Development of Environmentally Robust Crops based on Crop Design technology

"Food insecurity threatens peace" is a relatively common expression. Accomplishment of our Moonshot would enable us to create crops that are highly adaptable to the environment and to swiftly spread them worldwide, thereby globally addressing risks of food shortage and helping in the establishment of a peaceful future for the next generation.

We also believe that "full utilization of crop functions" will contribute to not only ensuring crop robustness but also achieving a wide range of Sustainable Development Goals (SDGs), as it will be possible to overcome environmental problems and respond to innovations in industrial technology.

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Achieving zero food risk by improving crop robustness through cyber-physical systems

Keywords: Environmental degradation, Crop design, Wild plants

Background

Need for robust crops capable of coping with environmental degradation caused by global warming

In 2050, the world population is expected to reach 9.7 billion, requiring 1.7 times more food than as of 2010. However, the progression of global warming has increased the prevalence of extreme weather conditions worldwide. In addition, the slowing production growth of major grains will make it difficult to meet our grain needs in 2050. Development of crops that are strong and tolerant enough to cope with environmental degradation caused by global warming is an urgent necessity.

Research Contents

Elucidating the "robustness" of wild plants and establishing a digital crop design technology

In this project, we will elucidate the mechanism underlying the "robustness" of wild plants and establish a digital crop design technology to rapidly develop robust crops that can be grown under environmental stresses such as nutrient deficiency and drought.

We will elucidate the genes related to the "robustness" (nutrient deficiency, drought, and salt damage etc.) of wild plants (Task1), digitally predict their growth using information science technologies such as AI (Task2, Task4), and simultaneously make improvements to multiple genes involved based on those designs (Task3). This will not only enable the development of new crop varieties but also shorten the time required for domestication from thousands of years to only a few years.

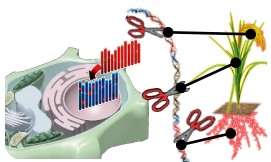
Task1.
Developing robust crops

Elucidating the resilience of wild plants and other organisms

Task2.
Digital Crop Design

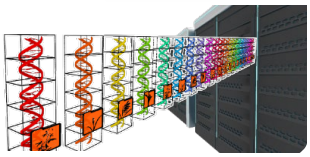
Cyber-Physical System (CPS)

Task3.
Dynamic genome modification



Task4.
Encyclopedia of stress tolerance genes

Accumulate useful genetic information



【MS Target】 We will develop crops adapted to climate change, such as rice, wheat, and soybean, to ensure stability of food supply even in conditions of severe drought and salt damage.

【Solutions to Social Problems】 We will launch the "Digital Crop Design Center" by 2030, release robust crops fully utilizing biological functions by 2050 to achieve sustainable food production without waste or inefficiency on a global scale.

The system to quickly design and release crops according to their purpose

Targets by 2030

By 2030, we will establish a prototype system to design crops in cyber space by fully utilizing the outstanding biological functions of wild plants or wild plants genomes. We will also establish another prototype system which enable us to verify the characteristics of designed crops. These systems will enable us to rapidly develop crops with high environmental adaptabilities that will result in increased food production. In addition, we will start operating the "Digital Crop Design Center" and releasing robust crops with the aim to eliminate verification of the designed crops in physical space and enabling the development of new crops in cyberspace alone.

Cooperating Research Institutes

The University of Tokyo / National Agriculture and Food Research Organization / Japan International Research Center for Agricultural Sciences / RIKEN / Japan Agency for Marine-Earth Science and Technology / National Institutes for Quantum and Radiological Science and Technology / Fukushima University / University of Tsukuba / Nagoya University / Kyoto University / Kobe University / Shimane University / Yamaguchi University / Kyushu University / Nagoya City University / The University of Shiga Prefecture / Osaka Metropolitan University / Ryukoku University / Kazusa DNA Research Institute