Agritech Report

:From the Perspective of Food Security and Environmental Impact

Excerpt From the Original Report in Japanese

New Energy and Industrial Technology Development Organization（NEDO）
Technology and Innovation Strategy Center （TSC）
International Strategy Unit
(Co-op : Agriculture and Food Technology Unit)

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1. Introduction

Introduction

- Due to Covid-19-pandemic, extreme weather and Russian aggression against Ukraine, food prices have jumped since 2020, and the world has faced various food supply chain challenges, including widespread hunger in developing countries. As the world's population continues to grow and demand for food continues to increase**, food security** become a global priority issue.

- At the same time, agriculture is required to respond to environmental issues. The **environmental impact** of pesticides on ecosystems and the pollution of groundwater and rivers due to runoff of fertilizers into the nature. Furthermore, as the world targets carbon neutrality, agriculture sector is also required to reduce GHG emissions and to transform to sustainable one.

- In Japan, the Diet passed a bill this year (2024) to partially revise the "The Basic Law on Food, Agriculture and Rural Areas". The main points of the revisions include the reinforcement of food security and the transformation to environmentally-friendly agriculture as well as enhancing the productivity for the sustainable growth.

- This report summarizes the current global situation related to agriculture and the development trends of Agritech (agriculture-related technology) from the perspectives of food security and environmental impact. We do hope this report will serve as a reference for those involved in agriculture in Japan as well as for R&D personnel with aim to start a business.

2. Current State of World Agriculture

- Basic information - *Population trends and food demand, food prices, number of workers, production volume and productivity*

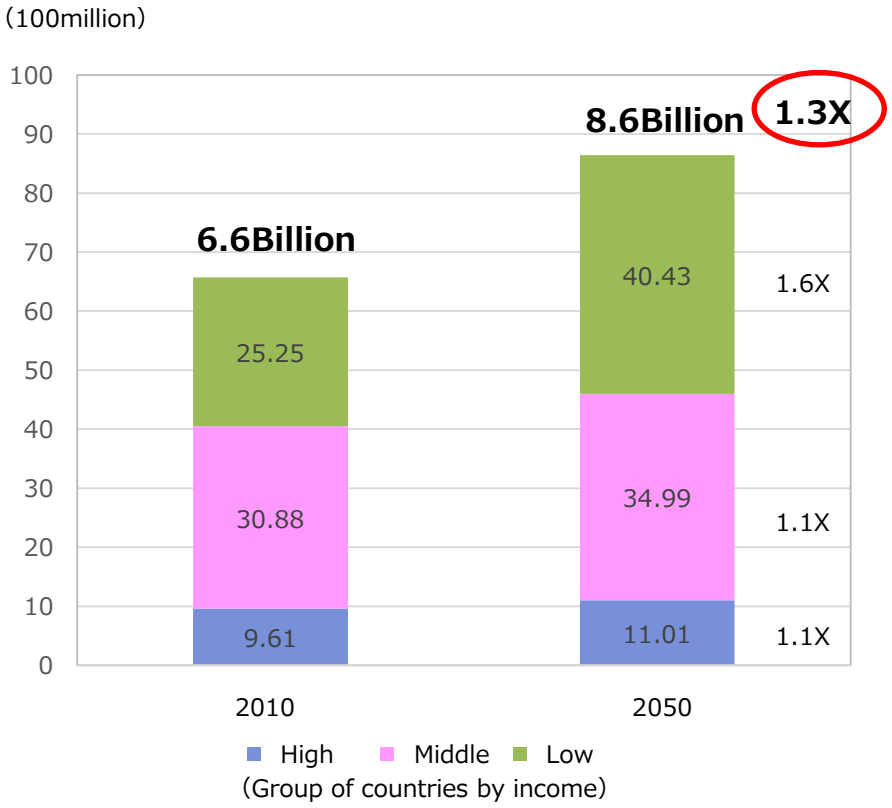
- Food security - *Food self-sufficiency ratio of major countries and food security risk cases*

- Environmental impact - *GHG emissions*

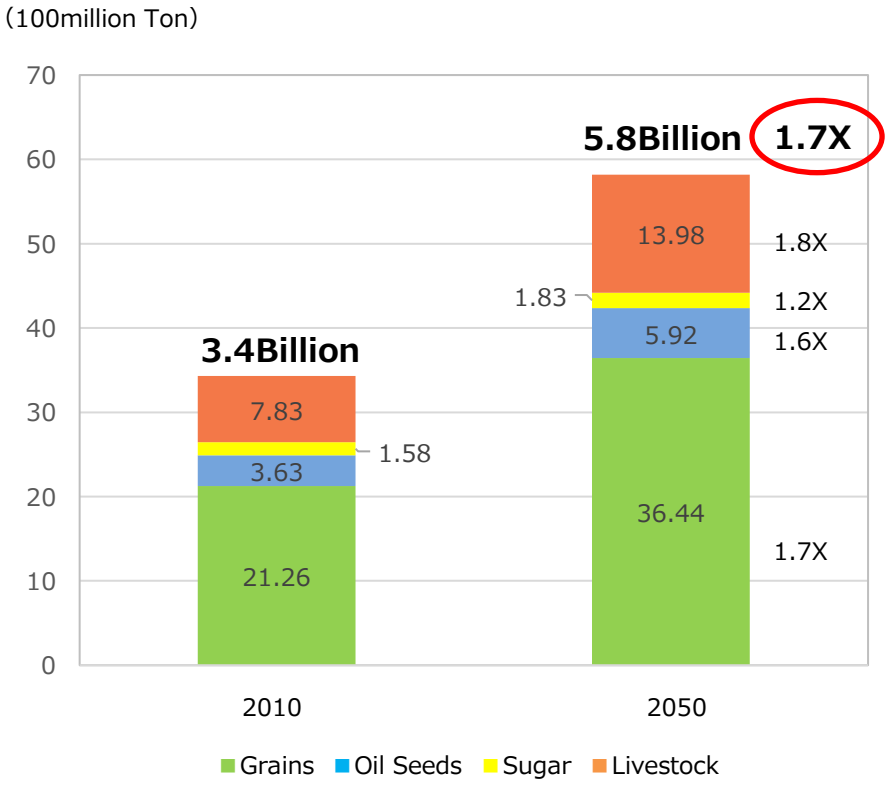
Population and Food Demand Forecast

- By 2050, the world population will increase to nearly 9 billion, mainly in developing countries (1.3 times of 2010 level).
- Food demand will be 1.7 times of 2010 level (5.8 billion tons), exceeding the ratio of population growth.

Forecast of world population



Forecast of world food demand

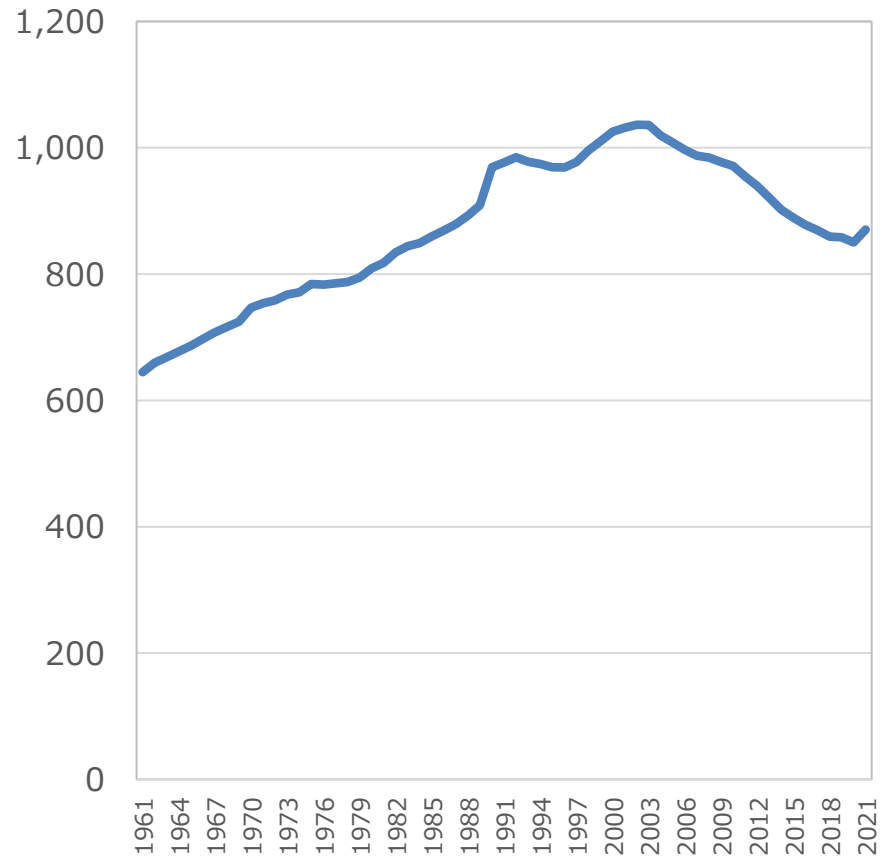


Source : Created by NEDO's TSC based on the report "Global food supply and demand outlook in 2050" by Ministry of Agriculture, Forestry and Fisheries

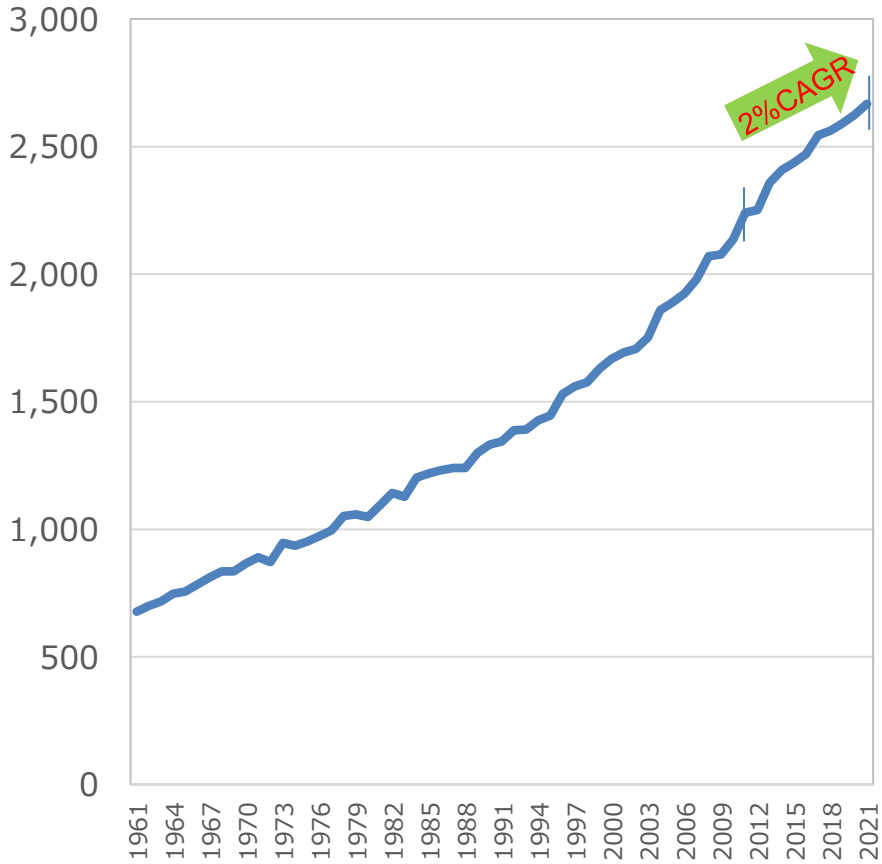
Number of Agricultural Workers and Production Value in the World

- The number of agricultural workers worldwide peaked in 2002 and has been on a downward.
- Despite the decline in the number of workers, the growth at 2% CAGR has been secured for agricultural output during 2010 to 2021.

Number of agricultural workers



Production value

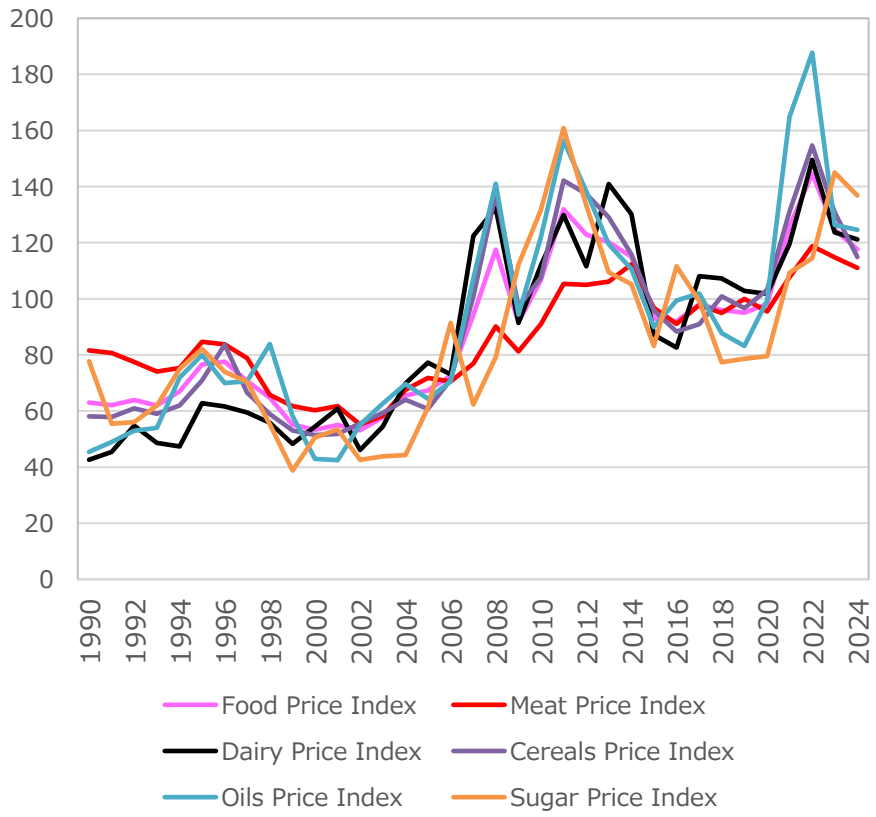


Source : Created by NEDO's TSC based on USDA data "TFP indices and components for countries, regions, countries grouped by income level, and the world, 1961-2021"

World Food Prices and Hunger Numbers

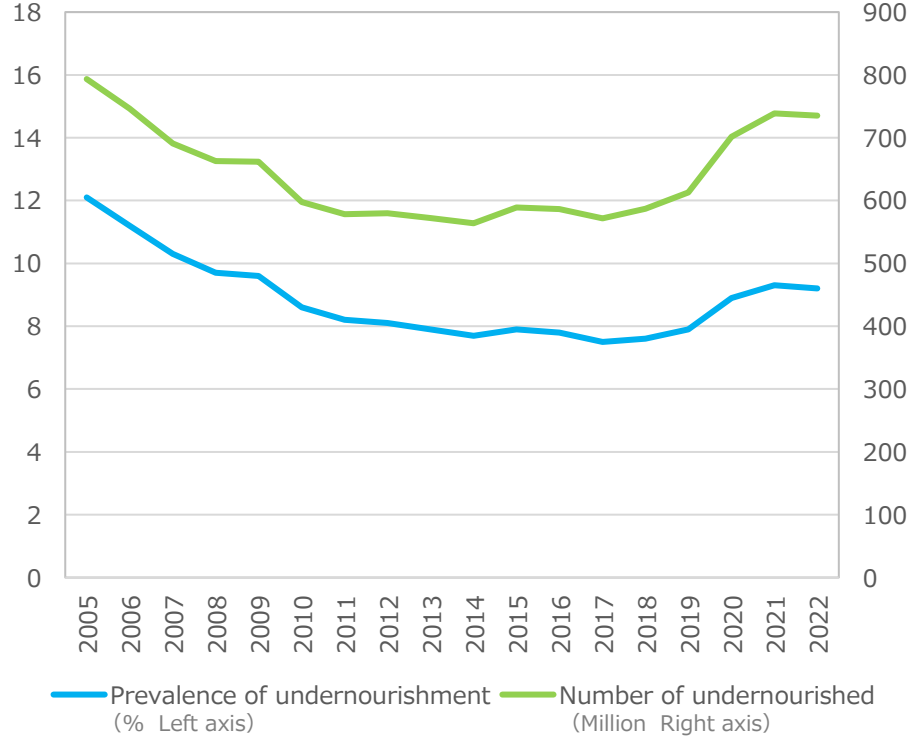
- Food prices hit highest record in 2022 due to Covid-19 pandemic and Russian aggression against Ukraine, exposing supply chain vulnerabilities.
- The number of hungry people in the world increased since 2017, mainly due to population growth in Africa, and exceeds 700 million people.

World food price Index
(2014~2016=100)



Source : Created by NEDO's TSC based on FAO report "Annual FAO Food Price Indices"

World hunger numbers

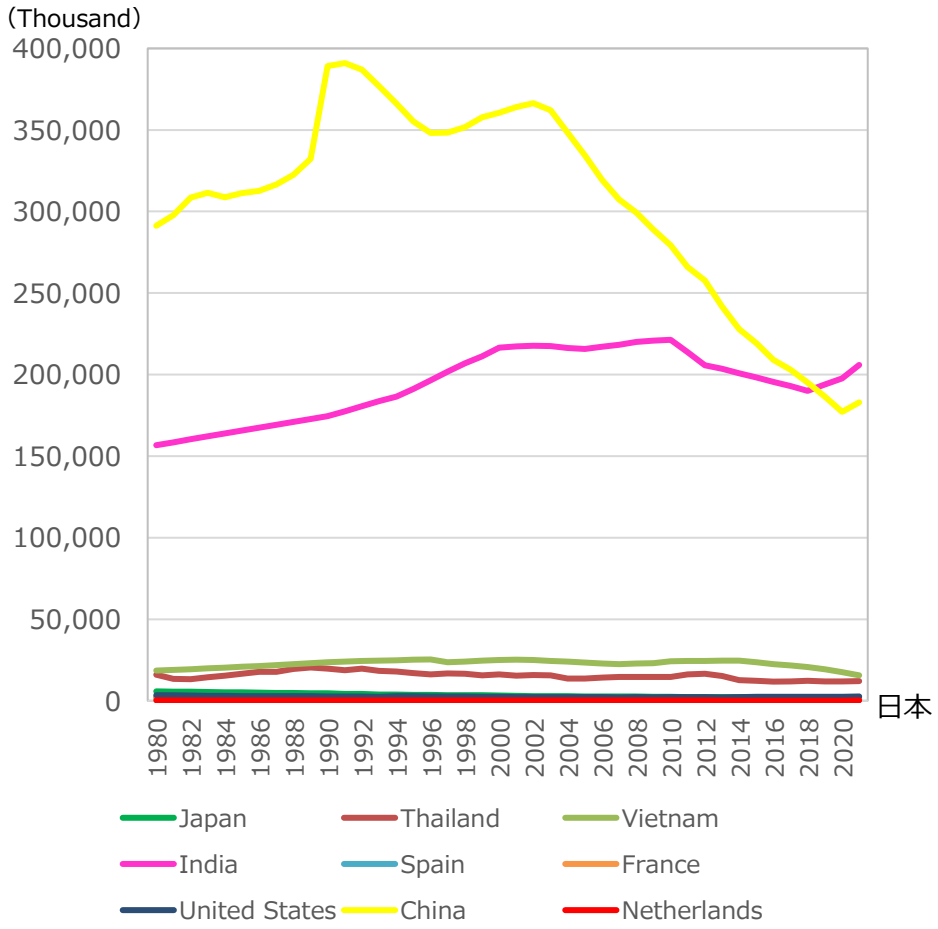


Source : Created by NEDO's TSC based on FAOSTAT "Suite of Food Security Indicators"

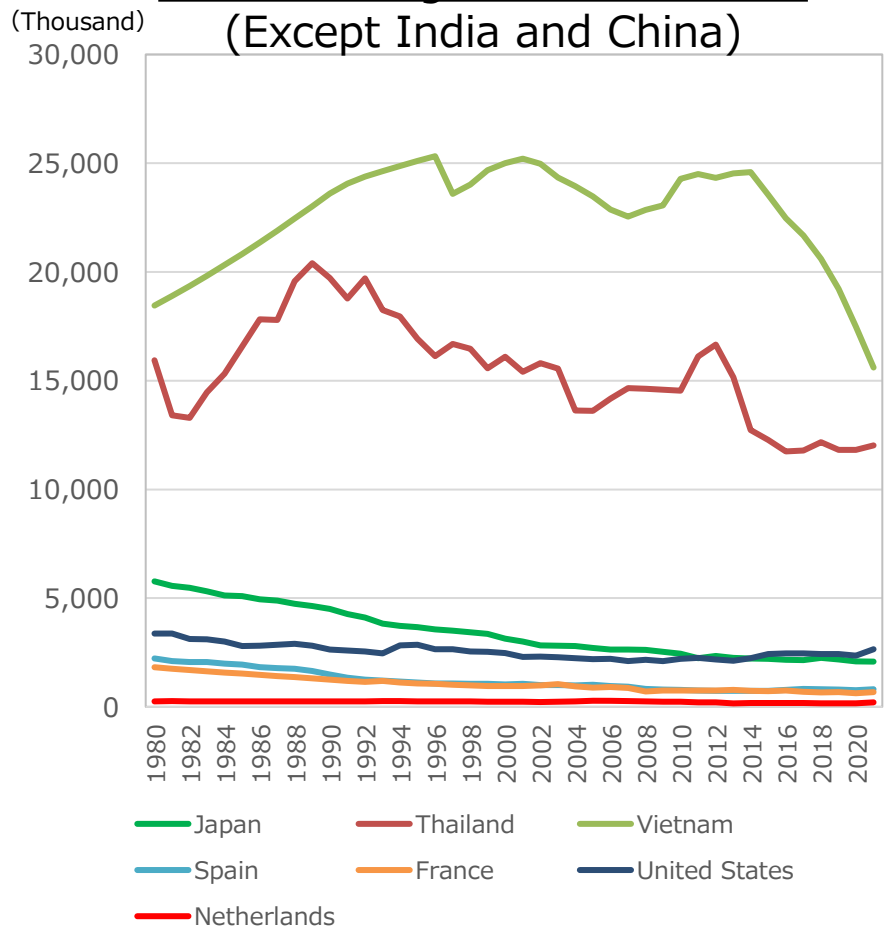
Number of Agricultural Workers by Major Countries

- The number of agricultural workers in China, Vietnam, and Thailand started to decline, while that of India became the world's largest.
- Japan, US and Europe have almost bottomed out.

Number of agricultural workers



Number of agricultural workers (Except India and China)

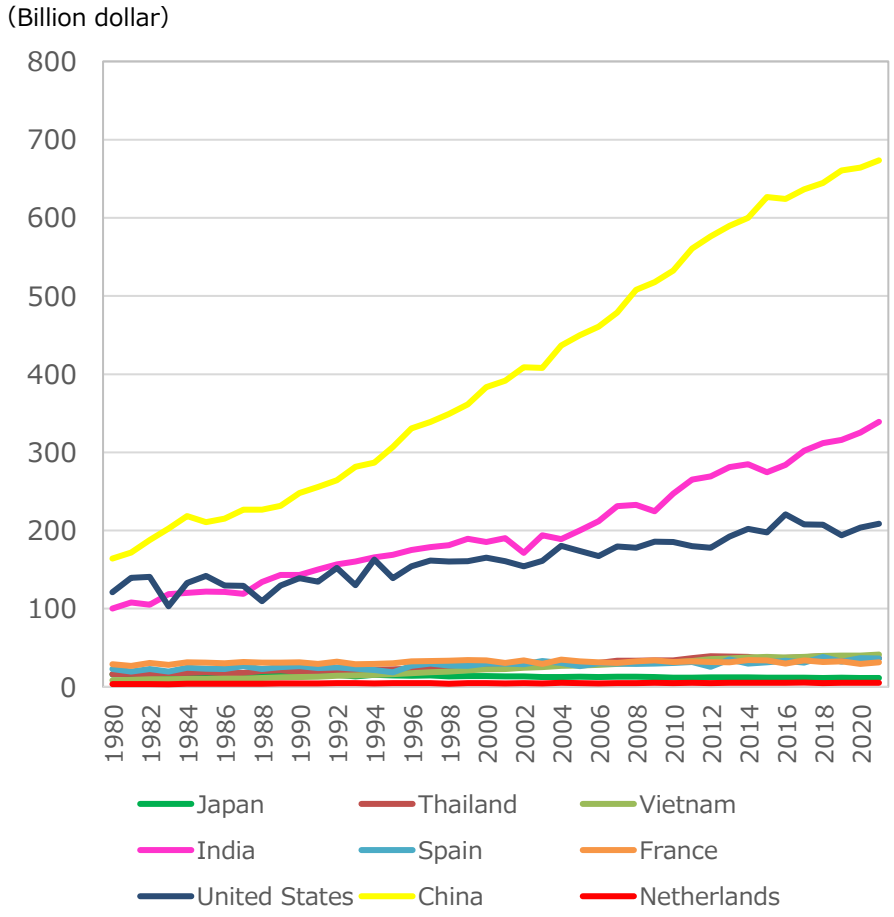


Source : Created by NEDO's TSC based on USDA data "TFP indices and components for countries, regions, countries grouped by income level, and the world, 1961-2021"

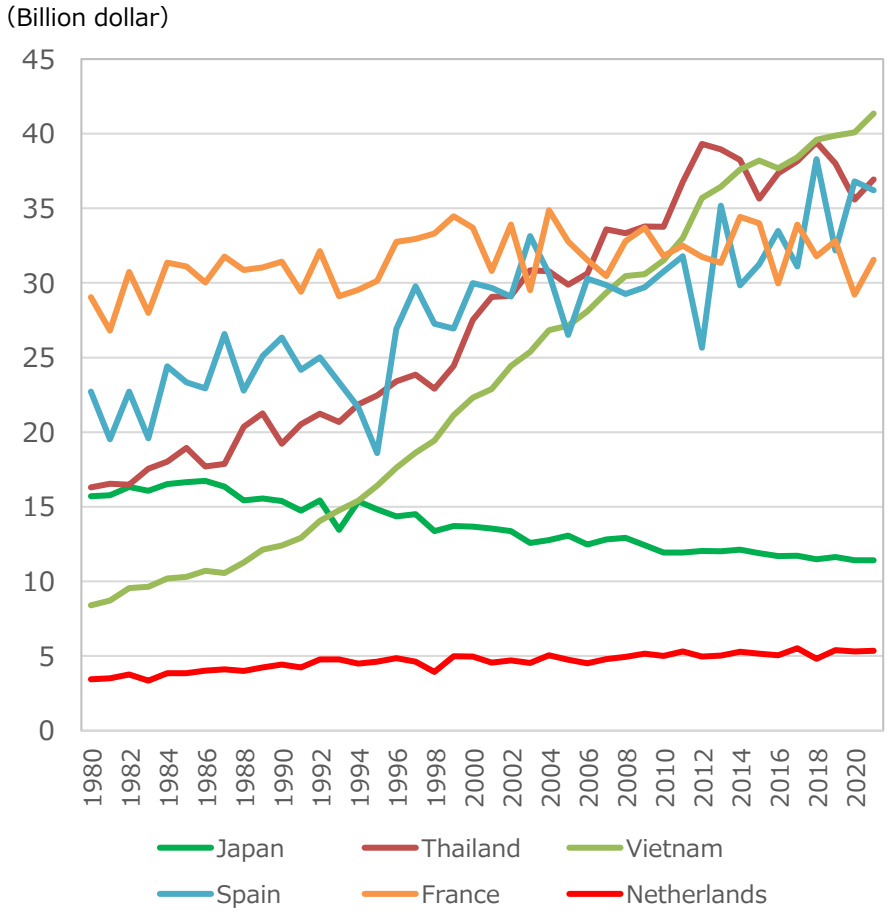
Crop Production in Value by Major Countries

- China, India and US are far ahead of other countries, and the growth trend continues.

Crop production in value



Crop production in value (Except China ,India and US)

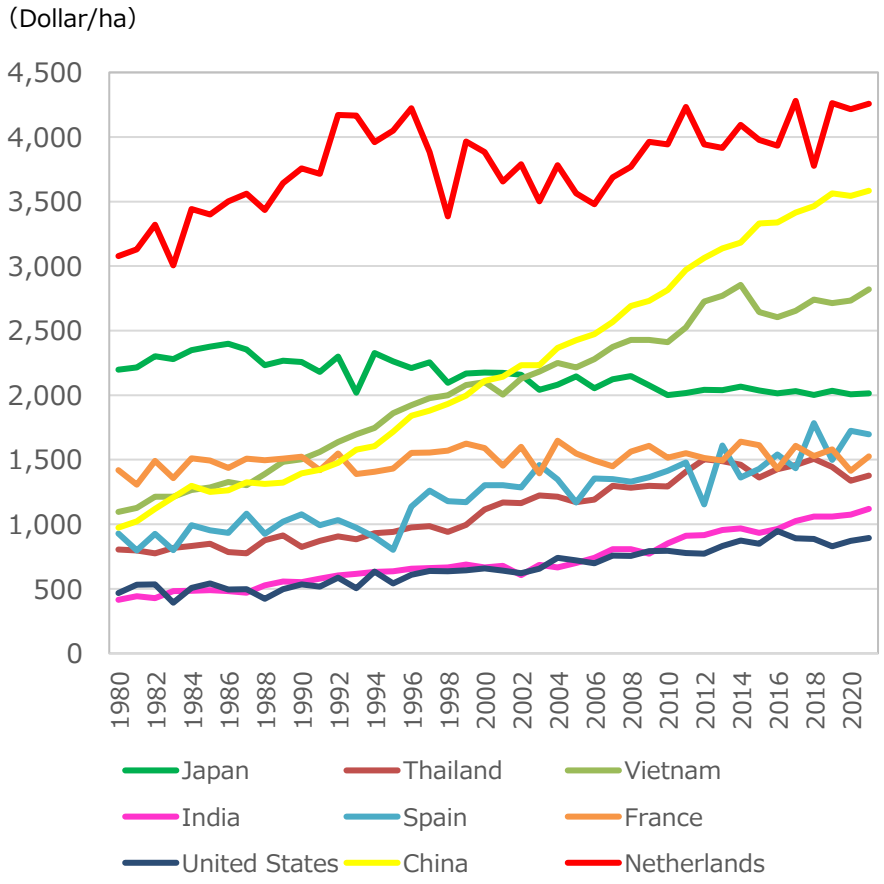


Source : Created by NEDO's TSC based on USDA data "TFP indices and components for countries, regions, countries grouped by income level, and the world, 1961-2021"

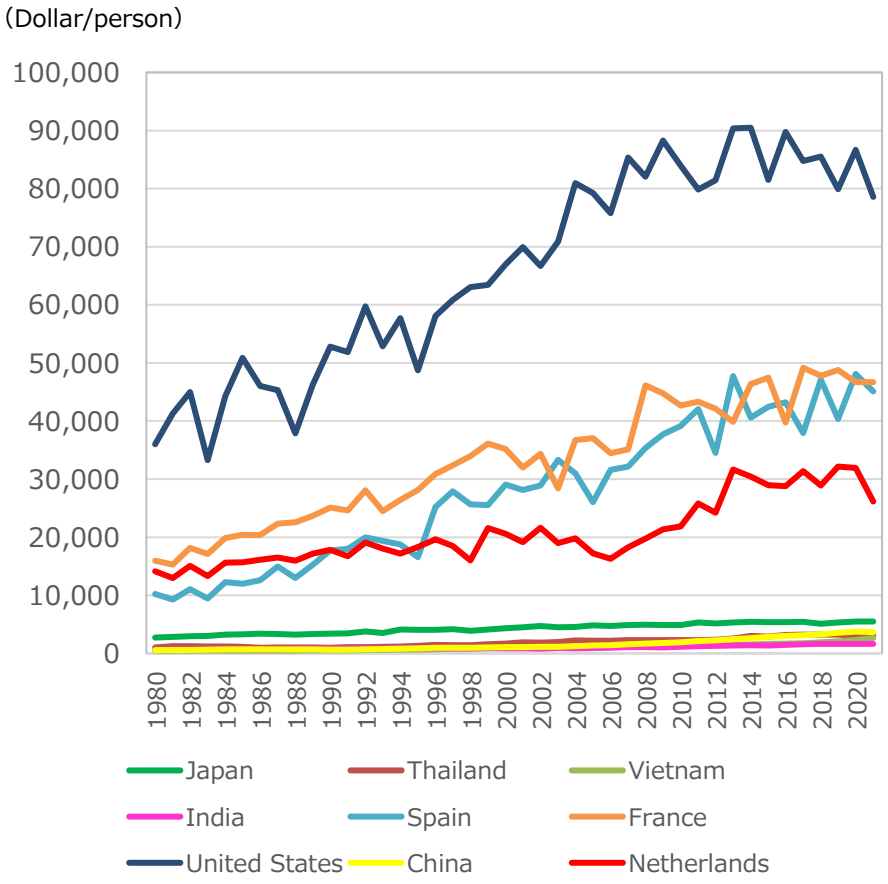
Productivity（Land Productivity and Labor Productivity)

- The Netherlands outstands in land productivity. So does US in labor productivity.

Land productivity



Labor productivity

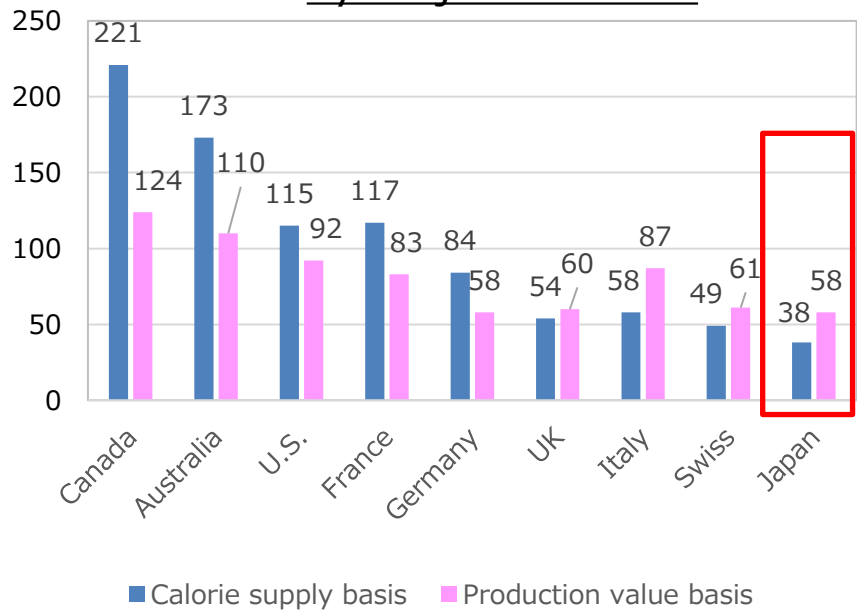


Source： Created by NEDO's TSC based on USDA data "TFP indices and components for countries, regions, countries grouped by income level, and the world, 1961-2021"

Food Self-sufficiency Ratio of Major Countries

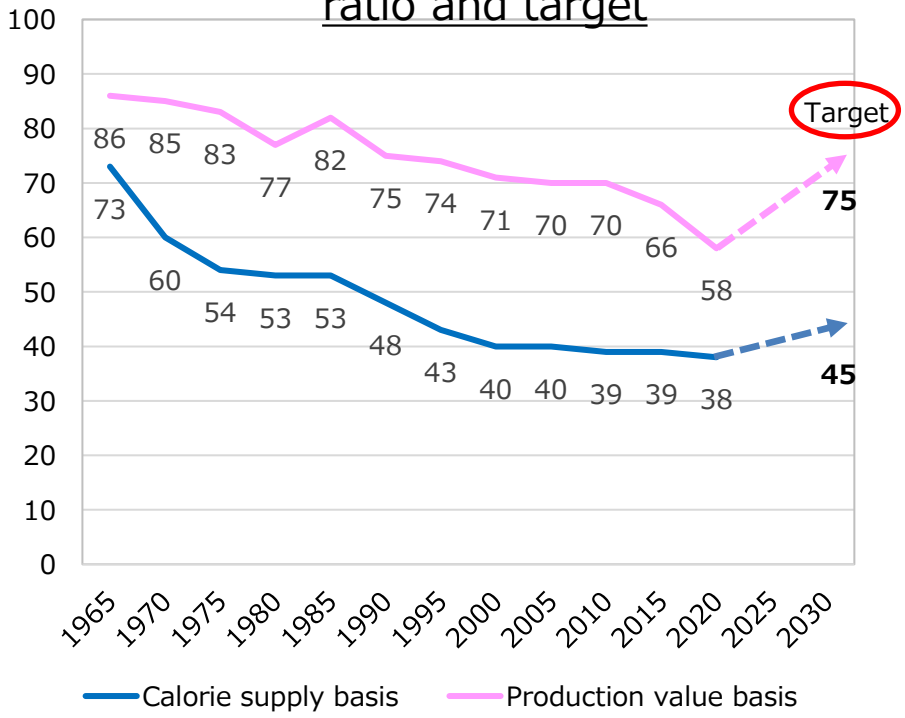
- Japan's food self-sufficiency ratio is relatively low both on a calorie supply basis and on a production value basis.
- As Japan's food self-sufficiency ratio continues to decline, “The Basic Plans for Food, Agriculture, and Rural Areas” established in 2020 sets the 2030 food self-sufficiency target at 45% on a calorie supply basis and 75% on a production value basis.

Food self-sufficiency ratio by major countries



Source : Created by NEDO’s TSC based on the report “Food self-sufficiency ratio of Japan and major countries” by Ministry of Agriculture, Forestry and Fisheries

Japan’s food self-sufficiency ratio and target



Source : Created by NEDO’s TSC based on the report “Japan’s food self-sufficiency ratio” by Ministry of Agriculture, Forestry and Fisheries

Food Security Risks ～Recent Cases～

- Recently some governments have implemented export restrictions of food for domestic and political reasons, which affected global food supply chain and impacted global food prices. (See left below)
- The export restrictions extend to fertilizers and their raw materials. The bias towards exporting countries has become apparent as a risk to food security.

Turkey
April 2020,Turkey has subjected lemons to export control amid a rising domestic demand due to Covid-19 pandemic. Turkey has 13% export share of Lemon.

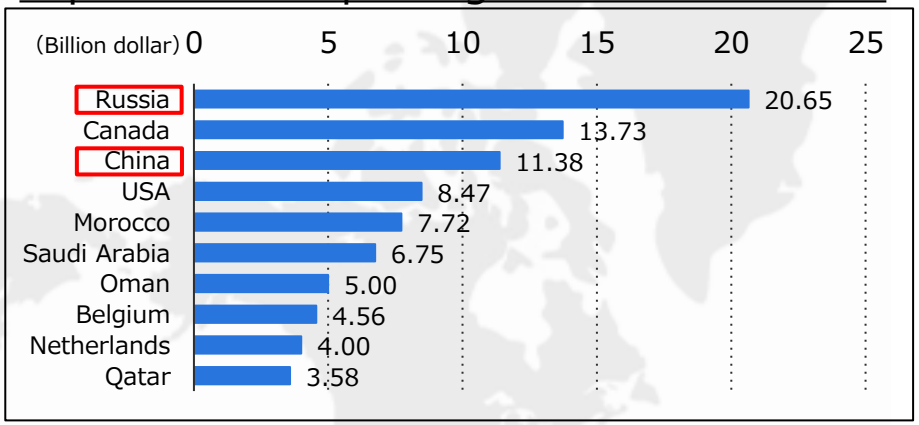
Russia
July 2023,An agreement allowing the safe Black Sea export of Ukraine's grain expired after Russia quit.

India
July 2023, The world's largest rice exporter, banned the exports of white rice, as the government sought to tame surging domestic food prices.

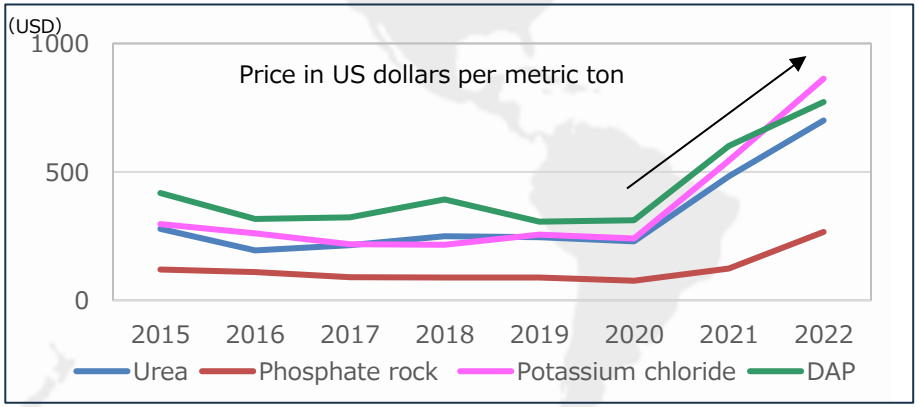
Russia
2022 November, the Russian government introduced a two-month export ban on certain types of ammonium nitrate fertilizers.

China
2023 December, China imposed measures including export quotas and lengthy inspection requirements on the fertilizer ingredients to cool domestic prices.

Top fertilizer exporting countries (2022)



Price trend of fertilizer materials



Food in bule box and Fertilizer in orange box

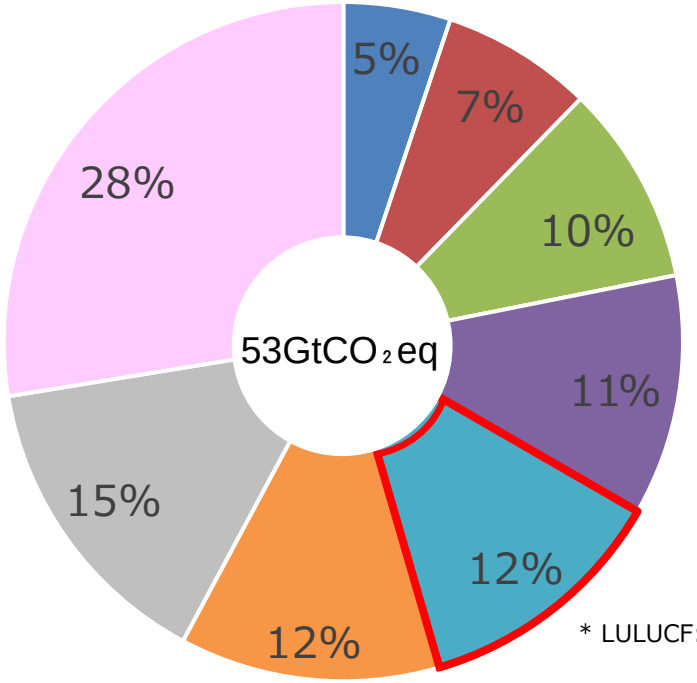
Source : Created by NEDO's TSC based on various news report

Source : Created by NEDO's TSC based on Statista report "Fertilizer industry worldwide"

GHG Emissions from Agriculture

- Anthropogenic GHG emissions worldwide in 2021 reached 53Gt (CO_2 equivalent).
- Agriculture sector accounts for 6.5 Gt which is 12% of the total GHG emissions.
- Among agriculture sector, livestock-related accounts for 63% while crop production-related accounts for 37%.

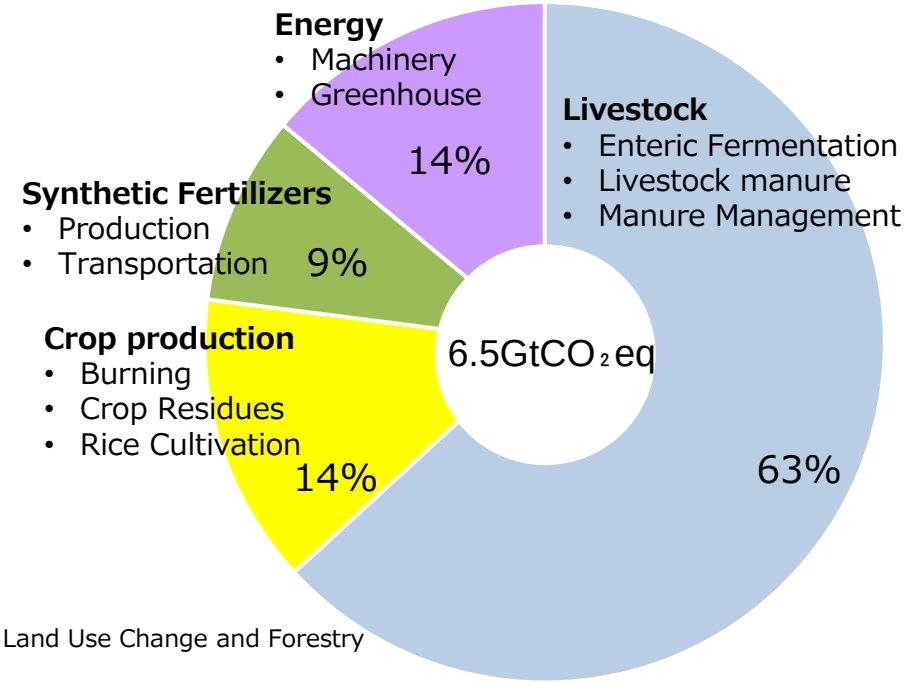
Total GHG emissions (2021) (Excluding LULUCF*)



Agriculture Buildings Fuel Exploitation
Industrial Combustion Power Industry Processes
Transport Waste

Source : Created by NEDO's TSC based on Statista report "EdgarEDGAR/JRC Annual greenhouse gas (GHG) emissions worldwide from 1990 to 2022 by sector"

GHG emissions in agriculture sector (2021)



Livestock Crop production
Fertilizers Energy

Source : Created by NEDO's TSC based on Statista report "FAO Emissions from agriculture and forest land worldwide in 2021 by component"

* LULUCF:Land Use, Land Use Change and Forestry

3. International Agreements and US/EU Policy Trend on Agriculture

- International agreements: Agreements and targets on environmental aspects of agriculture

- Policy trend: Key agricultural policies of US and EU

Agreements and Targets on Environmental Aspects of Agriculture

- At both two COP conferences, Convention on Biological Diversity and UN Climate Change Conference, the necessary actions for the environmental aspects of agriculture and food systems were concluded.

COP15 - Convention on Biological Diversity

Kunming-Montreal Global Biodiversity Framework

～Adopted at COP15 in 2022～

2020 UN BIODIVERSITY CONFERENCE
COP 15 - CP/MOP10 - NP/MOP4
Ecological Civilization-Building a Shared Future for All Life on Earth
KUNMING – MONTREAL

【Vision】

A world of living in harmony with nature where: “By 2050, biodiversity is valued, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet delivering benefits essential for all people.”

【2030 Targets relevant to Agriculture】

- Nature regeneration:
  - Restore at least 30% of areas of degraded ecosystem
- Pollution prevention/reduction:
  - Halving excess nutrients flowing into the environment
  - Halving the overall risk of pesticides and highly hazardous chemicals
  - Preventing and reducing plastic pollution
- Sustainable management of agriculture, forestry and fisheries:
  - Contributing to the resilience of production systems, long-term efficiency / productivity, and food security
- Sustainable consumption:
  - Halving food waste etc.

COP28 - UN Climate Change Conference

Emirates Declaration on Sustainable Agriculture, Resilient Food Systems, and Climate Action

～Adopted at COP28 in 2023～

COP28 UAE

【Objectives】

Urgently transform for the sustainable development of agriculture and food systems and for responding to the imperatives of climate change:

- Sustainable food security
- Integrated management of water
- Enhancing soil health and biodiversity, etc.

【5 areas to strengthen efforts by 2025】

① Integrate agriculture and food systems into National Adaptation Plans etc. of each country
② Reduce food loss, ecosystem loss and degradation Support income increase, GHG reduction etc.
③ Enhance access to all forms of finance
④ Accelerate innovations to increase sustainable productivity and production
⑤ Strengthen the rule-based, open, fair and transparent multilateral trading with WTO at its core.

Source : Created by NEDO’s TSC based on various news report

Key Agricultural Policies of US

- The United States aim to increase agricultural production by 40% while cutting the environmental footprint in half by 2050. The research strategy accelerates innovations incorporating technologies such as AI, Digital, Bioengineering, etc.

Agriculture Innovation Agenda (AIA)

5 goals are set to realize the increase of agricultural production by 40% while cutting the environmental footprint in half by 2050.

<AIA Goals>

- Increase agricultural production by 40% by 2050, to meet future demand for food
- Reduce food loss and waste by 50% by 2030 from the 2010 baseline
- Achieve a net reduction of current carbon footprint by 2050 by enhancing carbon sequestration, leveraging the renewable energy benefit and capitalizing innovative technologies and practices
- Reduce nutrient loss from agriculture by 30% nationally by 2050
- Support renewable fuels, including ethanol, biodiesel, and biomass, to achieve blend rates of E15 in 2030 and E30 in 2050

(Issued in February 2020)

USDA Science and Research Strategy 2023 - 2026

5 research priorities for the next generation of sustainable and resilient agriculture responding to climate change (*Technology examples after arrows)

1. Accelerate innovative technologies & practices
   - IT-enabled decision support systems, precision environmental management tools, digital twins,
   - Combined AI and autonomous robot, AI embedded diagnostic, 3D printing,
   - Advanced microbial, agricultural nitrogen cycle etc.
2. Drive climate-smart solutions
   - Quantitative analysis and modeling of agricultural emissions and sequestration,
   - Biophysical/socioeconomic climate change indicators
   - AI-assisted remoted sensing climate-smart decision-support tools,
   - Biotechnology & biomanufacturing for agriculture and food, etc.
3. Bolster nutrition security & health
4. Cultivate resilient ecosystem
   - Precision agriculture to strengthen soil vitality,
   - Water quality and quantity prediction, etc.
5. Translate research into action

(Issued in March 2023)

Source : Created by NEDO's TSC based on various news report

Key Agricultural Policies of EU

- EU set Farm to Fork (F2F) Strategy to make food systems sustainable and, based on Common Agricultural Policy (CAP), each country designed the national strategic plan, while there exist certain oppositions from farmers in view of rising fertilizer prices etc.

Farm to Fork (F2F) Strategy

As a core part of the European Green Deal, F2F Strategy articulates a comprehensive approach to sustainable food systems for EU. (May 2020)

<2030 Targets>

- 50% reduction of chemical pesticides use*
- 50% reduction of nutrient losses
- 20% reduction of fertilizers use
- 50% reduction of antimicrobials sales for farmed animals and aquaculture
- 25% of the EU's agricultural land under organic farming

EU pursues the development of Green Alliances on sustainable food systems with all its partners. It seeks to incorporate a sustainability chapter in bilateral trade agreements.

*This 50% pesticides reduction faced the strong opposition from farmers and the EU Commission baked away from making it mandatory. (February 2024)

Common Agricultural Policy 2023-2027

CAP has 10 objectives including "climate change action", "to preserve landscapes and biodiversity", "fostering knowledge and innovation" and so on. Each country designed its own strategic plan accordingly, thus contributing to F2F Strategy. (January 2023)

Nature Restoration Law

The law intends to restore ecosystems across EU. Each country shall restore its degraded land and sea areas at least 20% by 2030, 60% by 2040 and 90% by 2050. (June 2024 - Adopted at EU Council)

EU Deforestation Regulation

The regulation sets mandatory due diligence rules to sellers in EU market or exporters from EU to trace 7 products such as coffee, soy, cattle and so on, as well as their derived products are free from risks of deforestation and forest degradation. (June 2023)

Source : Created by NEDO's TSC based on various news report

EU/US Efforts for CO_2 Sequestration in Farmland

- EU and US promote policies for CO_2 sequestration, as well as measurement, reporting and verification of GHG emission reduction, in the farmland.

Regulation on an EU certification for carbon removals (Proposal)

- European Commission announced a proposal for the voluntary certification scheme for carbon removals in November 2023.
- The scheme enhances carbon farming practices, storing carbon in land and forests through soil improvements and reforestation, in addition to BECCS/DACCS.
- It aims to prevent green washing and integrate carbon removals into Emission Trading System.
- Some agricultural associations expressed dissatisfaction for:
  - details of verification methods not clear until the regulation is adopted
  - some practices like precision fertilization not recognized as carbon farming.

Investment in measurement, monitoring, reporting & verification of GHG emission

- USDA announced the $300 million investment in July 2023 from Inflation Reduction Act (IRA).
- It advances “Federal Strategy to Advance Greenhouse Gas Measurement and Monitoring for the Agriculture and Forest Sectors”.
- Key focus areas include establishing a soil carbon monitoring and research network, establishing a GHG research network, expanding data management, improving assessment models and tools etc.
- IRA provided $19.5 billion for USDA’s Natural Resources Conservation Service program, including this investment, and tasked USDA with quantifying/tracking carbon sequestration and GHG emissions and evaluate effectiveness of climate-smart mitigation practices.

ARPA-E program “SMARTFARM” - monitoring and analytics for bio-fuels

- ARPA-E under Depart of Energy runs a R&D program of “Systems for Monitoring and Analytics for Renewable Transportation Fuels from Agricultural Resources and Management” (SMART).
- It funded technologies, with $20 million for 2021 ~ 2024, to quantify feedstock-related emissions and enable new market incentives for efficiency in feedstock production and carbon management.
- Its phase 1 adopted 5 projects for quantification using drone system, sensing etc.

Source : Created by NEDO’s TSC based on various news report

Summary: World's Agriculture Status (Chapter 2) and Agricultural Policies (Chapter 3)

- Globally, agriculture sector faces the need to respond to food security issues by increasing its production and at the same time to manage environmental impact by reducing its GHG emissions and its use of fertilizers and pesticides.

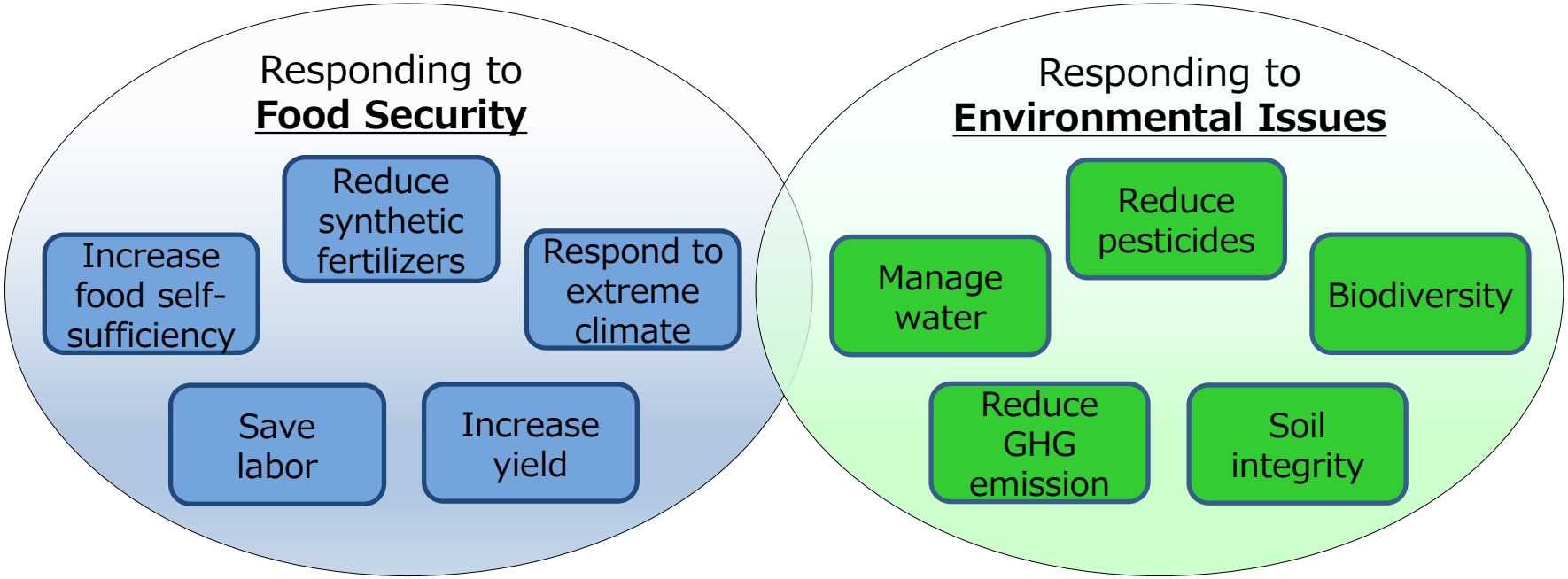
- ✓ The world's population in 2050 is expected to reach 8.6 billion, 1.3 times that of 2010, and food demand is expected to grow 1.7 times. With the number of agricultural workers in the world decreasing, it is essential for agriculture to increase production over the long term and reduce the number of hungry people.

- ✓ The world is also facing vulnerabilities in the global food supply chain through the COVID-19 pandemic and Russian aggression against Ukraine. Export restrictions by some major food and fertilizer exporting countries, as well as extreme weather, have caused historic surges in food prices and problems in food supply and demand. While food security becoming more important than ever, countries such as US and EU implement policies to strengthen the food systems.

- ✓ Agriculture accounts for 12% of total GHG emissions and causes issues such as the runoff of pesticides and fertilizers into the natural environment. Both two COP conferences, Convention on Biological Diversity and UN Climate Change Conference, concluded targets in responding to the environmental issues of agriculture. In this course, the AIA in US and F2F Strategy in Europe have set targets such as reductions of fertilizer use, as well as contributions to carbon storage in farmland, ecosystem restoration and so on.

Issues in Agriculture to be Resolved for Food Security and Environmental Issues

- Key issues to be resolved for food security and environmental response can be categorized as below.



※The issues shown here have been categorized for the convenience of the structure in this report.
They do not necessarily correspond to either "food security" or "environmental issues" alone.

In Chapter 4, we summarize agritech trends, identifying which of these issues the technology is effective at.

4. Global Agritech trends -Technology development trends in US and Europe

- Fertilizers

  Highlight: NEDO's efforts in the agricultural sector (1), (2), (3)

- Precision Farming

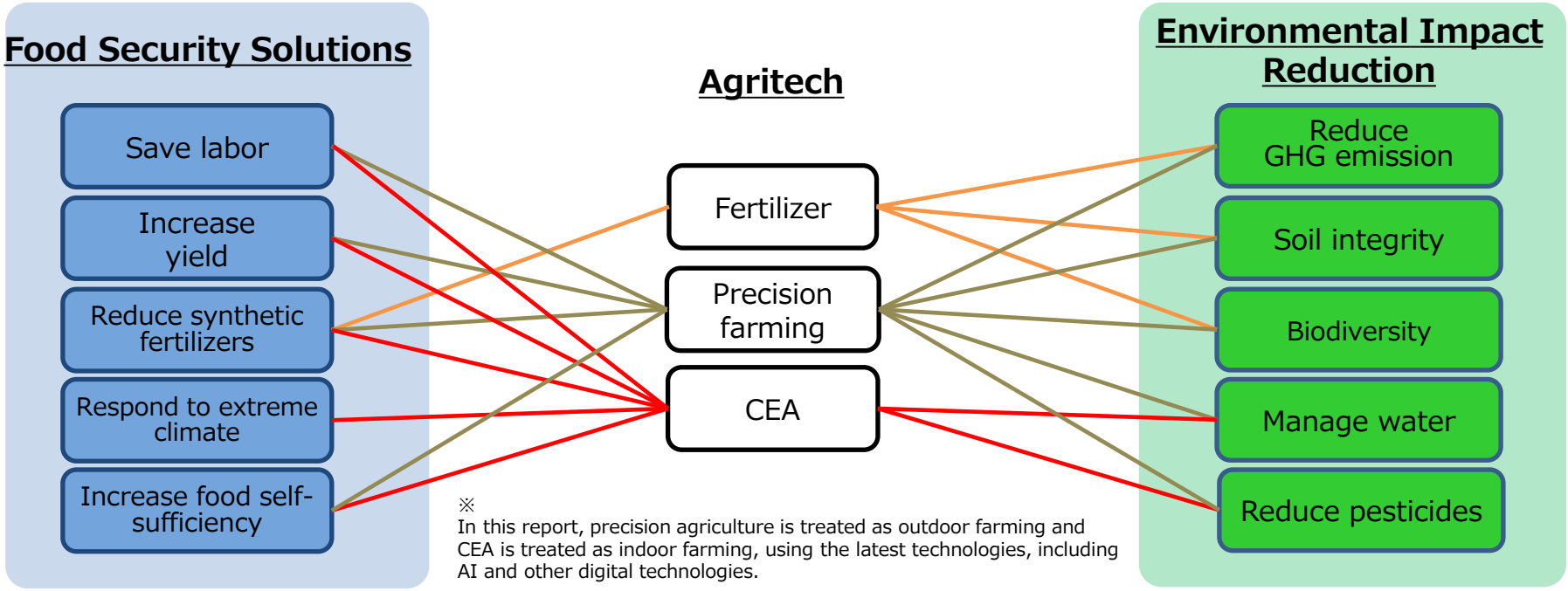
  Highlight: NEDO's efforts in the agricultural sector (4)

- Controlled Environment Agriculture (CEA)

  Highlight: NEDO's efforts in agriculture (5), (6), (7), (8)

Agritech for Food Security and Environmental Impact

- This report focuses on three agritech categories, Fertilizers, Precision Farming, and Controlled Environment Agriculture (CEA), in consideration of overseas efforts and initiatives to solve food security and reduce environmental impact, as well as relevance to NEDO. The figure below shows the relationship between each of these issues and technologies.
- ✓ Reduction of synthetic fertilizers could contribute not only to reduce GHG emissions, but also to reduce the dependency of the import of fertilizers from specific countries.
- ✓ Precision farming, driven by digital technology, is expected to contribute to labor saving, yield increase and reduction of the use of pesticides and fertilizers for the environment.
- ✓ Controlled Environment Agriculture (CEA) could contribute to food security by increasing yields even under extreme weather in addition to mitigating environmental impact.



※
In this report, precision agriculture is treated as outdoor farming and CEA is treated as indoor farming, using the latest technologies, including AI and other digital technologies.

Fertilizers

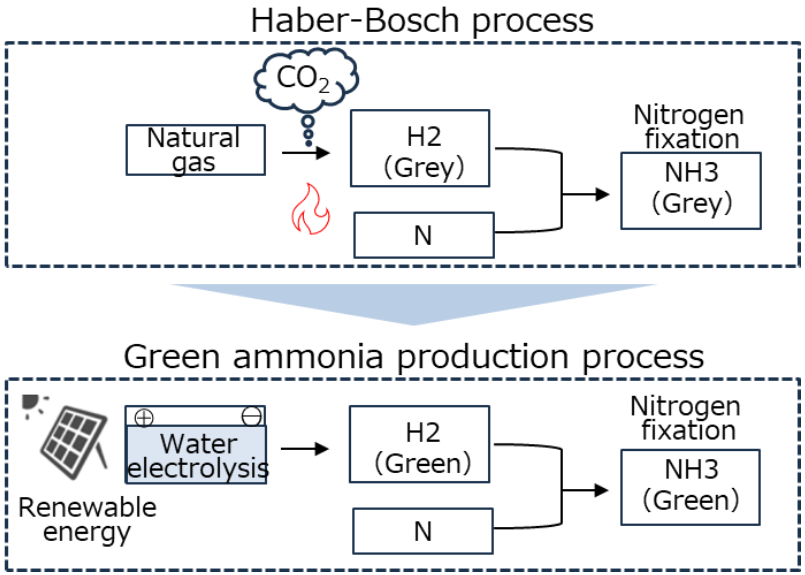
Nitrogen Fertilizers

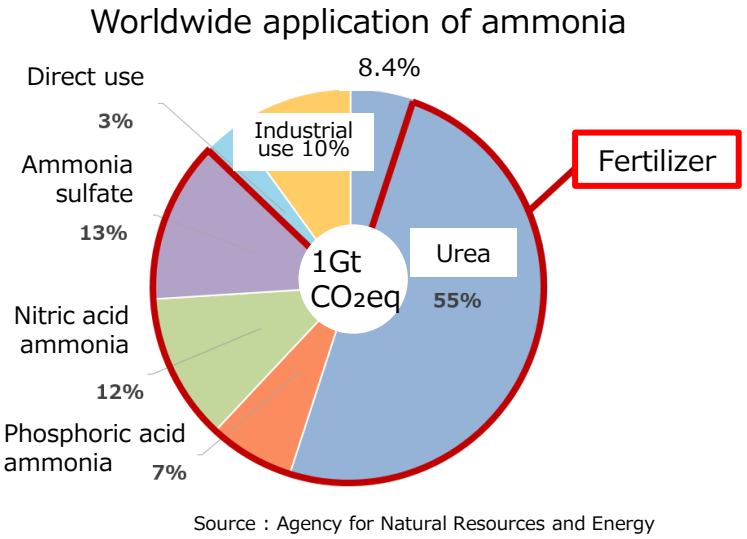
- Development of low-carbon nitrogen fertilizers is ongoing

Nitrogen fertilizer made with green ammonia

Reduce GHG emission

The current Haber-Bosch process for ammonia synthesis uses fossil fuels and emits CO_2 ,which accounts for about 1gigaton/year (1.8% of total emissions). And 80% of the ammonia applications are for fertilizers. Now water electrolysis hydrogen generator powered by renewable energy is being developed, through which green ammonia with less CO_2 emission can be synthesized.
A Scandinavian fertilizer company YARA has signed a contract with the Indian renewable energy company ACME for the supply of 100,000 tons per year starting in 2027.





Source : Agency for Natural Resources and Energy

Nitrogen fixation by plasma

Reduce synthetic fertilizer

Reduce GHG emission

Nitrogen fixation by lightning strikes is done artificially using plasma technology. The project aims to produce nitrogen fertilizer without the use of ammonia, using only air, water, and renewable energy. The nitrogen fertilizer will be produced on the farm, so this will also reduce GHG emission from transportation. A demonstration project was carried out by a start-up, Nitricity, under an ARPA-E program.

Bio-based Fertilizers

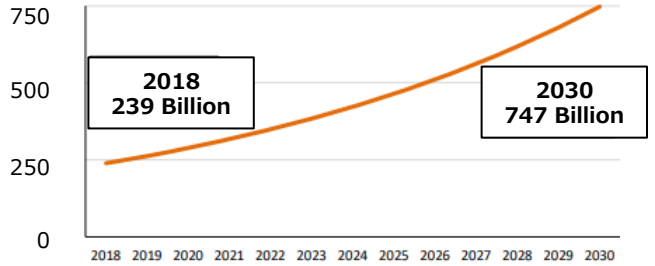
- Development of bio-based fertilizers is promoted, especially by European manufacturers who have set synthetic fertilizer reduction targets in their F2F strategy.
- Since most of bio-based fertilizers are made from natural materials, it can contribute to reduce the risk of dependency on specific fertilizer-exporting countries.

- **Biostimulants (BS)** Reduce synthetic fertilizer | Reduce GHG emission | Soil integrity | Biodiver-sity

They are materials that increase plant and soil activity, reduce plant stress, increase resistance against disease and promote growth. BS are naturally derived from microorganisms, seaweed extracts, amino acids, humic acids, mineral salts, and some chemicals. In EU, BS is defined in the new fertilizer regulation of 2022 and is expected to grow at CAGR 10% or more between 2018 and 2030. BS made from 100% natural materials can be certified as organic fertilizers. The European Commission considers BS as one of the measures to reduce the dependency of fertilizers on specific countries.

BS is also promoted for regenerative agriculture in FIMA2024

(Billion Yen) **Global biostimulants market**



Source : Created by NEDO's TSC based on the report "Agriculture, Forestry and Fisheries Research Innovation Strategy 2021" by Ministry of Agriculture, Forestry and Fisheries

- **Biochar** Reduce synthetic fertilizer | Reduce GHG emission | Soil integrity | Biodiver-sity

Charcoal made from biomass such as rice husks, livestock manure, and tree bark can improve soil water retention and permeability, neutralize soil moisture, and purify water, thereby increasing crop yields. At the same time, CO_2 in the Biochar can be sequestered in the soil for a long period.
The European Biochar Industry Consortium (EBI) positions Biochar as a negative emission tool to address climate change.

NEDO's efforts in the agricultural sector ① Low-carbonization

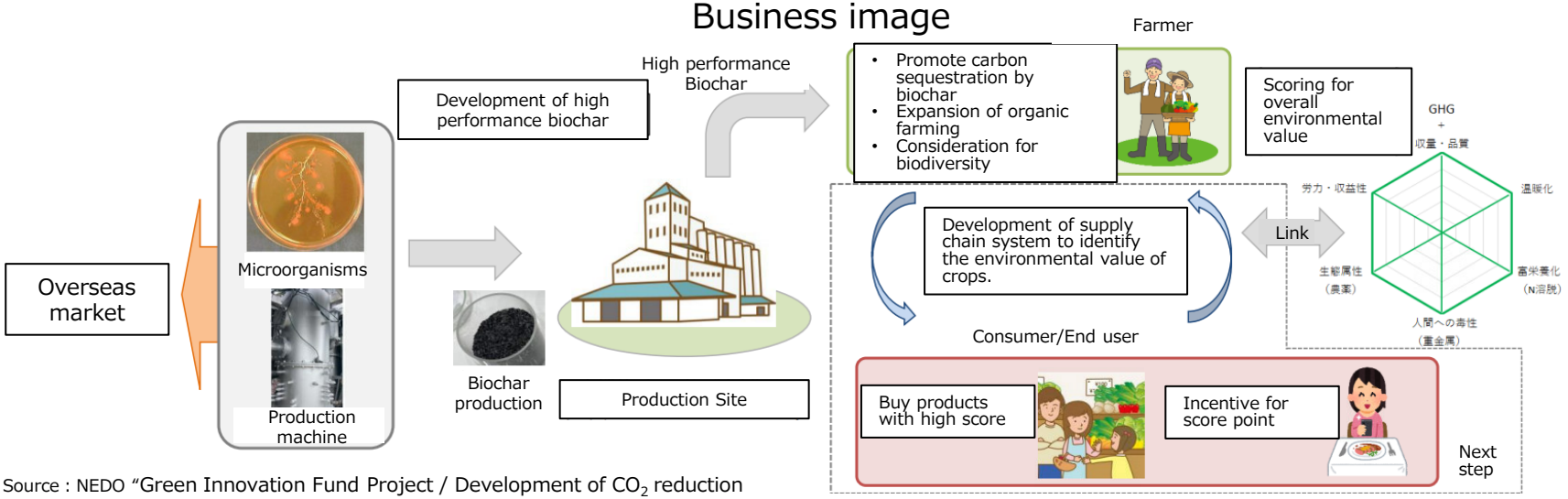
- Green Innovation Fund Project / Development of CO_2 reduction and absorption technologies for food, agriculture, forestry and fisheries industries **～Establishment of a production and application system of high performance biochar made from agricultural byproducts～**

  (Participating organizations : Gurunavi Inc., Katakura & Co-op Agri Co., YANMAR ENERGY SYSTEM CO. LTD., National Federation of Agricultural Cooperative Associations, National Agriculture and Food Research Organization)

Objectives & Overview:

- To expand the use of biochar, develop high performance biochar at low cost in production and application, and at the same time improve crop yields by adding effective microorganisms that help the growth of crop.
- Establish a methodology to objectively evaluate the "environmental value" of crops produced in carbon sequestered farmland. And make it possible to add this value on to the transaction price to improve the profitability of biochar carbon farming.
- Project period: FY2022-2030

Business image



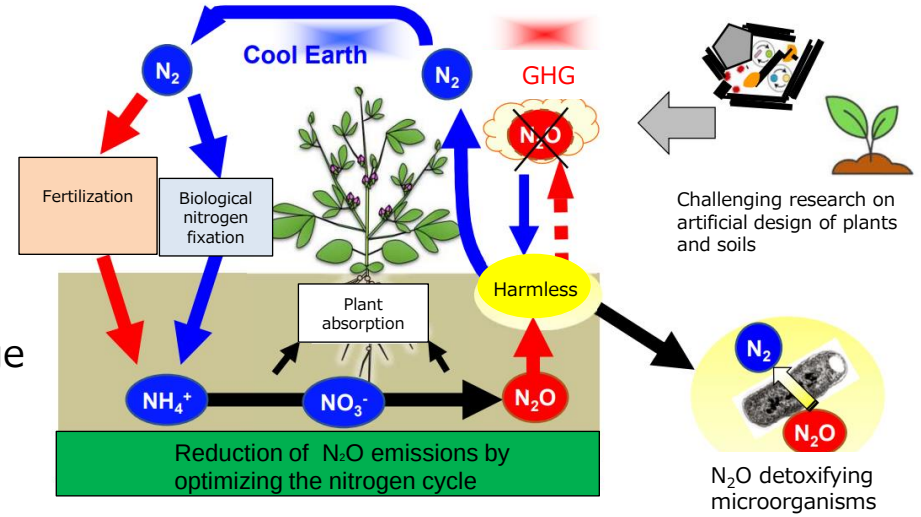
Source : NEDO "Green Innovation Fund Project / Development of CO_2 reduction and absorption technologies for food, agriculture, forestry and fisheries industry"

■ Moonshot Research and Development Program
～Reduction of greenhouse gas emissions from farmland through optimization of resource circulation～
(Participating institutions : Tohoku University, The University of Tokyo, National Agriculture and Food Research Organization)

Objectives and Overview:

- Aim to significantly reduce N_2O (Dinitrogen monoxide) emitted from farmland towards 2050 by the establishment and demonstration of recycling technologies.
- N_2O has a GWP 265 times of that of CO_2 and 59% of its anthropogenic emissions comes from agriculture. The main source of N_2O emissions from farmland is synthetic nitrogen fertilizers.
- In the natural nitrogen cycle, atmospheric nitrogen gas is fixed by microorganisms, transformed into ammonia and nitric acid, and finally returned to the atmosphere as nitrogen gas.
- The project aims to activate the material circulation function of N_2O detoxifying microorganisms, thereby reducing GHG emissions from the farm field.
- Project period: FY2020-2029 (maximum)

N_2O detoxification circulation image



Source : NEDO "Reduction of greenhouse gas emissions from agricultural lands through optimization of resource circulation"

NEDO's efforts in the agricultural sector ③ Low-carbonization

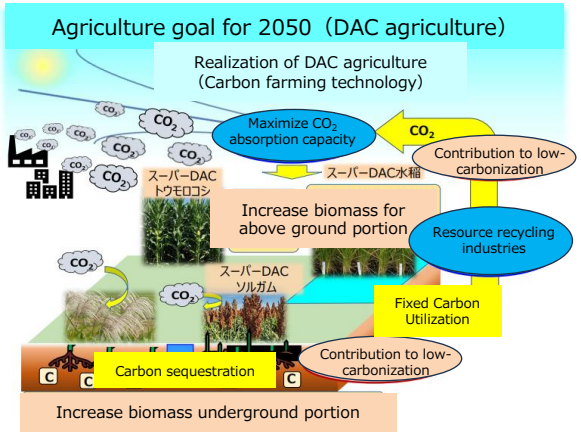
Moonshot Research and Development Program

～Realization of DAC agriculture for a super carbon-circulating society～

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

Objective and Overview:

- Utilize the CO_2 absorption characteristics of crops. By developing crops with dramatically improved CO_2 fixation capacity and dramatically increased biomass production capacity, aim to realize a new type of agriculture (DAC agriculture), in which the produced biomass is used for energy source or useful substances that can contribute to decarbonization.
- Realize plant breeding of three types of crops, rice, corn, and sorghum, by genome editing technology and crossbreeding with wild species to increase dramatically their biomass capacity. In addition, to maximize the carbon sequestration function of farmland, enlarge the underground portion (roots and stems) of crops that remains in the soil.
- Carry out the assessment of environmental impact and economic viability from the production of crop biomass through the utilization.
- Project period: FY2022-2024



Theme & target to realize DAC agriculture

Technical theme	Target for 2030	R&D Theme
Doubling CO_2 fixation capacity of crops 1	Development of super DAC crops Rice yield 1.5X Maize yield 2X Sorghum yield 2X	• Theme1 Development of super DAC rice with increased CO_2 absorption & fixation capacity • Theme2 Research of carbon fixation by increase of crop biomass
Soil sequestration of biomass 2	Increase underground portion of biomass & development of carbon farming assessment technology	• Theme2 Research of carbon fixation by increase of crop biomass
Resource recycling and utilization of above-ground portion of biomass 3	Analysis & research of resource recycling breakthrough of super DAC crops	• Theme3 Economic value and environmental impact assessment of resource utilization processes in DAC agriculture

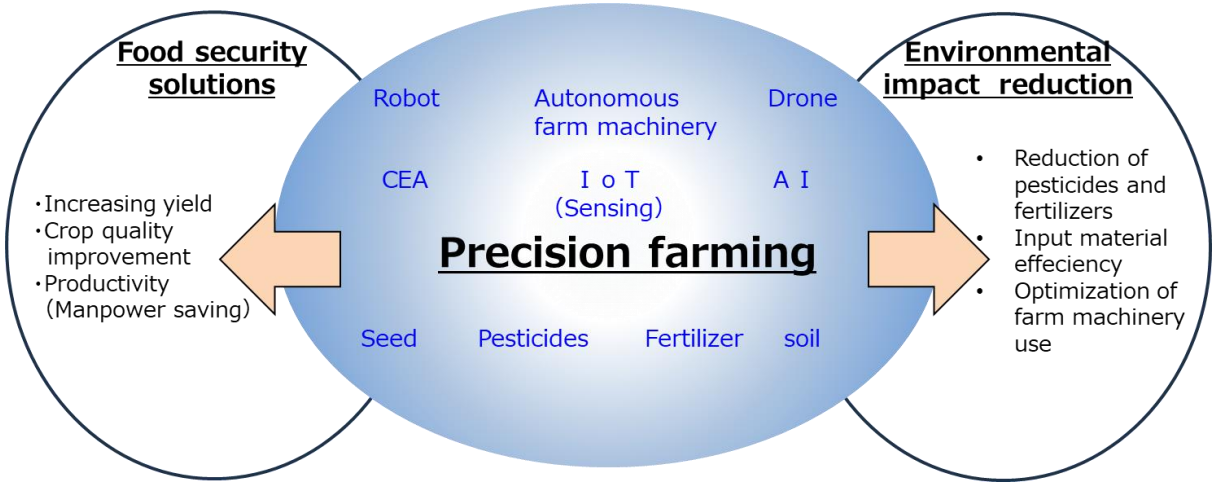
Source : NEDO "Realization of DAC agriculture for a super carbon-circulating society"

Precision Farming

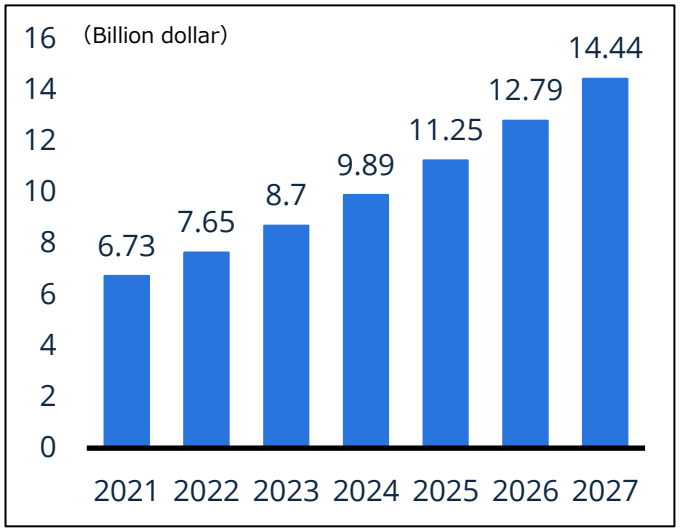
Precision Farming

- Precision farming began in the 1990s as a farming method to minimize the input of agricultural materials while aiming to increase yields with quality. The goal is to maintain soil fertility, increase the yield and reduce the environmental impact by meticulously managing the field of a variety of soils and varying the amount of seeding, pesticides, fertilizers and other inputs according to the location within the field based on the data.
- With recent sensing and digital technologies that makes it more precise and less labor intensive, various industries and start-ups, especially in Europe and the US, have entered this market. Now data-driven precision farming is becoming a trend.
- According to a survey by the Association of Equipment Manufacturers (AEM) in the US, farmers who have implemented precision farming using technologies have reported 4% increase in yield, 7% reduction in fertilizer, 9% reduction of pesticides, 6% reduction in fossil fuel consumption, and 4% reduction of water. And there are yet rooms for further improvements.

Digital Technology Advances Precision Farming



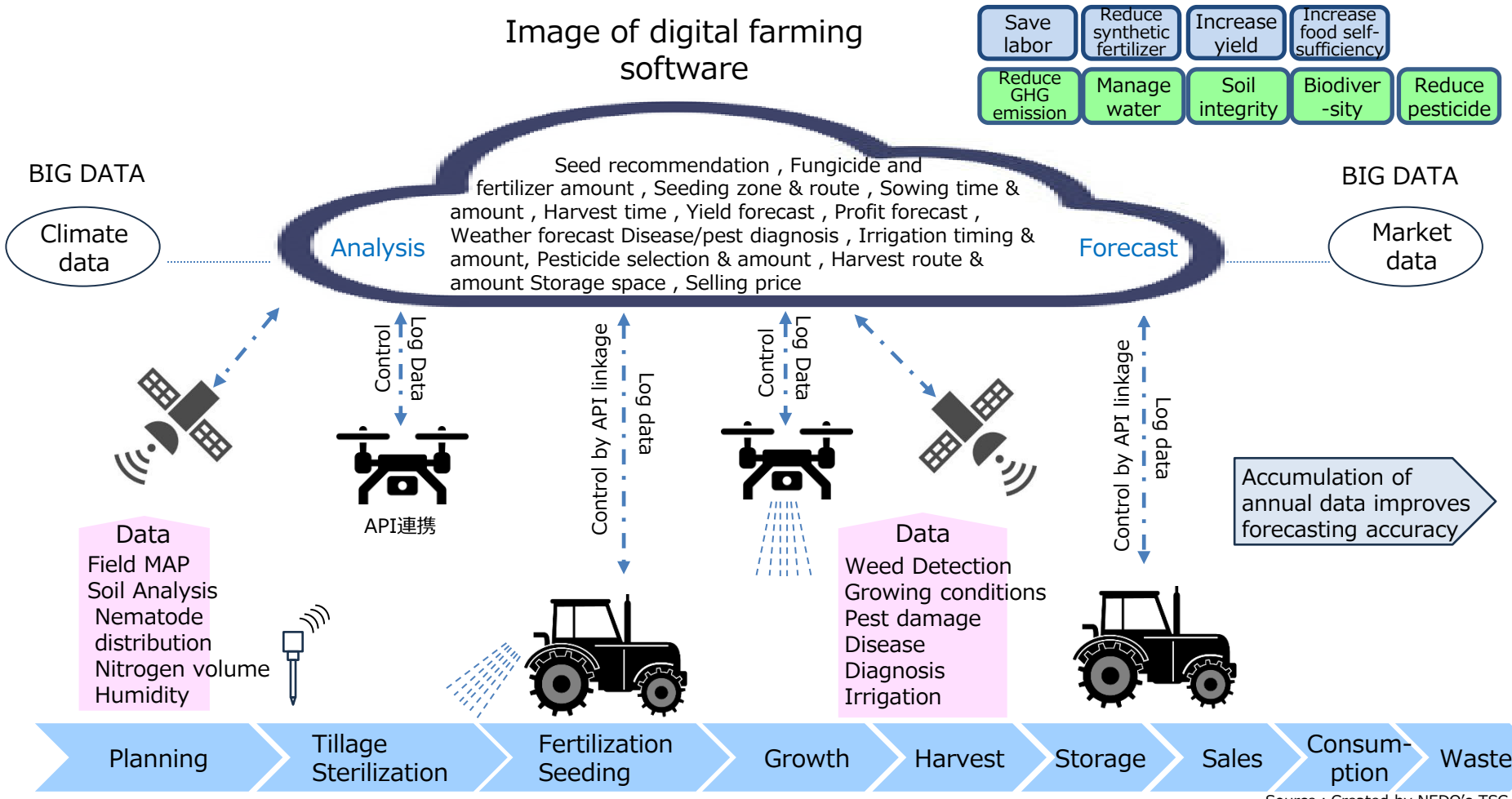
Market size of precision farming technologies



Source : Created by NEDO's TSC based on Statista report "Forecast market value of precision agriculture worldwide from 2021 to 2027"

Digital Farming Software

- Digital farming software is at the core of precision farming. Available software tools vary from simple digitalized versions of work diaries that farmers used to write by hand, to those that provide and prescribe necessary information for farmers' decision-making in all stages, from seed selection to crop selling price recommendation, and that even control farm machinery, by linking various data including the one through sensing tools.



Source : Created by NEDO's TSC

Digital Farming Software (Agrochemical Companies)

- Major agrochemical companies that aim to enclose farmers entered the market because they can recommend their own seeds and agrochemicals prescriptions. FieldView and Cropwise were originally developed by startup and software company. Through M&A processes, they belong to current company. Below are examples of functions. Each company has different functions depending on the region & crops

Company	BAYER	Syngenta	BASF
Software	**FieldView**	**Cropwise**	**xarvio**
Data origin	Satellite, farm machinery log, weather data, seedlings and crops data	Satellite, weather data, seedlings and crops data	Satellite, weather data, seedlings and crops data
Visualization function	• Cultivation record • Management • Growth and disease maps • Variable seeding map • Pesticide application map • Fertilizer application map • Yield analysis and soil condition maps • Storage space	• Variable Seeding Map • Seeding priority map • Pesticide application map • Fertilizer application map • Disease, pest, and weed monitoring • Harvesting route map	• Soil integrity map • Growth map • Weed map • Average vegetation • Elevation and slope map • Variable fertilization and seeding map
Analysis and forecasting functions	• Seed prescription • Yield Prediction • Field weather forecasting	• Seed prescription • Yield revenue • Recommended application dates for pesticides and fertilizers	• Weather forecast • Spray timing • Growing stage forecast • Weed management • Disease alerts
Compatibility	• Map export • Compatible with Trimble • Compatible with John Deere	• Map Export • Compatible with CHN & John Deere	Map export

Source ; Created by NEDO's TSC based on HP

Digital Farming Software（Startups）

- In Europe, many startups have entered the market using image data from the earth observation satellites (Sentinel-2).
- There are various lineups, from simple and inexpensive ones for small size farms to those with more substantial contents for corporate farms. (Photos below are examples from FIMA 2024)

xFarm（Italy）

A startup former farmer, offering management software for Eur.195-2,400 per year.
More than 300,000 users.

Visualization features:
Field maps (satellite images), weather data, field humidity, diseases, pests, farm machinery maintenance history, farm machinery tillage history, inventory, pests, farm machinery maintenance history, farm machinery tillage log, inventory management, reporting.

Forecasting function:
Planting plan, seeding time, pesticide/fertilizer application, yield, financials

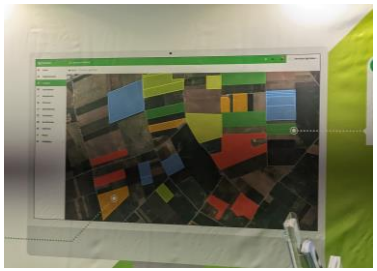
Linkage with the following in-house sensing tools
Soil humidity sensor, pest sensor, weather sensor, GNSS

ISAGRI（France）

Simple farm management software. Manages activities by manually inputting activities.It can be linked with their weather sensor. There are 150,000 users in five countries.

Agricolum（Spain）

Field management software by manual input. free for up to 2 fields. Eur.14/month for 9 fields. Over 50,000 users in Spain.



Source : Created by NEDO's TSC based on FIMA2024 information and home page

Digital Farming Software （Farm Machinery Manufacturers）

- Major farm machinery manufacturers acquired startups, developers of autonomous driving technology and precision farming software, to reinforce digital farming field through both hardware and software.

- John Deere Operation Center
  The world's largest farm machinery manufacturer strengthened this field by acquiring startups such as Blue River Technology for machine learning of image data and Bear Flag Robotics for ADAS development. The Operation Center software allows farm management and farm machinery control (Level 3). Its data can also be linked to BAYER's Fieldview.

- CLAAS Connect
  German farm machinery manufacturer CLAAS, which owns digital farming software company 365FarmNet, announces CLAAS Connect, a single cloud-based farming platform that combines digital farming management software with autonomous steering, machinery management, and other functions in 2024. This makes seamless field and machinery management possible. Control of third-party farm machinery is also possible via ISOBUS connectivity.


Field map of CLAAS Connect


Cockpit of autonomous farm machinery

ISOBUS connection kit

Huge machinery of CLAAS

Source : Created by NEDO's TSC based on FIMA2024 information and home page

Digital Farming Software（IT Giants）

- Microsoft, Alphabet & IBM entered the market in partnership with major agrochemical companies to become agricultural solutions providers that collect and integrate vast amounts of agriculture-related data and provide highly accurate forecasts through AI analysis.

- **Microsoft (MS)** announced the Azure Data Manager for Agriculture preview version in March 2023. The company aims to develop tools to support decision making in all phases of agriculture including the value chain. MS partnered with **BAYER** to complement each other's data. MS provides satellite and climate data to BAYER and BAYER provides specialized agriculture-related data.

- **Alphabet** spun off its Moonshot R&D as a company named Mineral. It is collecting agricultural data with the goal of developing high-performance AI models to help farmers, researchers, and breeders to achieve sustainable agriculture that predicts crop yields, increases production, reduces waste, and minimizes chemicals and water. It has already surveyed and analyzed 10% of the world's farmland using data sources from camera-laden rovers, satellite imagery, farm machinery, and public databases. Also, it partnered with **Syngenta** to collect agricultural data.

- In 2018 **IBM** launched the Watson Decision Platform for Agriculture to support farmers' decision-making through AI-based predictive analysis of climate data and field sensing tools, etc. In 2020 it partnered with **YARA**, a major agrochemical company in Scandinavia, to improve forecasting accuracy and enhance farm data collection. In 2021 it released the Environmental Intelligence Suite with enhanced AI-based forecasting capabilities.

Source : Created by NEDO's TSC based on various news report

Sensing (Earth Observation Satellites Sentinel-2)

- ESA (The European Space Agency) started Sentinel-2 for Agriculture project in 2014 and, since the early stage, it has been demonstrating the use of satellites in the agriculture sector. Thanks to this project, many startups and companies are using the satellite data (free of charge) to develop digital farming software.
- Due to the limited pixel resolution, early detection of pests and diseases is not possible, and the combined use of drones and ground sensors is required.

Save labor | Reduce synthetic fertilizer | Manage water | Soil integrity | Reduce pesticide

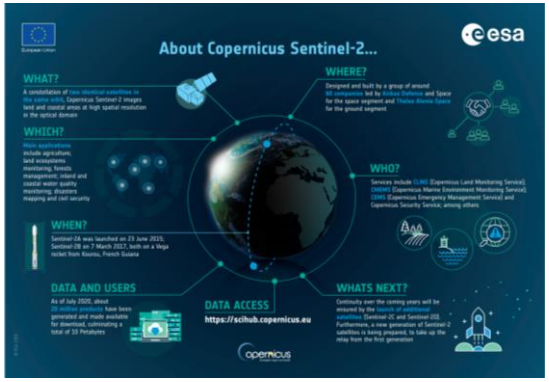
- Overview

Ownership: ESA
Satellite type: meteorological and earth observation satellites (support for agriculture, forest monitoring, land cover change, natural disaster monitoring, etc.)
Launch year: 2015 (2A), 2017 (2B)
Capabilities: multispectral data: 13 bands over visible, near-infrared, and short-wavelength infrared, 5-day cycle, Spatial resolution of 10-20 m, almost global coverage

- Agricultural Applications

Field maps
Soil moisture and irrigation need
Estimation of chlorophyll content
Crop growth conditions

One of its mission is Agriculture support



Source : Copernicus

NDVI image of Sentinel-2

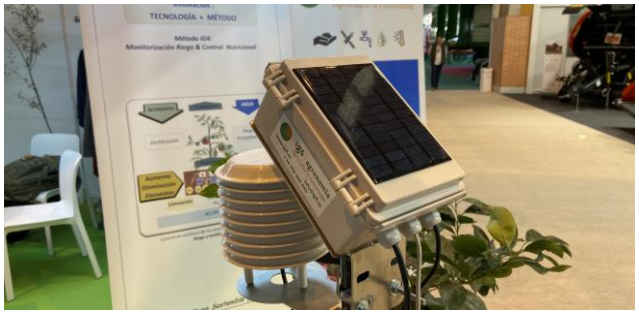
Source : USGS
NDVI: Normalized Difference Vegetation Index

Sensing (IoT device)

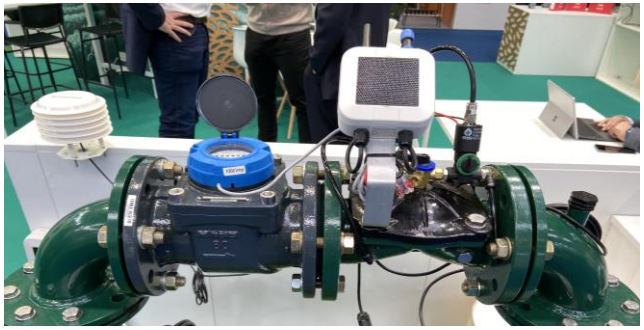
- IoT devices include weather sensors, soil humidity sensors, pest sensors, soil nitrogen sensors, etc. Communicate with the application on smartphone via SIM cards and powered by batteries (some use solar power) . Some products link with digital farming software.
  (Photos below are from FIMA2024, a farm machinery exhibition held in Spain.)

Save labor | Reduce synthetic fertilizer | Manage water | Soil integrity | Reduce pesticide

xFarm's weather, soil humidity and pest sensors. Operated through their digital farming software.



IG4's Weather and soil (humidity, nutrients) sensors



Irrigation remote control systems from SPHERAG. Solar-driven soil humidity sensor and water valve remote control

ISAGRI's weather sensor Linked to their digital farming software

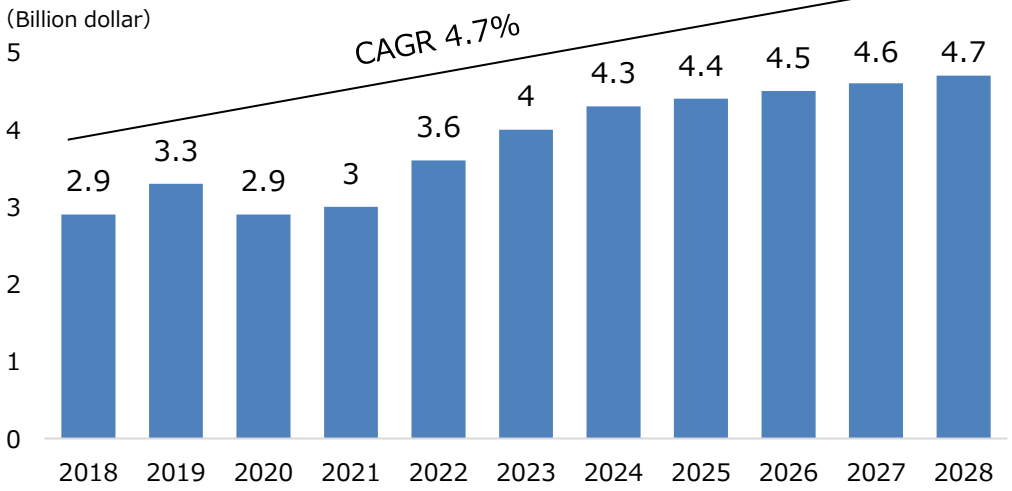
Source : Created by NEDO's TSC based on FIMA2024 information and home page

Drones

- Agricultural drones are used for (1) sensing and (2) spraying. The first is monitoring of crop growth as well as soil conditions, including pest and disease detection, using high-resolution camera images (RGB, multispectral), that cannot be captured by satellite images. The second is spraying of seeds, pesticides and fertilizers in hilly terrain and other medium-sized fields that are difficult for tractors to enter.
- Overall drone market revenue is expected to reach $4.7 billion by 2028. The agricultural use accounts for approximately 11% of the overall market as of 2022. The manufacturers such as XAG and DJI Agriculture develop dedicated drones for agriculture.
- DJI has 76% of overall market as of 2021, while is added to the US entity list.
- Advancements in batteries are expected to extend operation time, and features such as wireless power supply are being studied for the future.

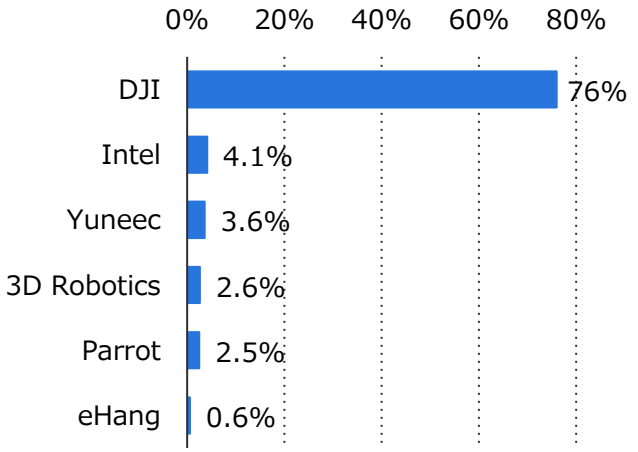
Save labor | Reduce synthetic fertilizer | Manage water | Soil integrity | Reduce pesticide

Drone market size



Source : Created by NEDO's TSC based on the report of Statista "Drones-market data & analysis"

Drone market share (2021)



Source : Created by NEDO's TSC based on the report of Statista "Global market share of consumer and commercial drone manufacturers in March 2021, based on sales volume"

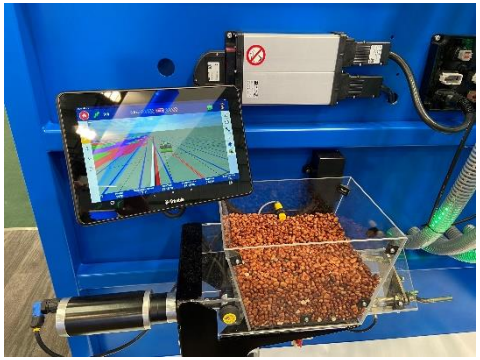
Auto Steering Systems

- Auto steering systems connected through ISOBUS (International standard ISO 11783) of tractors become popular. It can realize Level 1 autonomous driving for owned tractors. The basic kit consist of 3 pieces, handle for ISOBUS connection, GNSS receiver, and monitor.
- Many startups are entering the market by combining China-made ODM 3-pieces kit with Sentinel-2 satellite images. The low-priced models are available from as low as 5,000 euros, making it easy for farmers to start precision farming with their current farm machinery assets.
- Trimble's equipment offers variable seeding, fertilizer application, and pesticide spot spray functions. It also works with BAYER's FieldView. The Ministry of Agriculture, Forestry, and Fisheries (MAFF) of Japan mentions that the system can reduce overlapped work, allow unskilled farmers to work with the same or better accuracy and speed as skilled farmers, and could increase the working area per unit time by approximately 10 to 25%.me.

Save labor | Reduce synthetic fertilizer | Manage water | Soil integrity | Reduce pesticide

Basic kit consist of steering for ISOBUS, GNSS receiver and monitor

Trimble system connected with BAYER's Fieldview



Variable seeding and pesticides spot spraying function of Trimble

Source : Created by NEDO's TSC based on FIMA2024 information and home page

Autonomous Farm Machineries

- Fully autonomous models (Level3) are available in the market. However, those prices are more than double compared with conventional models.

Save labor | Reduce synthetic fertilizer | Reduce pesticide

Type	Manufacturer	Model	Overview	Price range
Tractor	John Deere (USA)	Autonomous 8R	Equipped with 6 cameras and ECU (Nvidia), image recognition with 4GB/s high-speed processing, data constantly uploaded to the cloud for AI machine learning.	0.5～0.8 million dollar
	CLAAS (Germany)	XERION 12.650	CLAAS established world's first consortium to promote automation and autonomous driving for multi-manufacturers, 3A-ADVANCED AUTOMATION & AUTONOMY. This machinery is compatible with it.	0.95 million dollar～
	Monarch (USA)	MK-V	Equipped with 2 3D cameras and 6 standard cameras with ECU (Nvidia) and Jetson Edge AI for data processing. EV, 70 HP, mainly for wine farms.	75 thousand dollar～
Weeder	FarmDroid (Denmark)	FD20	Fully automated field robot both for seeding and weeding operations. Mechanically removing weeds between each plant with an accuracy of 8 mms. Operates up to 24 hours per day using PV as a sub-power source, covering up to 6.5 hectares/day.	97 thousand euro～
	NAÏO Technologies (France)	TED	Weeding farm robot for wine farms, precise mechanical weeding without herbicides, 8 hours per day autonomous operation, EV,5 ha/day workload.	200 thousand euro～
Sprayer	FEDE (Spain)	KFAST	Autonomous drive and spray pesticides with high precision in the orchard. Can prevent pesticide exposure to workers. Will be available in 2025.	

Source : Created by NEDO's TSC based on FIMA2024 information and home page

Farm Machineries with Alternative Energy

- Tractors under 100HP segment see the electrification with EV models. In the upper segments where the higher power is required, multiple fuels type, compressed methane, hybrid diesel, fuel cell (FC), etc. are being considered.

Seg-ment	Manufacturer	Model	HP	Overview
Under 100 HP	Kubota (Japan)	LXe-26	26	Equipped with lithium-ion battery. In average 3-4 hours of continuous operation is possible by 1-hour quick charge.
	Case（CNH) (Netherlands)	Farmall 75C Electric	75	Powered by 110 KWh lithium-ion battery , Max. torque 320 Nm, 4 hours operation,
	Fendt（AGCO) (USA)	e100 Vario	75	Powered by 100 kWh lithium-ion battery,5-7 hours operation.
Upper 100 HP	John Deere (USA)	Multiple fuels Tractor	168	Multiple fuels types (vegetable oil, biodiesel, renewable diesel, etc.), under demonstration.
	New Holland (CNH) (Netherlands)	Methane Power CNG	270	6.7-litre methane-fueled engine, it can reduce CO2 emissions by 878 tons annually by bioLNG operation, under demonstration.
	STEYR（CNH) (Netherlands)	Hybrid CVT Tractor	260	Combination of diesel and electric motor. 10-15% fuel savings, Up to 260hp, under demonstration.
	Fendt（AGCO) (USA)	FC Tractor	134	Fuel cell, 100 kW (134 hp) electric motor. Demonstration underway to establish a hydrogen infrastructure for farmland

Reduce GHG emission

Case（CNH) Farmall 75C Electric

Source : CNH Home page

John Deere Multi-fuel

Source : Another model in CES2024

EV、Alternative fuels

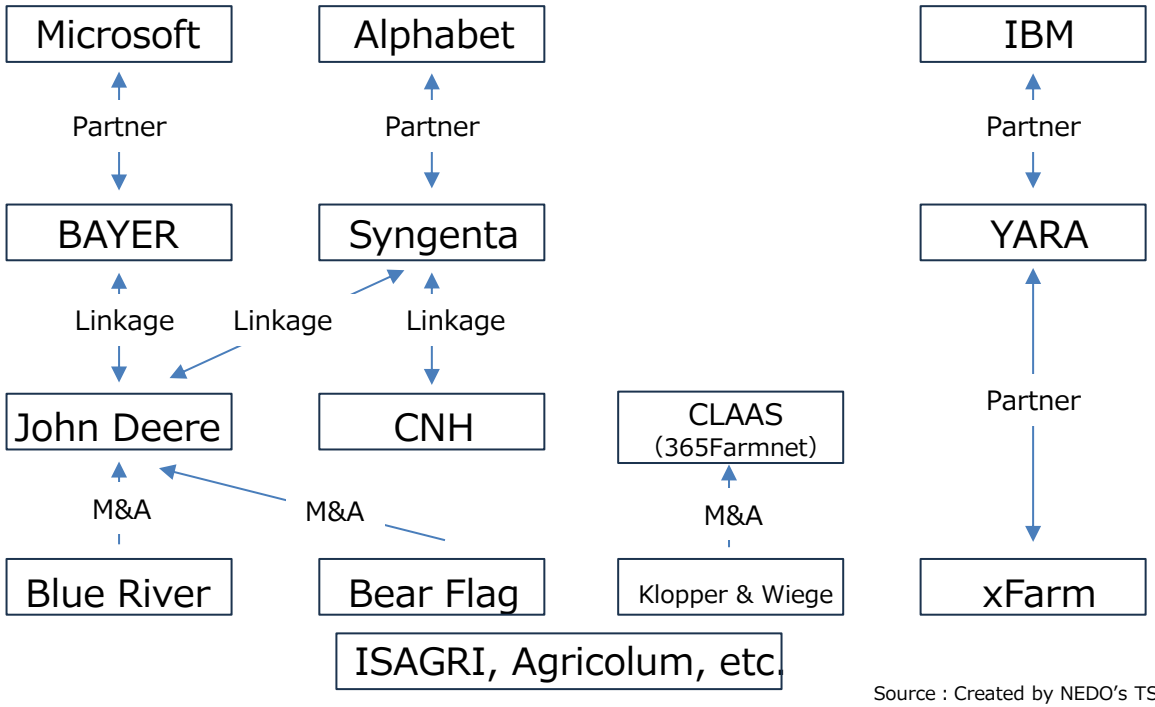
Source : Created by NEDO's TSC

Movement in the Digital Farming Software Industry

- Startups, farm machinery manufacturers, and IT giants have entered the digital farming software market, which had been developed under the leadership of major agrochemical companies.
- While each company developed their own software, they are complementing each other for data and technologies to improve accuracy and expand functionality. The companies are aiming to become the leading provider of digital farming technology in alliance with the partners.
- Farm machinery manufacturers open their APIs to expand sales opportunities, and are enhancing linkage functions, e.g., the control of their machinery on other companies' applications.
- Startups' inexpensive and simple software is a favorite of many users, which has contributed for digitalization of agriculture.

Players	Strengths
IT Giants	AI analysis, machine learning, Big Data analysis, data integration and classification, image analysis, climate forecasting
Major Agrochemical Companies	Soil and crop data, seed, pesticide and fertilizer information, pest and disease data
Farm Machinery Manufacturers	ADAS and farm machinery information, soil and crop data, seed, pesticide and fertilizer information
Startups	Innovation, simplicity, low costs

Movement in the digital farming software industry



Source : Created by NEDO's TSC

Reference: Trend of Standardization of Agriculture-related Data

- In the ISO (International Organization for Standardization) the American National Standards Institute (ANSI) and the German Standards Institute (DIN) lead the Strategic Advisory Group (SAG) on Smart Agriculture since 2021. Following the final report of the SAG, both associations proposed to establish a new Technical Committee (TC).
- In response to this proposal, TC347 on "Data-driven agrifood systems" was newly established in October 2023. The goal is to standardize data on technology in the agri-food sector, improve interoperability, and promote data-driven decision-making systems.

Status of Agriculture-related Standardization Activities in ISO

ISO/TC23
Tractors and machinery for agriculture and forestry
(1952-)

More than 400 standards related to agriculture were published up to now. Below are outcome examples of the SC.

- SC4 Tractors
- SC6 Equipment for crop protection
- SC19 Agricultural Electronics

※ISO 11783 for ISOBUS standardization was published under SC19.

ISO/TC347
Data-driven agrifood systems
(Established in October,2023)

DIN of Germany is in charge for the secretariat and start discussions on data standardization in agriculture and food systems. The following SCs will be established.

- Indicators and data in sustainable models/agri-food systems
- Greenhouse, controlled environment, urban agriculture, etc.

SAG: Strategic Advisory Group, TC: Technical Committee, SC: Sub Committee,

Source : Created by NEDO's TSC based on ISO HP

NEDO's efforts in the agricultural sector
④ Alternative Energy

- Collaborative Industry-Academia-Government research and development project for "Solving Common Challenges Toward Dramatically Expanded Use of Fuel Cells and Related Equipment."
- **～ Demonstration research for practical application of fuel cell powered tractors ～**
  (Grantee : Kubota Corporation)

Objective & Overview:

- Expand the use of fuel cells in the agriculture sector which could contribute to the increase of the hydrogen demand and the establishment of its infrastructure in rural areas towards CN society.
- Develop "Next generation medium and large sized tractor powered by fuel cell" with high CO_2 reduction effect, which is superior to battery in terms of its high power and long operating hours.
- Project period: FY2021 - FY2024

FC Tractor for demonstration

Source : Kubota corporation News release

FC/HDV roadmap

Source : NEDO "Roadmap for Fuel Cell & Hydrogen Technology Development"

CEA : Controlled Environment Agriculture

CEA (Controlled Environment Agriculture)

- CEA generally refers to the cultivation of crops and plants in a protected indoor area, with a highly controlled environment throughout the year.
- It is positioned as an urban way of agriculture that strengthens the resilience of food supply while transforming agriculture, which has a large environmental footprint in terms of GHG emissions and water use, into a sustainable one. (According to OECD, agriculture sector accounts for about 70% of the world's water use.)

Save labor | Respond to extreme climate | Reduce synthetic fertilizer | Increase yield | Manage water | Reduce pesticide

Major cultivation methods

Aeroponics

Plant roots are exposed and a mist containing nutrients is applied directly to the roots.

Features
- Roots can easily take in oxygen and plant growth rate is fast
- Up to 95% of water reduction
- No pesticides required
- No soil required (CO2 emissions reduction)

Source : NASA

Hydroponics

Method of growing plants using a water-based nutrient solution. Vertically stacked culture trays can increase yield per floor space.

Features
- Up to 95% of water reduction
- No pesticides required
- No soil required (CO2 emissions reduction)

Source : USDA

Aquaponics

A system of aquaculture in which the waste produced by farmed fish supplies the nutrients for plants grown hydroponically, which in turn purify the water.

Features
Water reduction
No pesticides required
No fertilizers required
No soil required(CO2 emissions reduction)

出典：USDA

Source : Created by NEDO's TSC

Comparison of lettuce yield by water volume

	Water Volume	Lettuce Yield (per/㎡)
Open Field	250L	3.9Kg
Green House	20L	41Kg
CEA	1L	100Kg

Source : Created by NEDO's TSC based on the report of DANTHERM GROUP "Why Controlled Environment Agriculture (CEA) is the future of Farming"

Investment in CEA in the US

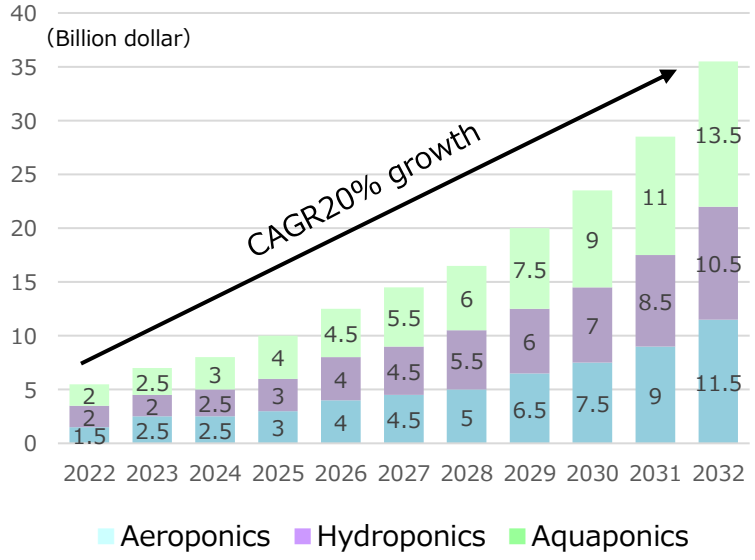
- In the US, USDA, NIFA, DOE and other institutions are making significant investments in developing innovative technologies and business models for CEA to establish the resilience of food supply and decarbonize agriculture. Below are just a few examples.

In June 2022, USDA announced $43.1 million for urban agriculture development.
In October 2022, USDA contributed $14.3 million for urban agriculture projects in 27 states.
In January 2023, USDA contributed $7.5 million for innovative project planning and implementation.
In February 2023, USDA and NIFA announced $70 million contribution for Sustainable Agriculture.
In September 2023,DOE committed $2.5 million for the development of CEA energy/water efficiency technologies as 2-year Accelerator Program.

Benefits of CEA

- Food Security
  - Increased yield per unit area
  - Less susceptible from extreme weather
  - Highly accurate yield prediction
  - Labor savings
- Reduction of environmental impact
  - Water saving
  - Fertilizer reduction
  - No pesticides required
  - No conversion of forests to farmlands
  - CO_2 emissions reduction during transportation for the cultivation near consumption areas

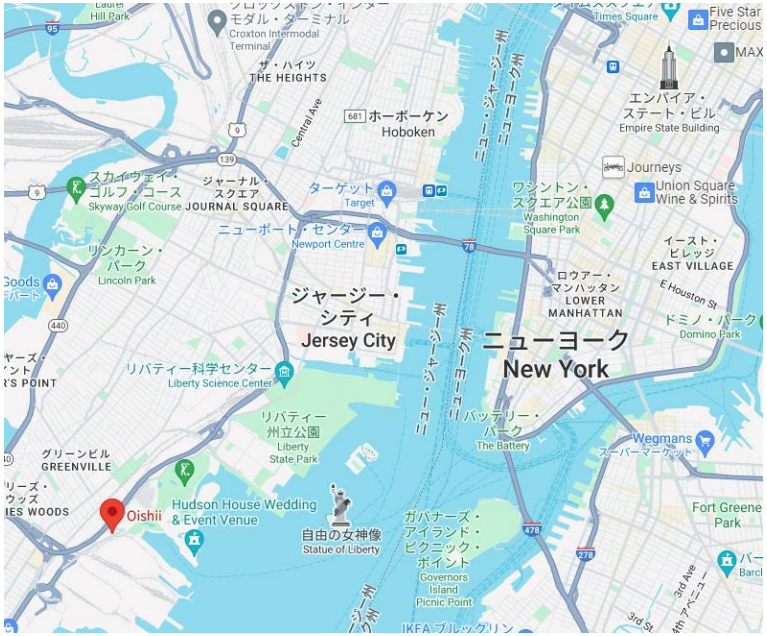
Global CEA value by method



Source : Created by NEDO's TSC based on Statista report "Indoor Farming"

CEA Case Study – Oishii Farm

- Oishii Farm, a Japan originated startup, opened “Mugen Farm”, the world's largest high-end strawberry plant factory in the suburbs of New York City, combining the traditional techniques of greenhouse horticulture and the ingenuity of CEA.
- The world's first successful stable mass production of strawberries using natural bee pollination.
- Replicate the unique climate (soft rain, mild heat, warm light, wind) necessary to improve and grow Japanese varieties in the plant.
- No use of pesticides, use of renewable energy, complete water circulation system, CO_2 control, automatic harvesting robots, etc.
- The sugar content is higher than strawberries in the US, which are mainly grown in open fields. After successful branding through direct sales to Michelin restaurants, it started selling at a premium price at $50/box of 8 pcs at upscale grocery stores.



“Mugen Farm”
Opening May 2022; over 74,000 square feet; 60% less energy use and 40% less water use than the company's initial farm. Urban farming located in Jersey City near Manhattan. Partnering with Yaskawa Electric to create a fully automated factory.

Source : NARO（No relation with Oishii Farm）

NEDO's efforts in the agricultural sector
⑤ Indoor harvesting robot

■ Project to Construct a Basis for R&D of Innovative Robots
～Development of fruit and vegetable crops harvesting system～
(Grantee : YANMAR HOLDINGS CO., LTD.)

Objectives and Overview:

- To support basic and applied research on elemental technologies such as "handling-related technology", "remote control technology", "new robot materials technology", and "general-purpose motion planning technology", which are key to the development of industrial robots that can handle a wide variety of products in small quantities, through collaborative R&D among industries, universities and other research institutions.
- Towards practical use of robots, it develops a recognition system for irregularly shaped crops and fruits, and an end-effector for harvesting fruits without damaging them.
- Project period: FY2020 - FY2022

Image of Project to Construct a Basis for R&D of Innovative Robots

Source : NEDO "Project to Construct a Basis for R&D of Innovative Robots"

Large sized tomato harvesting robot prototype
Exhibited at the 2022 International Robot Exhibition

Source : YANMAR HOLDINGS CO., LTD. News release

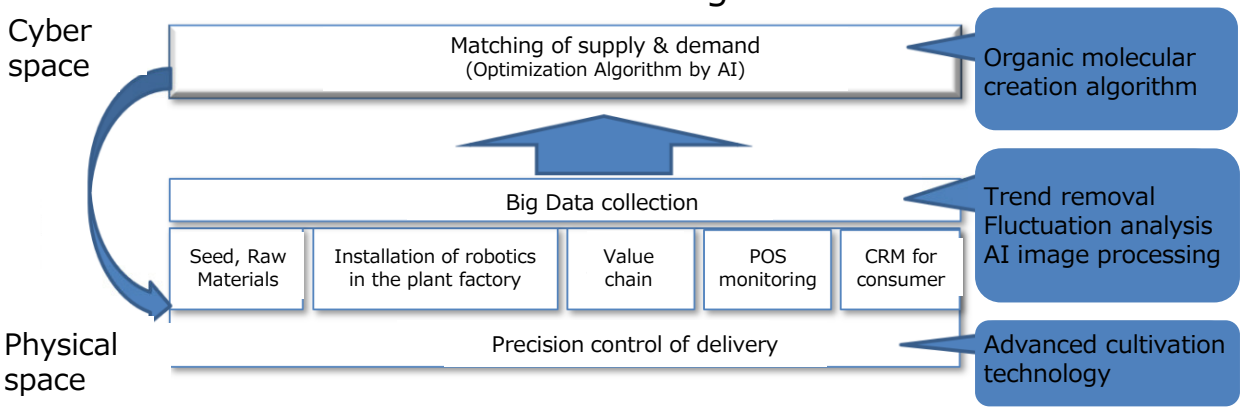
NEDO's efforts in the agricultural sector
⑥ AI

- Realization of a Smart Society by Applying Artificial Intelligence Technologies
  ～Value chain efficiency by AI system for plant factories etc.～
  (Grantee : Farmship, Inc.)

Purpose and Overview:

- The Japanese government set in 2017 the "Goals of artificial intelligence R&D and a roadmap for the commercialization" and positioned three priority fields where artificial intelligence (AI) technology must be implemented in society: "productivity," "health and medical/nursing care" and "spatial movement".
- In those three fields, R&D projects were conducted to verify the effectiveness of the technologies by demonstrating AI technologies and cyber-physical systems (CPS) in actual fields.
- It developed a system to collect data from agricultural value chain, from the procurement of agricultural materials including seeds to consumers' purchasing behaviors, with aims to analyze such data by AI technologies, to predict the amount of production and demand of crops such as vegetables and to match supply and demand quickly and accurately.
- The goal was to build the efficient value chain and reduce waste and loss by 20% onsite.
- Project period: FY 2018-FY2022

Overall R&D image



Source : Farmship,Inc News release

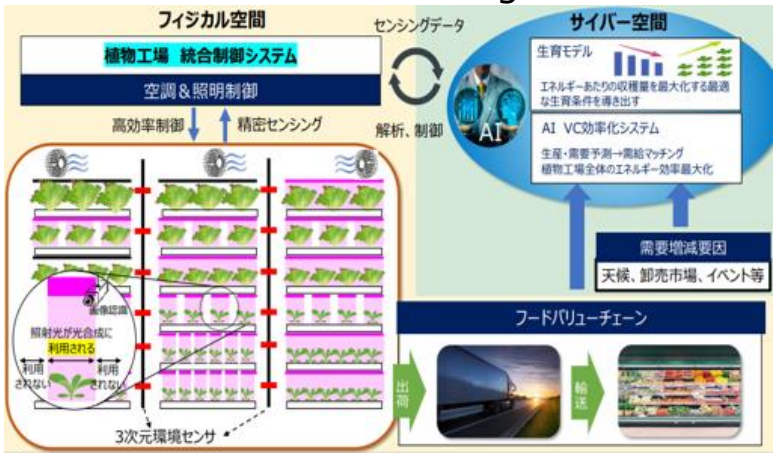
NEDO's efforts in the agricultural sector
⑦ Energy saving

- Program to Develop and Promote the Commercialization of Energy Conservation Technologies to Realize a Decarbonized Society （Public solicitation in 2022）
  ～ Development of innovative energy-saving plant factory technology ～
  （Grantee : Farmship, Inc.）

Objective and Overview:

- While demand for CEA (controlled environment agriculture) is expanding thanks to its stable quality crop production, its high energy consumption mainly by lighting and air conditioning become serious issues.
- For CEA, develop IoT technologies to observe environmental variations and to control the facility for optimal environment by AI, including the control of lighting and air conditioning, to minimize the energy consumption.
- Project period: FY2022-2024 (this theme)

Overall image



【Expected outcome】
Energy saving by 30% in lighting, 52% in air-conditioning and 36% in total. Cost saving by 20% through the reduction of equipment, consumables, and waste losses. The technology is expected to spread widely.

Source : NEDO "Program to Develop and Promote the Commercialization of Energy Conservation Technologies to Realize a Decarbonized Society"

NEDO's efforts in the agricultural sector
⑧ Startups support

■ The 44th NEDO pitch **(Agritech ver.)** November.2,2021

Objective and Overview:

- NEDO and the Japan Open Innovation Venture Creation Council (JOIC; Secretariat by NEDO) have been organizing "NEDO Pitch", a pitch event for startups to create open innovation.
- At the 44th NEDO Pitch (Agritech ver.), five startups that aim to solve problems faced by agriculture spoke on the following themes.

  - Protection against both heat and dryness through own mechanism of plants
    Ac-Planta Inc.
  - Making agriculture possible even on the moon
    TOWING Ltd.
  - Farming robot with advanced autonomous driving technology
    REGMIN inc.
  - Genome editing breeding with fast development speed
    GRA & GREEN Inc.
  - Pinpoint application of pesticide for the safety enhancement
    AgroDesign Studios Co., Ltd.

Summary of Global Agritech Trends（Chapter4）

- In terms of fertilizers, R&D for bio-based fertilizers using naturally derived materials such as seaweed and microorganisms are being promoted mainly in Europe from the viewpoint of environmental responsiveness and reducing the risk of dependence on specific countries. Low-carbon nitrogen-based fertilizers that emit less CO_2 during production are also being developed.

- Digital farming software, which aims to provide and prescribe information necessary for farmers' decision-making in all stages, are becoming more accurate with the evolution of sensing and AI technologies. Autonomous driving technology for farm machineries has been established up to Level 3 which saves manpower. However, due to its high price, auto steering systems (Level 1) for the aftermarket are expected to become the mainstream for the time being.

- As for alternative energy for farm machineries, the trend is towards EVs under 100HP segment, while, for the upper segments, manufactures are trying to develop other ways like hybrids, FC, etc. which require the establishment of supply chains, too.

- Startups, farm machinery manufacturers, and IT giants have entered the digital farming software market, which had been developed under the leadership of major agrochemical companies. They are complementing each other for data and technologies to improve accuracy and expand functionality. The companies are aiming to become the leading provider of digital farming technology in alliance with the partner.

- In the US, CEA is positioned as a way of agriculture that contributes to resilient food supply and decarbonization, and the government is investing significant amount for it. There are successful examples of mass production of high value-added foods such as strawberries, and further market expansion is expected.

5. Summary and consideration

Summary and consideration

Agriculture faces the needs to respond to food security and environmental impact globally. This report summarizes the trends of agritech which is expected to contribute to solve these issues.

- In Europe and the US, various goals and regulation are set to urge the agriculture sector to transform to biodiverse and climate-friendly one. Agrochemical companies, farm machinery manufacturers and IT giants are promoting precision farming, as well as CEA, which aims to minimize inputs and maximize yields of quality crops by making full use of digital technologies.

- As the bio-based fertilizers such as BS become more popular in parallel with the reduction of pesticides and synthetic fertilizers by precision farming, it will further reduce the environmental impact, improve fertilizer self-sufficiency, and be an important factor to contribute to food security issues.

- By combining the agricultural data, including seeds, soil, fertilizers and prescription know-how, held by agriculture related companies and the advanced technologies of IT companies for climate forecasting, data analysis, AI and so on, the prediction accuracy of digital farming software will evolve. This will enable scientific agriculture with higher productivity and lower environmental impact. Furthermore, by implementing data not only from the production phase, but also from the distribution, consumption, and disposal phases, it will be possible to build the system that covers entire food value chain.

- One of the objectives of the recent revision of Japan’s "The Basic Law on Food, Agriculture and Rural Areas” is the sustainable growth of agriculture. To sustain the growth, it will require to keep having new people. Agritech has the potential to support the future of agriculture by attracting the farm successors from the younger generation, new workers and new businesses from the different sectors, as Agritech can make the farming more of fun, cool and profitable.

- As introduced in Highlight, NEDO is working to formulate and implement various projects from the perspective of carbon neutrality and agriculture-industry collaboration. NEDO will continue to promote such projects in consideration of global technology trends.

Postscript

- This report concludes with two impressions at FIMA 2024 (International Agricultural Machinery Exhibition) held in Spain.

  The first was the large number of teenager visitors (successors to farmers). They were experiencing the auto steering systems of various companies as if they were playing a game. They looked happy to climb into the cockpit of the huge CLAAS farm machinery. It was thoughtful that farm machinery manufacturers positioned teenagers as their next customers and took positive measures to attract them. Digital technology has lowered the hurdle for unexperienced peoples to enter the agricultural industry. This contributes to invite workers from the next generation.

  Second is about startups. Data-driven precision farming is yet at the stage of dawn era and many startups are greedily entering the market of auto steering systems and digital farming software. It was impressive that all of them were using Sentinel-2 satellite image which is available at free of charge. As Japan promotes the Tellus* initiative, it is worth considering to create such mechanisms further.

  （※） Satellite data platform service from Japan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TSC Foresight

Agritech Report
～From the perspective of food security and environmental impact～

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