingi analysis[1)]

*Contributes to organic transition, disease suppression, yield increase, and GHG emission decrease

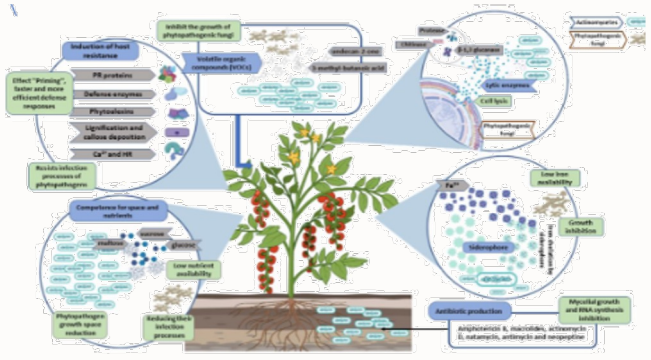




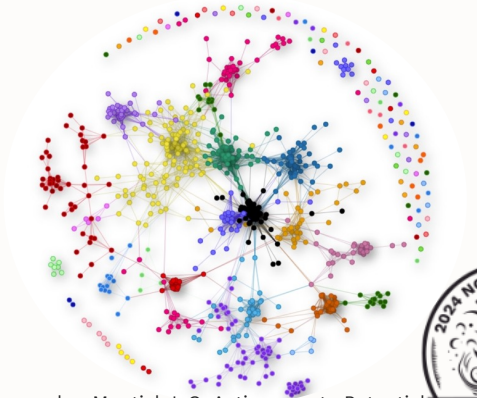
Quantifying the effect of SORATAN



Revealing the mechanism of disease suppression[2)]



Quantification through multi-omics



1) Toju, H., Peay, K.G., Yamamichi, M. *et al.* Core microbiomes for sustainable agroecosystems. *Nature Plants* **4**, 247–257 (2018).

2) Torres-Rodriguez, J.A.; Reyes-Pérez, J.J.; Quiñones-Aguilar, E.E.; Hernandez-Montiel, L.G. Actinomycete Potential as Biocontrol Agent of Phytopathogenic Fungi: Mechanisms, Source, and Applications. *Plants* **2022**, *11*, 3201.

Multiple benefits obtained through the technology

The technology increases fertility of soil leading to increased yield of crops, while upcycling local material and storing CO_2 into soil

1 Super fast soil preparation

It takes around **five years** to prepare soil ready to use organic fertilizer

Shorten the soil preparation to **one month**

2 Yield increase utilizing organic fertilizer

Organic fertilizer is underutilized as yield is typically lower using it

Increase the yield compared even to chemical fertilizer by **+20~70%**

3 Suppress disease

Farmer is facing continuous threats from diseases caused by multiple factors

For certain diseases, **suppress the risk** of the appearance of it

4 Upcycle waste

Companies are paying cost for handling unused biomasses

Upcycle unused biomasses to biochar and convert it into valuable product

5 Store CO_2

Carbon is emitted in the conventional agricultural practice

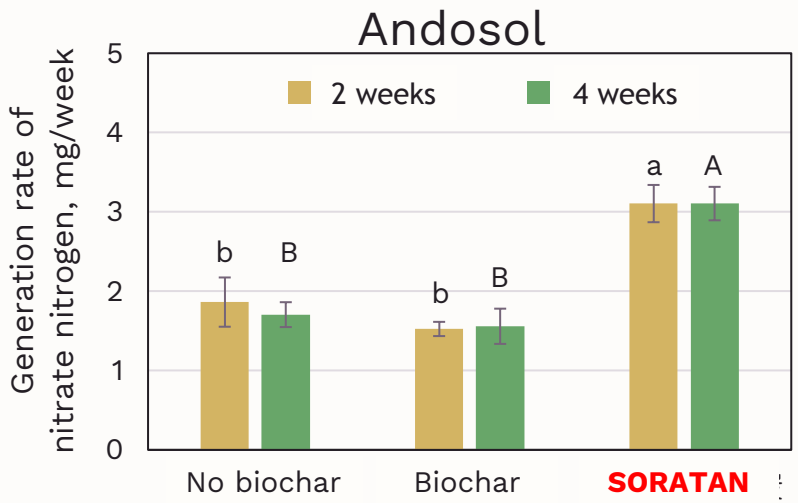
Store **10 ton CO_2e** of carbon in 1 ha (first year, Dependent on biomass type)

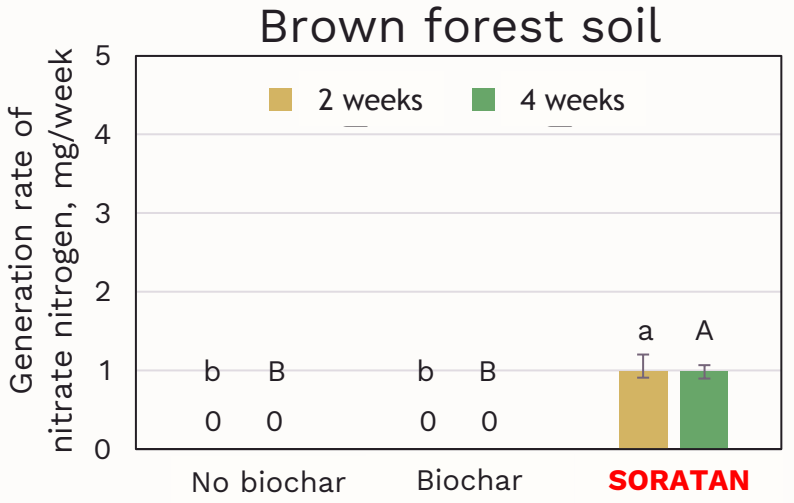
1 Effects of microorganism in soil preparation

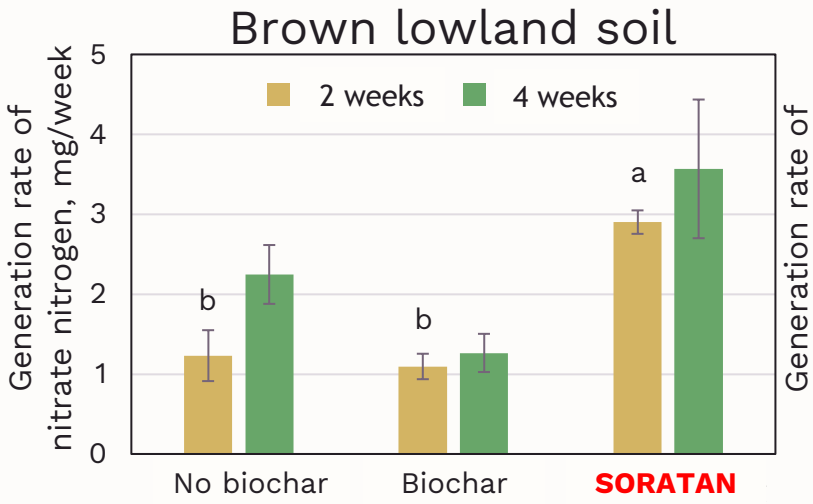
After 4 weeks of soil preparation in 5 major Japanese soil types, nitrate generation levels stabilize and soil organic fertilizer decomposition rates increase.

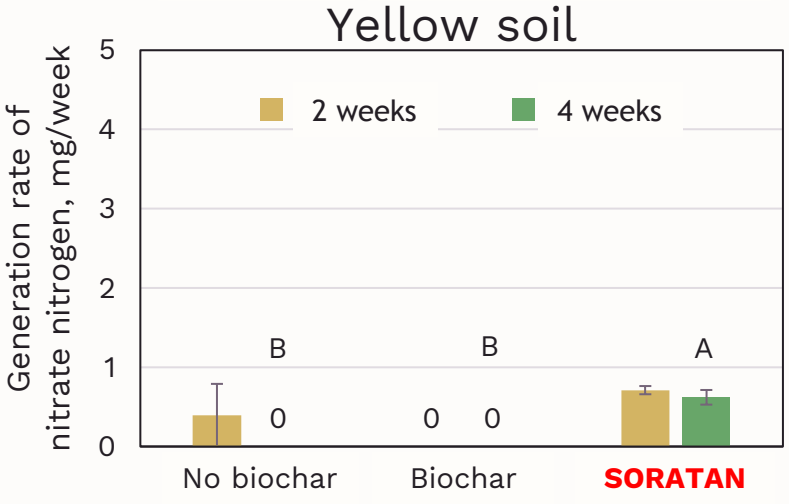
Condition

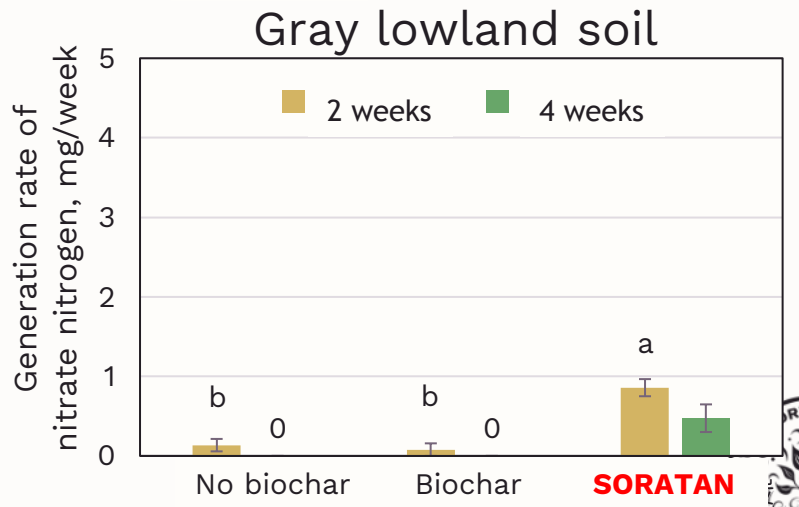
- Amount of soil：100 ml
- Biochar type ：Rice husk
- Mixing rate：25 vol%
- Fertilizer type ：Fish soluble
- Amount of fertilizer ：6 mgN/week
- Operation：Rinsed with 100 ml of water once a week
- Measurement item： Nitrate nitrogen content in soil











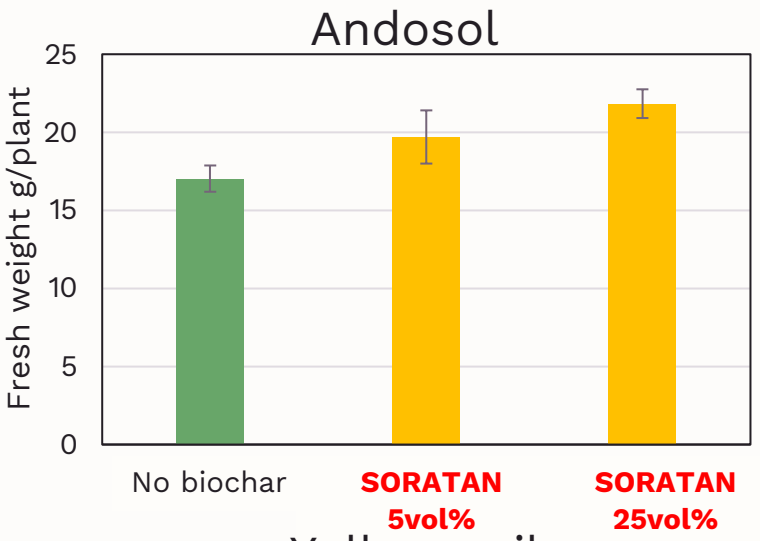
※ Significantly different at 95% confidence level between different symbols, N=3 (Tukey's test)

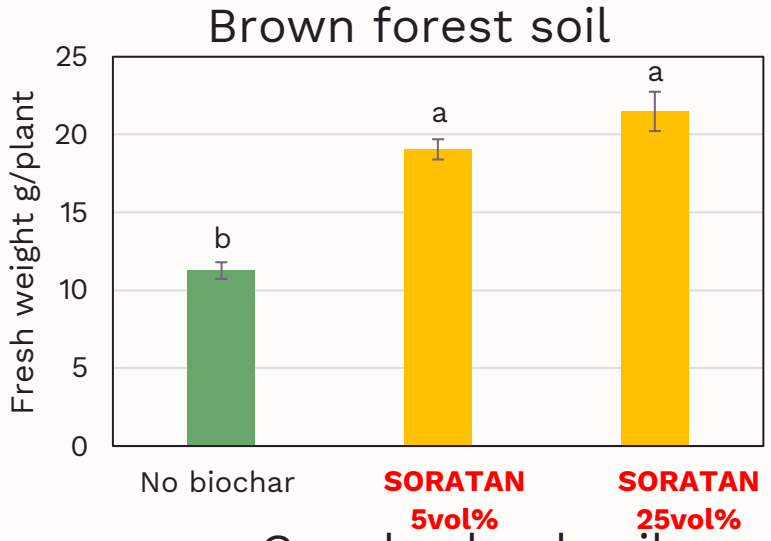
② Yield increase observed

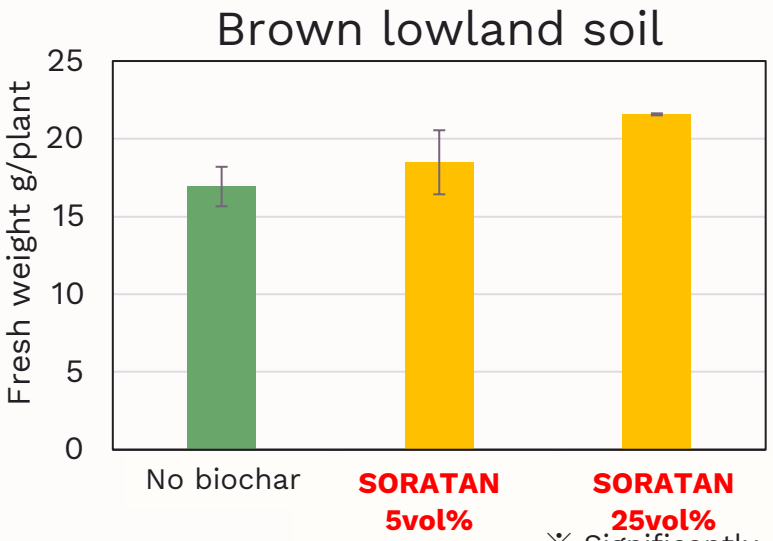
Yield increased by more than 20% with the application of SORATAN in 5 major Japanese soil types

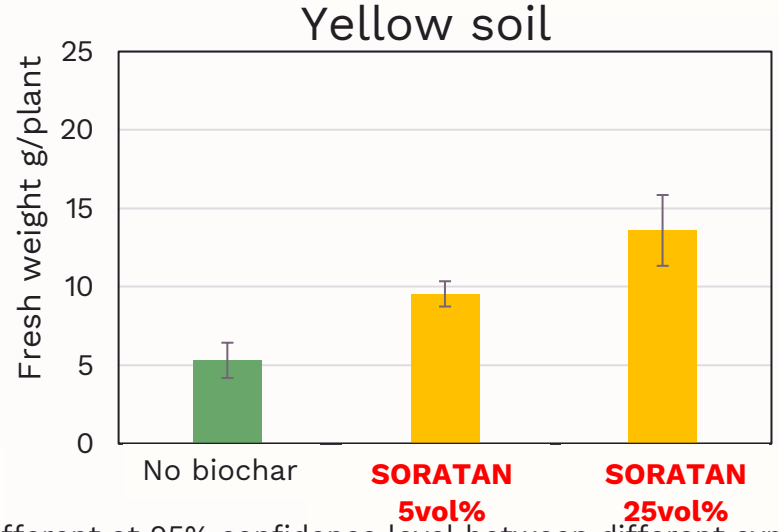
Condition

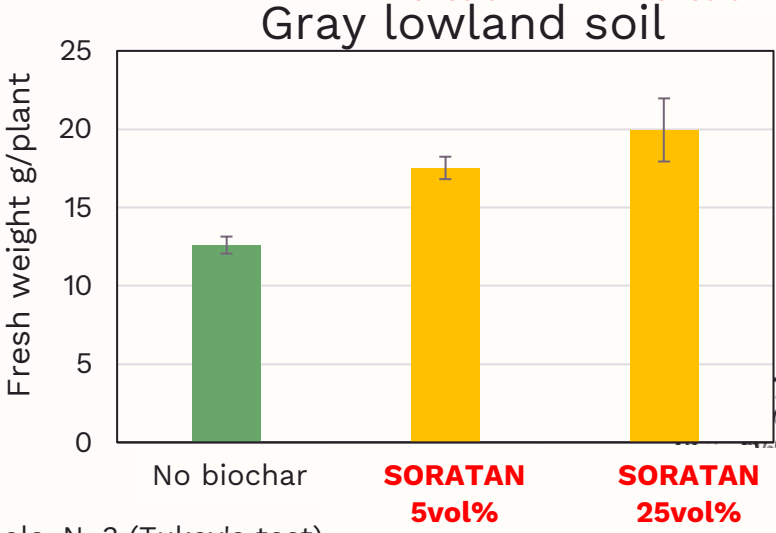
- Amount of soil：300 ml
- Biochar type ：Rice husk
- Fertilizer type ：Fish soluble
- Amount of fertilizer ：4 mgN/day
- Measurement item：Fresh weight
- Growing period：35 days
- Plant type：Japanese mustard spinach











※ Significantly different at 95% confidence level between different symbols, N=3 (Tukey's test)

2 Other crops in test

Gathering data from around 200 farmers in Japan and observing +20~70% yield increase

Lettuce (+27%)

Onion (+35%)

Watermelon (+37%)

Eggplant (+57%)

※Compared with chemical fertilizer.

188 farmers

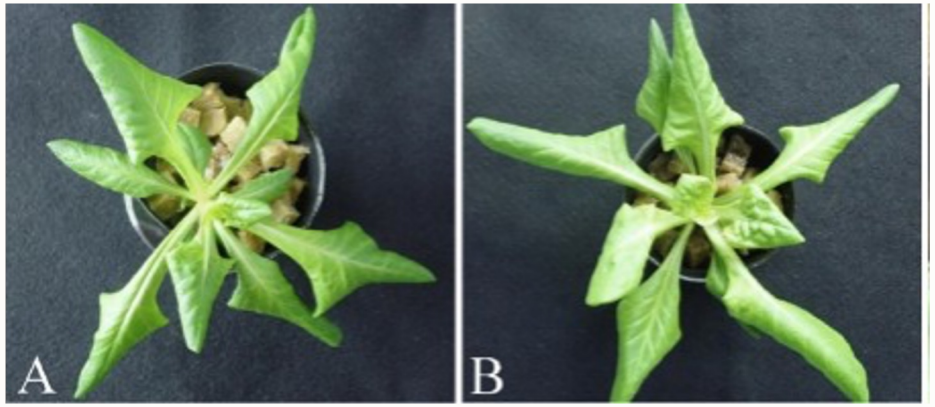
30+ Crop types

- **Green pepper**
- **Tomato**
- **Strawberries**
- **Rice**
- **Sorghum**
- **Cabbage**
- **Snap peas**
- **Wild Rocket**
- **Ginger**
- **Soybeans**
- **Okura**
- **Zucchini**
- **Mary Gold**
- **Chamomile**
- **Others...**

3 Disease suppression

Biochar and specific soil microorganisms inoculated with biochar suppress the development of certain soil-borne diseases.

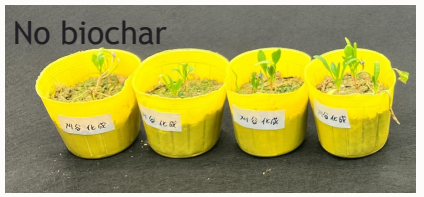
Suppression of root rot disease by *Fusarium oxysporum* f. sp. *Lactuca*[1)]



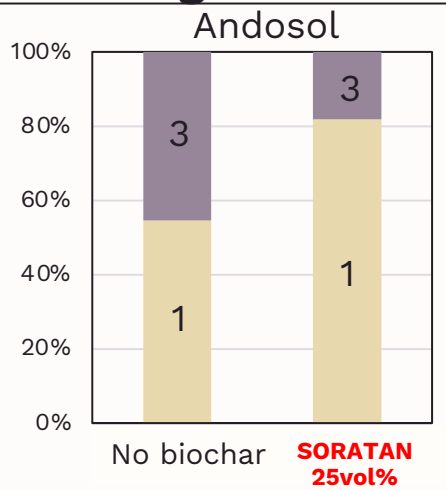
A : No inoculation
B : Inoculation with same technology as SORATAN
C : Inoculation without same technology as SORATAN

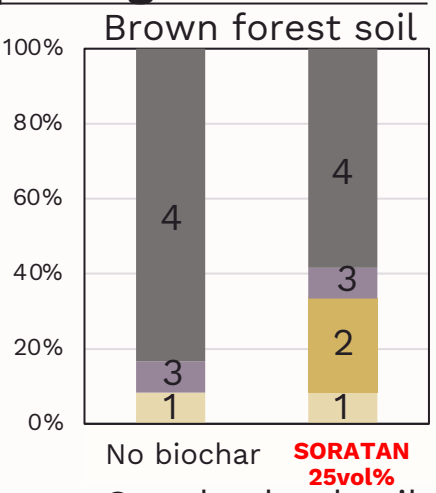
1)Meeboon, J.*et al.* Generation of *Fusarium oxysporum*-suppressive soil with non-soil carriers using a multiple-parallel-mineralization technique. *Sci Rep* 12, 7968 (2022).
2)Test result by TOWING lab

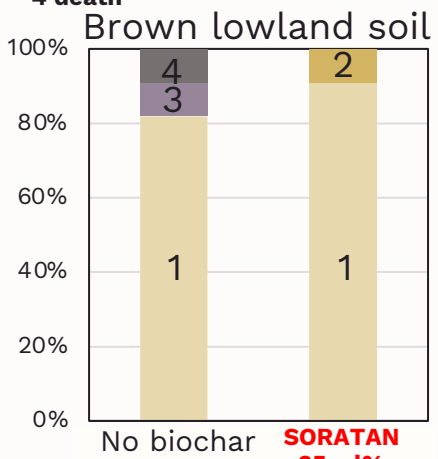
Assessment of disease symptoms in soil mixed with SORATAN using the same pathogen[2)]

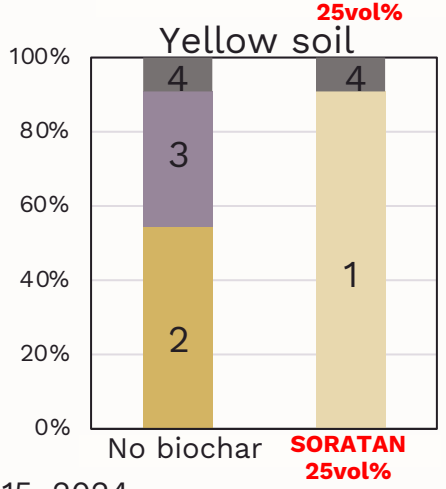


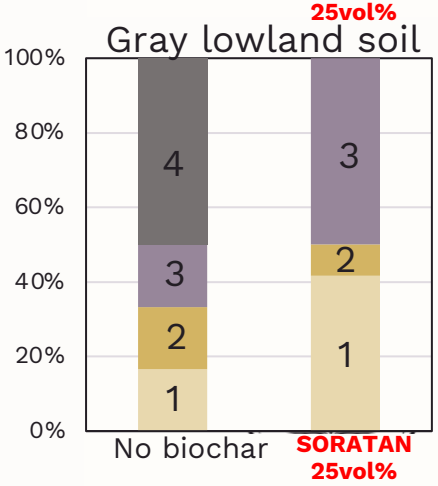
Disease symptom index: 1 healthy, 2 some leaves wilt, 3 all yellowing, 4 death







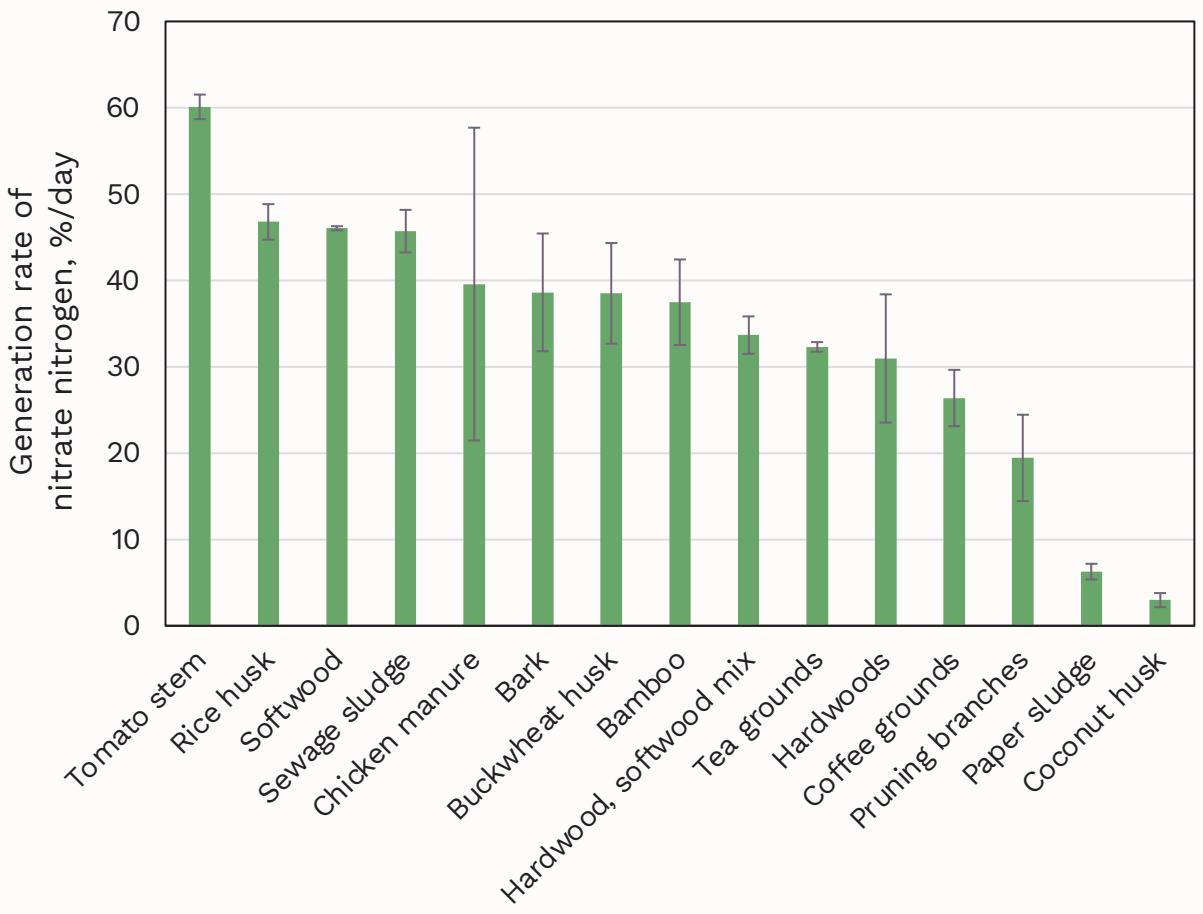




4 Upcycle of unused biomass

Testing more than 200 biomass to be used as a SORATAN.
SORATAN performance depends on physical and chemical properties of biochar

Nitrate nitrogen recovery rate of major biochar




Rice husk


Livestock manure


Vegetable stem


Sugarcane bagasse

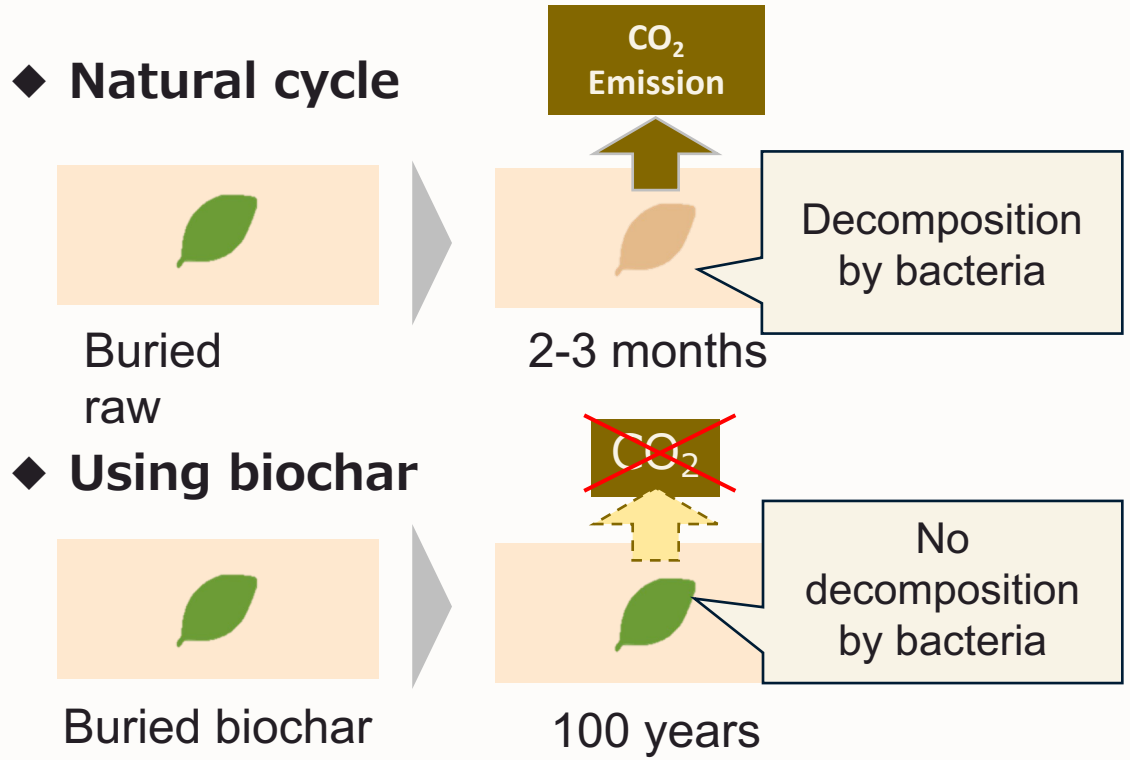

Bark


Branches

5 Carbon fixation by biochar and its limitations

Biochar can fix large amounts of CO_2 in agricultural fields, but there is a limit to the amount applied

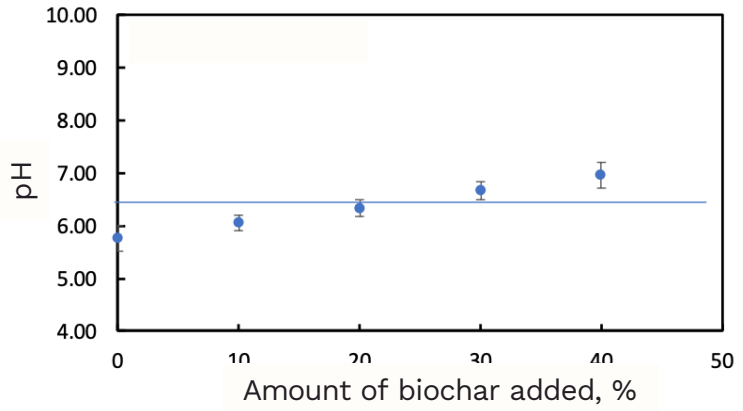
Mechanism of carbon fixation



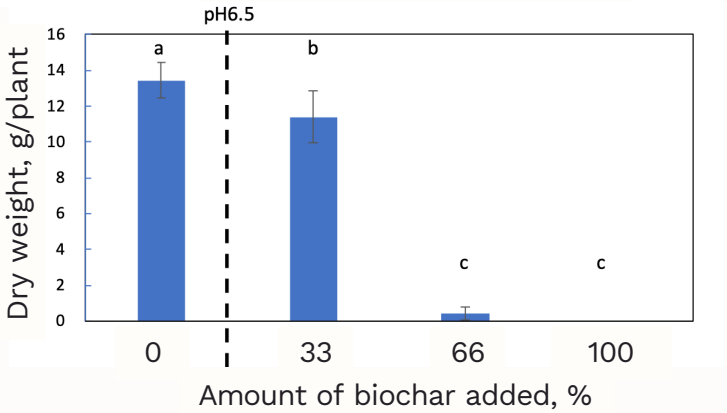
Prevents supposed CO_2 emission

Excessive increase in soil pH[1)]

Soil pH increase



Yield decrease



There is an upper limit to the amount of biochar mixed

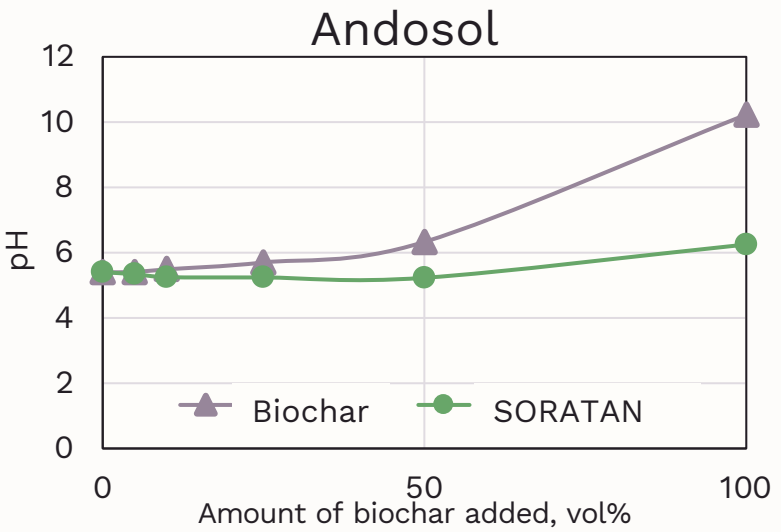
1) Japanese ministry of agriculture, forestry and fisheries

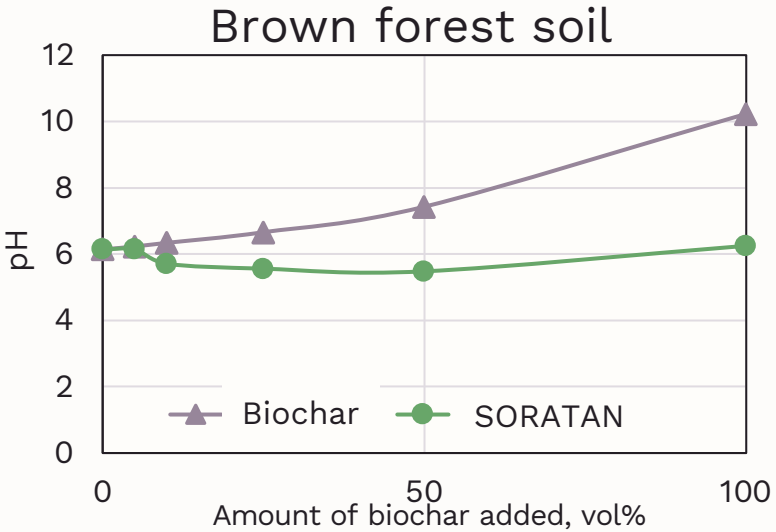
5 Methodology of carbon sequestration and storage by biochar

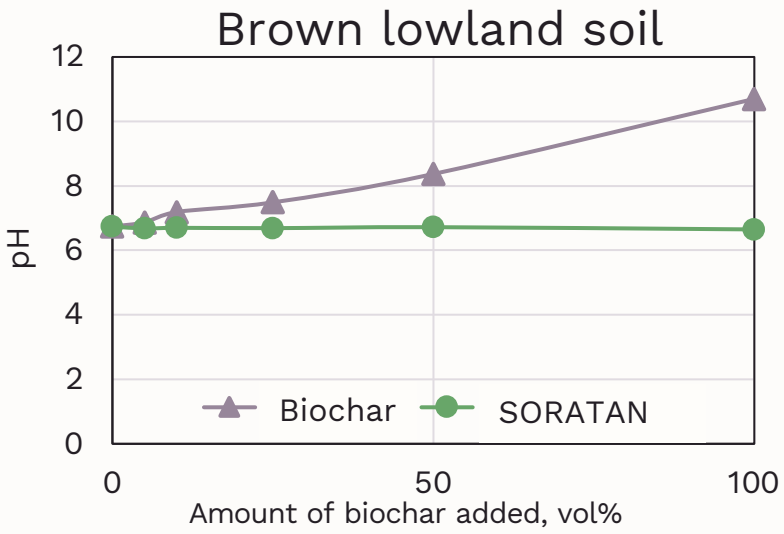
SORATAN does not have an upper limit on the amount of mixture because the pH does not increase excessively as the amount of mixture increases in 5 major Japanese soil types

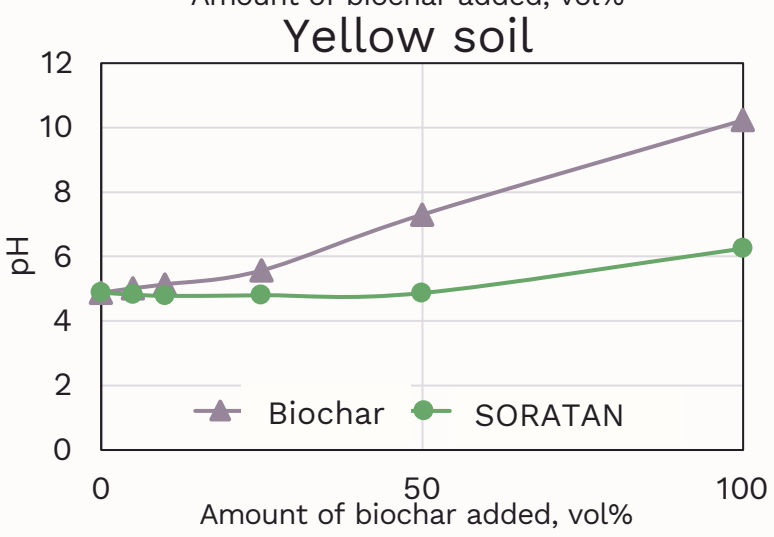
Condition

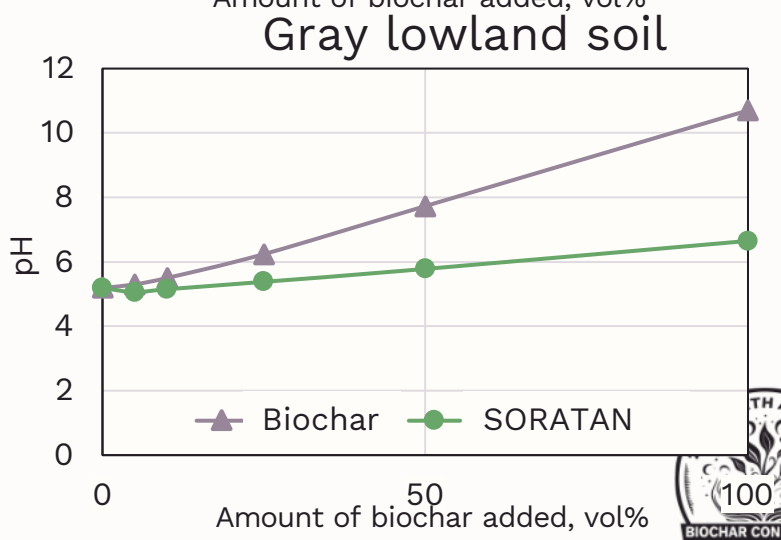
- Amount of soil：100 ml
- Biochar type ：Rice husk
- Mixing rate：25 vol%
- Operation：Add 250 ml pure water and shake for 6 hours
- Measurement item： Soil pH







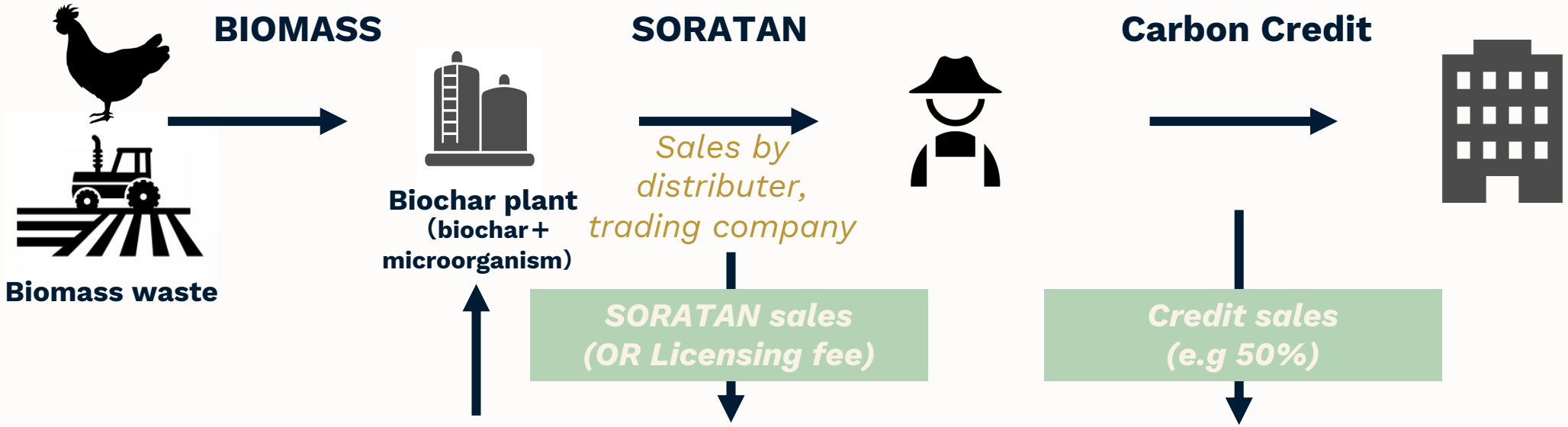




Overview of our business model

We assume revenue from sales of SORATAN plus carbon credit generation.
Also, considering to provide technical licensing to a biochar producer

Biomass procurement and SORATAN production → ***SORATAN application*** → **Carbon Credit Generation**



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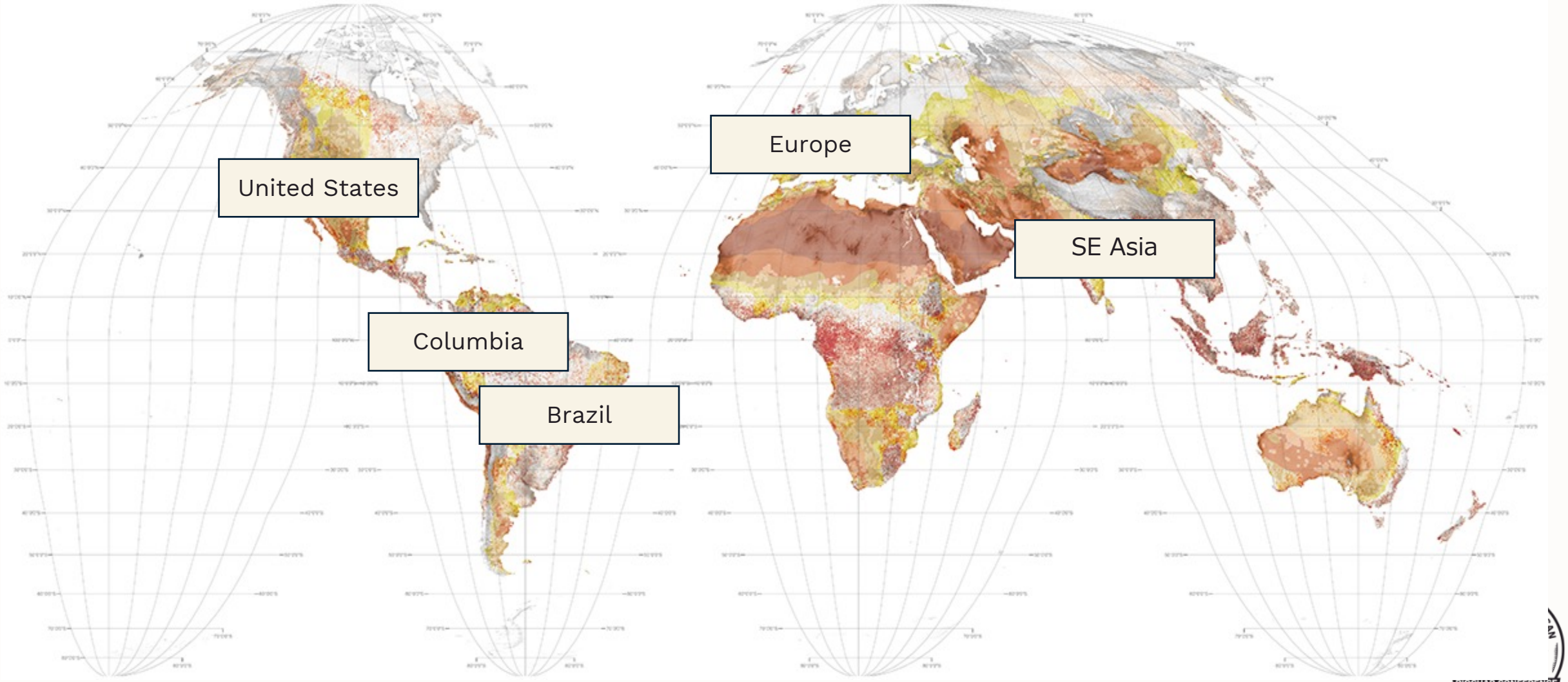
Global Implementation

We are in initial discussion with multiple countries



Source) Atlas for the end of the world

Impact on SDGs goal

SORATAN can make impact on various aspects of SDGs goals

- SORATAN enhances the usage of organic fertilizer, which has positive impact on food health and well being

- SORATAN increases the soil fertility by putting back microorganism into the soil

- Utilizing unused local biomass will reduce unnecessary use of resources

- Excess nutrition from farming derived by chemical fertilizer lands to the ocean in the end, and creates a pollution there. By reducing the usage of chemical fertilizer, we believe there is a positive impact on ocean also

- CO_2 capture in the agricultural farmland has huge potential of carbon sequestration, potentially sequester 7 billion tons of CO2e per year

Source; United Nations

Team

We are a team of soil scientists, professionals, and project developers, with around 50 people

CEO : Kohei Nishida

Established TOWING to achieve development of agriculture in the Earth and the Universe
Master from Graduate school of Environmental Studies, Nagoya Univ.

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CHRO : Kae Fujimori

Sustaining business operation by the past experience of HR and PR head in IT industry

CTO : Ryoya Nishida

Developing technology of SORATAN
D3 of Graduate school of Nagoya University. Experienced research in National Agriculture and Food Research Organization. Elected MIT technology review Innovators U35 Japan

MIT Technology Review Innovators Under 35 Japan
Forbes 30 UNDER 30 JAPAN 2023

Head of overseas expansion : Takuto Nagata

Developing and implementing overseas go to market strategy and partnership
Joined TOWING after management consulting and infrastructure investment industry. MBA, IESE

COO : Shunsuke Kimura

Developing and implementing business strategy utilizing the experience of new business launch and research
Joined TOWING after electronic and in-vehicle manufacturer

Sales of overseas expansion : Shogo Okishio

Developing and implementing overseas go to market strategy and partnership.
Joined TOWING after designing thermal product at in-vehicle manufacturer

Conclusion

We found that SOTRATAN not only upcycles local materials and stores CO_2 in the soil, but also improves soil fertility and increases crop yields

The following effects were observed in 5 major soil types in Japan using SORATAN application.

- **Nitrate generation levels stabilize and soil organic fertilizer decomposition rates increase.**
- **Yield increased by more than 20% with the addition of SORATAN.**
- **Biochar and specific soil microorganisms inoculated with biochar suppress the development of certain soil-borne diseases.**
- **SORATAN does not have an upper limit on the amount of mixture because the pH does not increase excessively as the amount of mixture increases**

We plan to update SORATAN and clarify its mechanisms as we test its effectiveness in soils around the world.