



Working Group 5

Innovation for future agriculture—satisfying both food production and environmental conservation

Chair: Dr. NOGUCHI Noboru, Sub-Chair: Dr. HASEBE Akira

【The Moonshot 'Area,' 'Vision,' for setting MS 'Goals,' candidate】

【 Area 】 · Turning the aging society into the innovative and sustainable society by harnessing diversity through technological transformation

【 Vision 】 · Industrial transformation by complete automation in agriculture
· Sustainable Resources Circulation
· Harmonization with nature

WG 5 will discuss creation of a new food production system which is both compatible with "expansion of food supply against world population growth" and "conservation of the global environment."

[Background]

1. The present methods will fail into a negative spiral through; 1) shortage and/or depletion of inputs such as fertilizers, 2) intensified contamination of farmland and groundwater, 3) Extinction of species like natural enemies, and 4) Acceleration of desertification and global warming.
2. With the progression of global warming, abnormal weather is occurring more frequently worldwide, and risks relating food supply will increase in the future.
3. Serious food shortage is foreseen, through the world population growth by a factor of 1.3, and the increase in food demand by a factor of 1.7 in 2050.
4. It is envisaged that the future increase in world food demand will have a serious effect on the Japanese food supply, whose food-sufficiency rate is very low.
5. On the other hand, if you consider the actual status of food consumption, every year 1.6 billion tons and 6.3 million tons of food is disposed of as waste worldwide and in Japan, respectively, and there are many issues associated with food such as obesity and diseases related to adult lifestyle habits.

WG5 will discuss following issues as targets.

[Target]

1. How can we maintain sustainable food supply and increase food production in the currently situation that the global warming is progressing and unprecedented weather events are occurring more frequently ?
2. How can we harmonize between "food production" and "conservation of global environment and biodiversity "?
3. How can we eliminate food waste, and how can we provide the necessary food to people who need?

1. Sustainable food supply and production in the future

- To increase food production, it is necessary to expand the use of barren and unused areas as farmland and dramatically improve crop yields.
- Current agricultural techniques symbolized by the "Green Revolution", such as extensive modern irrigation system and the use of large quantities of fertilizer will lead to the depletion of natural resources and thus the unsustainability.
- Therefore, we are urged to develop in a very short period groundbreaking crops, which are adapted to divergent regional climate conditions. We also need to develop the novel production system where biological functions in nature, such as microbes and insects, are fully utilized.
- For crop, it is the key to breed super crops incorporating drought-tolerant genes from their wild relatives, in an efficient manner and in a very short period of time.
- We need to develop breakthrough technologies for crop breeding, on the extremely new concept "from selecting to creating". There are three key elements, 1) divergent genetic resources, 2) merger of big data on genomic information and leading-edge AI technologies, and 3) the utilization of genome editing and synthetic biology.

1. Sustainable food supply and production in the future (continued)

- Response to frequent occurrence of meteorological anomalies is an urgent issue.
- Recent trend of global warming and frequent occurrence of meteorological anomalies make it difficult to be properly managed by farmer's experience and/or intuition. It is necessary to establish super-precision farming based on scientific evidence. To be prepared for the intense heat over 40 °C in summer and typhoon attack, it is necessary to develop flexible unmanned farming system by utilizing automated agricultural machines, relieving them from hard work.
- We propose “The establishment of world's first intelligent farming”.
 1. Make use of the long-term weather forecast on super computer.
 2. Detect abnormal crop growth and of pest and disease outbreaks at currently undetectable (very early) stage. Apply the pest and/or disease control program, simultaneously.
 3. Establish the optimized cultivation method (which produce maximum yield) on prediction, combining weather forecast and AI technology.
 4. Multiple AI agricultural machines work together autonomously (day and night), following the established prediction.

2. Harmony between "food production" and "conservation of global environment and biodiversity "

- To achieve the above, it is essential to introduce sustainable farming method to reduce fertilizer and chemical inputs, minimizing adverse effects on the environment.
- It is said that 1/4 of the world emissions of greenhouse gases originates from agriculture, forestry, and other land use. Methane and nitrous oxide (N₂O) produced by soil microbes constitute a large proportion of the greenhouse gases that originate from agriculture, therefore, reducing the emissions of these gases is an urgent requirement (for mitigating greenhouse effects in the agricultural sector).
- At the same time, promoting and strengthening of the absorption of carbon dioxide (CO₂) is a very important issue. To this end, we need to establish a method for the accurate evaluation of forests, organic matter in the soil, seaweed and other materials that absorb CO₂. On these methods, it is very important to strengthen absorption measures. Ocean resources and aquaculture need also innovation through biotechnologies (ICT, environment control technology, alternative protein resources).
- To recover and maintain biodiversity, we need to develop crops with a high disease resistance, contributing to minimized pesticides. Also, the large-scale reduction and optimization of chemical pesticides usage are needed.
- For the large-scale reduction and optimal use of pesticides, we need to develop methods for the accurate identification of the target pest species and control technologies that do not cause pests to develop resistance.

3. Reduce food loss and waste

- Major causes of food losses and waste are imbalances between supply and demand at each stage; production, distribution, processing and consumption. In addition, over one-third of food losses and waste occur primarily at the retailing and consumption stages in developed countries.
- Optimal software generated through AI on production, distribution, processing and consumption data, could remarkably reduce the food loss and waste.
- Innovation for the reuse of food residue and/or surplus from home should be developed.
- For example, 1) Food reprocessing technology by using 3D printing system, and 2) Alternative use for insect feed, which is thought to be useful for animal feed as high-protein materials, etc.
- Innovation for the promotion of a reasonable consumption behavior which is friendly to human health and global environment could dramatically reduce food loss and waste from home.
- Final goal is to globally extend and take root the concept of “local production for local consumption” and “semi-self-sufficient home”.

4. Others

- Japan and EU would like to establish collaborations between the Moonshot Research and Development program and the Horizon Europe mission. Both programs share similar timeline and goals related to SDGs. One major mission of Horizon Europe is focused on soils (holistic soil) and this will be the focus of future collaborations.
- With the development of new technologies, there should be a discussion of ELSI from various viewpoints, including the discussion about benefits and risks that the technology brings to society based on scientific evidence.

Conclusion



[MS Goal candidate]

- WG5 proposes creating a new food production system by 2050, which will enable both an "expansion of the amount of food supply" and "conservation of global environment".

[Target]

- We need to overcome constraints in water, fertilizers, and other resources supply by fully utilizing the biological functions or ecosystem services of nature.
 - We are tasked to develop solutions to eliminate food loss and waste and promote rational, health-, and environment-conscious food consumption.
 - We need to establish a robust agricultural, forestry and fisheries system which can adapt to rapid climate changes. (This target will be coordinated with WG 1 and 3.)
- Ø To achieve these, by 2030, we will develop a proto-type system with model crops or other organisms, and then conduct feasibility test.
- Ø Beyond that period, we will expand the number of target crops so that the new system will be extended all over the world by 2050, with parallel discussions on ELSI.