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Microbial networks for sustainable ecosystems -enabling to utilize natural resilience-

Background

Agroecosystems face multiple challenges worldwide. Agricultural lands are deteriorating, crops are exposed to extreme weather conditions, and new strains of pests resistant to chemical pesticides are emerging. In order to build sustainable agroecosystems, minimize devastating diseases, and maximize crop yield, understanding what drives ecosystem dynamics is of paramount importance so that the drivers can then be manipulated.

Technical Summary

The inventors developed a technology based on large-scale DNA analysis that identifies symbiotic networks between plants and microorganisms in the underground soil. The composition and function of microbiomes is assessed and changes in microbiota due to environmental factors can be estimated. By identifying 'core microbiomes', sets of microorganisms that form cores of interactions, the researchers then use them to optimize microbial functions at the individual plant and ecosystem levels (**Fig. 1**, Toju et al. 2018). This means that we can utilize natural resilience via enhancing the microbial communication network underground.

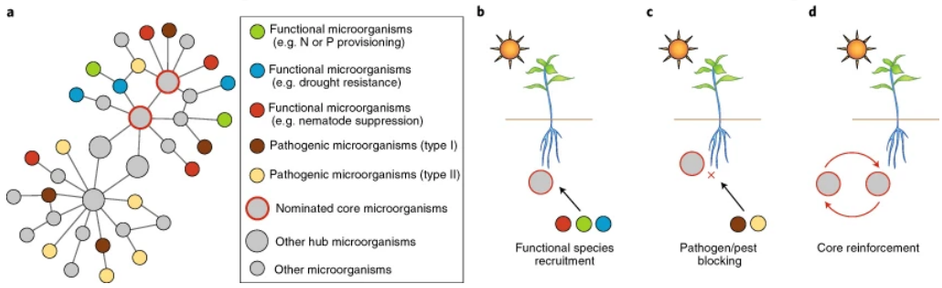

Figure 1. a) Identification of core microorganisms. Within a microbial network, hub microbial species or strains are defined based on network topology data. Microorganisms are scored based on their potential to recruit native microorganisms with diverse physiological and ecosystem functions (b) and potential for blocking pathogen/pest infection (c). Such roles of core microorganisms can be further reinforced by introducing pairs or sets of core microorganisms in facilitative interactions (d). From Toju et al. (2018) Nature Plants 4:247-257.

Different types of ecosystems can be analyzed including farmlands, forests, grasslands, freshwater and seawater ecosystems. The core species with beneficial biological functions such as the ability to decompose organic matter, transport soil nutrients, suppress pest/pathogens, and stimulate plants' immune systems are then chosen to 1) restore natural ecosystems 2) design sustainable ecosystems composed of more resilient species 3) produce enhanced plant seedlings to improve crop characteristics.

The technology was already tested in several plant species (green onions, tomatoes, komatsuna, strawberry; these were chosen for quick PoC) improving the growth and resilience of the crops by enhancing the plant-symbiont relationships (**Fig.2**). We observed more yield with fewer fertilizer/pesticides. This technology is inherently applicable to grains/trees.

Figure 2. Tomato without symbiotic fungi (left) and tomato with fungi (right).

Sunlit Seedlings is a spin–off from Kyoto University that develops sustainable agriculture technologies. We are looking for business partners.

Technology Readiness Level
7

Potential Applications
- Sustainable farming
- Ecosystem development and restoration
- Biodiversity analysis
- Information services: analysis of microbiome composition within a host

Advantages
- Sustainable agriculture incl. improved crop yield
- Ecosystem restoration following natural disasters
- Information-based agricultural cultivation

Possible Collaboration Mode(s)
- R&D collaboration
- Licensing
- Other

Patents No
WO2022-102389; 特開2022-133839; 特開2022-106643; 特開2022-077963 特開2021-149918; 特許7038451; 特許6899107; 特許6899107; 特許6899106

Publication(s)
Toju, H., et al. Core microbiomes for sustainable agroecosystems. Nature Plants 4, 247–257 (2018). https://doi.org/10.1038/s41477-018-0139-4

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