



# Moonshot Research & Development Program

## -- Creation of globally sustainable food supply industry--

November 27, 2020

Director of Moonshot R&D Goal 5 Program  
President, Tokyo University of Agriculture and  
Technology

Kazuhiro Chiba

*This is a tentative translation of the presentation material used for the lecture on November 27, 2020, and all responsibility for the translation lies with the Bio-oriented Technology Research Advancement Institution(BRAIN).*

# Program director (PD)



Kazuhiro CHIBA (Ph.D.)

President, Tokyo University of Agriculture and Technology



[Specialized fields]

Bioorganic chemistry, organic electrochemistry (electro organic reaction), and others

[Brief history]

Proactively worked on international research activities and human resources development. For example, in July 2013, he led the first conclusion of the Comprehensive Partnership Agreement between the national university in Japan and the UN Food and Agriculture Organization (FAO) as a vice-president, Faculty of Agricultural Research, Graduate School of Tokyo University of Agriculture and Technology.

April 2020, accepted a post as President of Tokyo University of Agriculture and Technology

Founded a **start-up (JITSUBO (Co., Ltd.))** based on his findings; thereby, has a **wealth of experience and knowledge about the social implementation of findings.**

# Vision of what a future society should be

A human-centered society where both economic development and solving social issues will be achieved

**Society 5.0**

**Human-centered society**

Society 4.0

**Information society**

Society 3.0

**Industrial society**

Society 2.0

**Agrarian society**

Society 1.0

**Hunting-gathering society**

# What types of food will we have 10 years later?

## SUSTAINABLE DEVELOPMENT GOALS 17 GOALS TO TRANSFORM OUR WORLD



Responsible consumption  
and production



# Global food market size

The beverage and food market size is estimated to be **1,360 trillion yen** in 2030, equivalent to 1.5 times of **890 trillion yen** in 2015.

The market size is estimated to expand from **420 trillion yen** to **800 trillion yen** by a factor of **1.9** in Asia.

from **220 trillion yen** to **280 trillion yen** by a factor of 1.3 in North America.

from **210 trillion yen** to **240 trillion yen** by a factor of 1.1 in Europe.

However, the costs incurred as of **2018** are:

Healthcare cost: **660 trillion yen** (obesity, malnutrition, etc.)

Environmental cost: **310 trillion yen** (contamination, harmful chemicals, etc.)

Economic cost: **210 trillion yen** (welfare, food loss, etc.)

Source: Growing Better

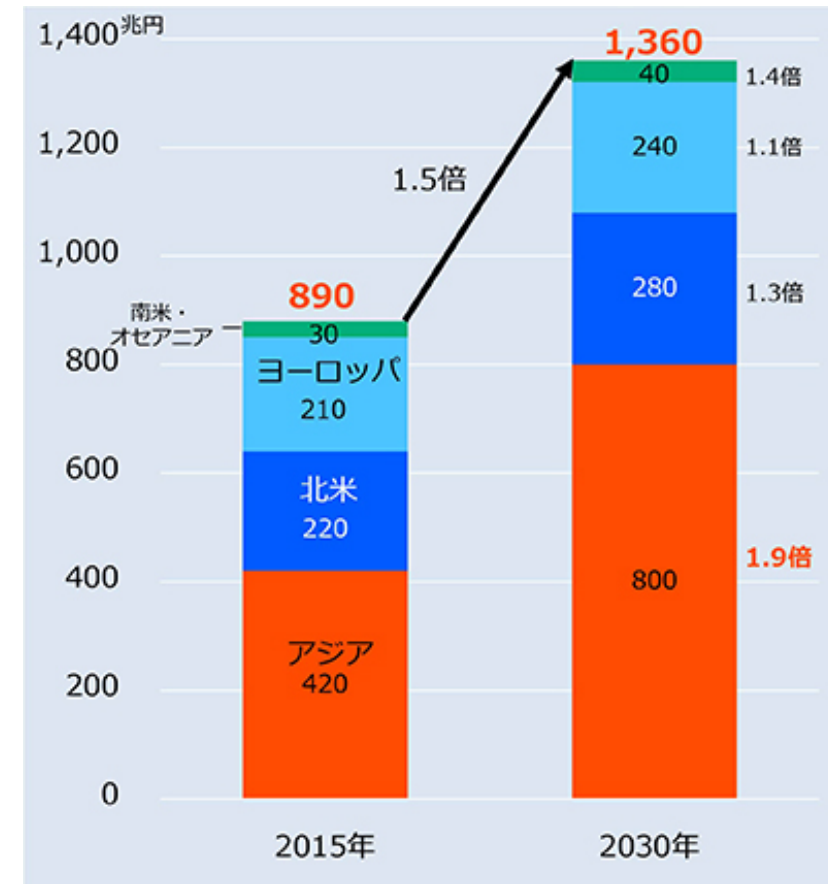


Fig. The beverage and food market sizes in 34 major countries

Policy Research Institute, Ministry of Agriculture, Forestry and Fisheries (PRIMAFF)

<https://www.maff.go.jp/j/press/kanbo/kihyo01/190329.html>



# What types of global measures should be taken?



## Environmental improvement

Achievement of true carbon neutral

Ideal cyclical utilization of resources including water, nitrogen, and phosphorus

Limiting the loss of diversity

Recovery of marine resources (planned fishery, plastic-free lifestyle, etc.)

Control of air pollution by food production and improper land use

## Contribution to healthcare promotion

Solving the issue of malnutrition by producing multifunctional proteins and nutritious food

Contribution to health care promotion by checking if calorie intake is too high and consumed food is terrible for the health

## Establishment of an inclusive society

Increase of the incomes of farm households and increase of yields of small-scale farmers with low productivity

Creation of appropriate jobs for over one hundred million persons in an agricultural community

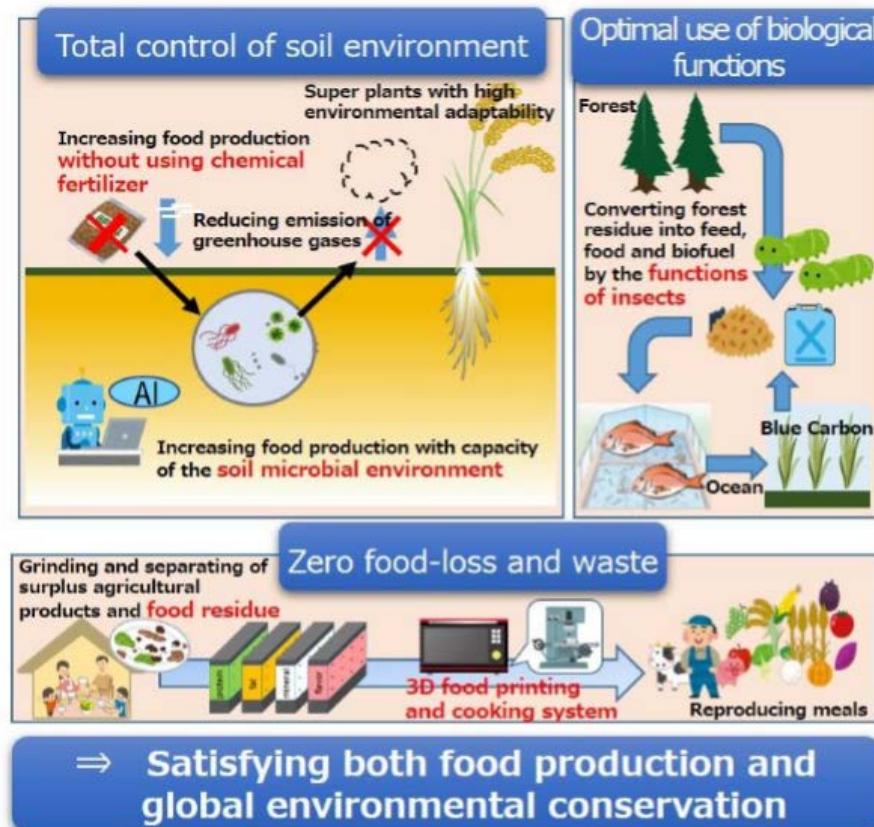
## Achievement of food security

Stabilizing food prices to supply a sufficient amount of high-quality food

Increase of incomes of farm households and the encouragement of young people to work in agriculture

The Moonshot Research and Development Program sets ambitious goals to attract people, and promotes challenging R&D projects with the aim of resolving difficult societal issues while bringing together the wisdom of researchers from all over the world.

**Moonshot Goal #5** Creation of the industry that enables sustainable global food supply by exploiting unused biological resources by 2050.

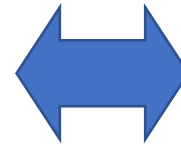


## Background of objective setting

The global demand for food is estimated to increase by a factor of 1.7 in the future; however, the conventional food production system focusing only on production efficiency may collapse the cyclical function of the earth.

### Increase in food demand

- **The global population is estimated to increase by a factor of 1.3.**
  - 6.6 billion (2010) to 8.6 billion (2050)
- **The food demand is estimated to increase by a factor of 1.7.**
  - 3.4 billion tons (2010) → 5.8 billion tons (2050)
  - Livestock product demands centering on middle-income countries, Increase in feed grains demand
- **A huge amount of food waste produced mainly by advanced countries**
  - The total waste generation in 2011 was 1.6 billion tons.



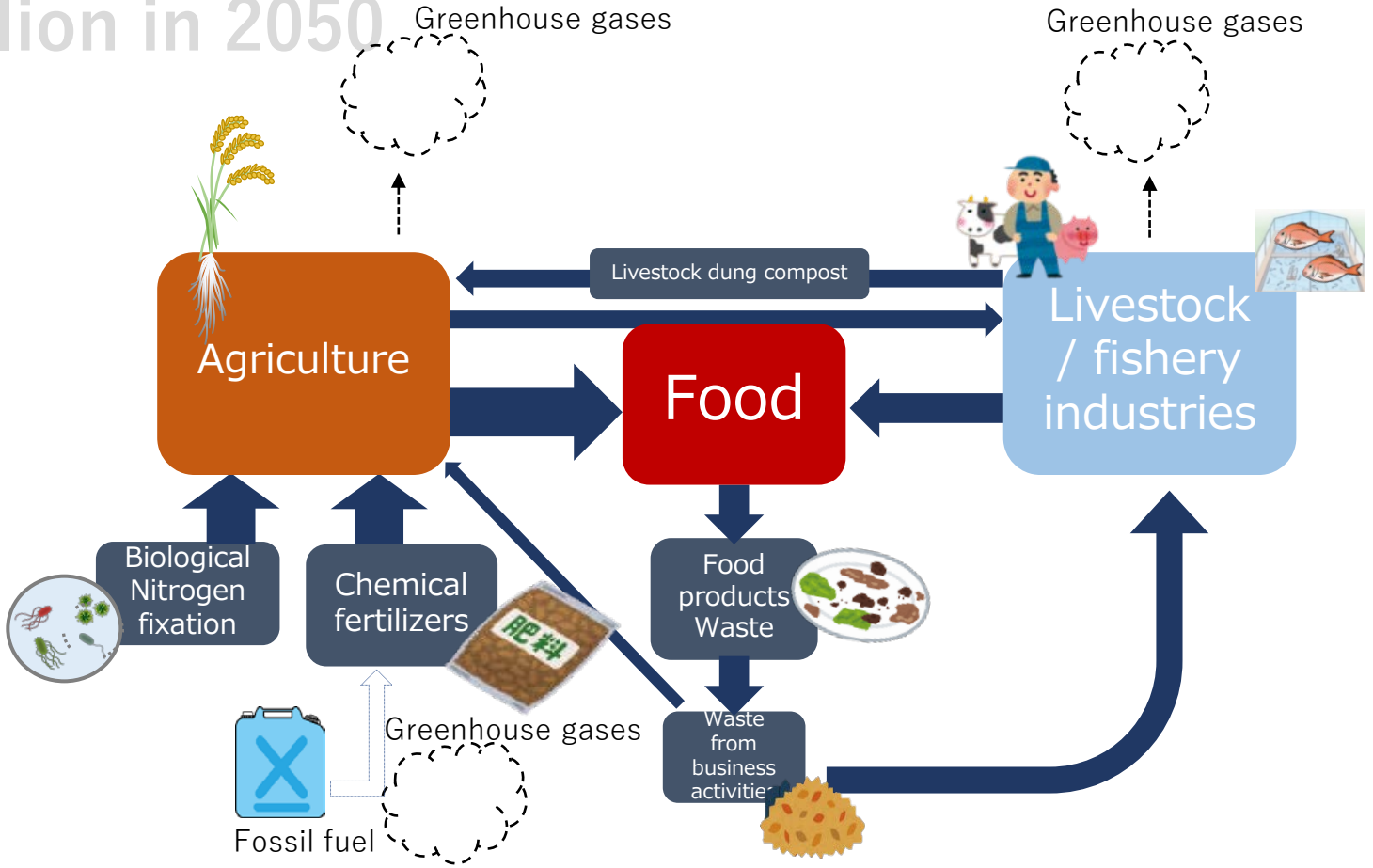
### The burden on the global environment due to farming

- **River, marine, and other water system pollution due to excessive reactive nitrogen derived from chemical fertilizers and the like**
  - Reactive nitrogen production by agriculture accounts for about 70% of total human-derived production.
- **Emission of greenhouse gases**
  - About 25% of total emission is caused by agriculture, forestry and other land use

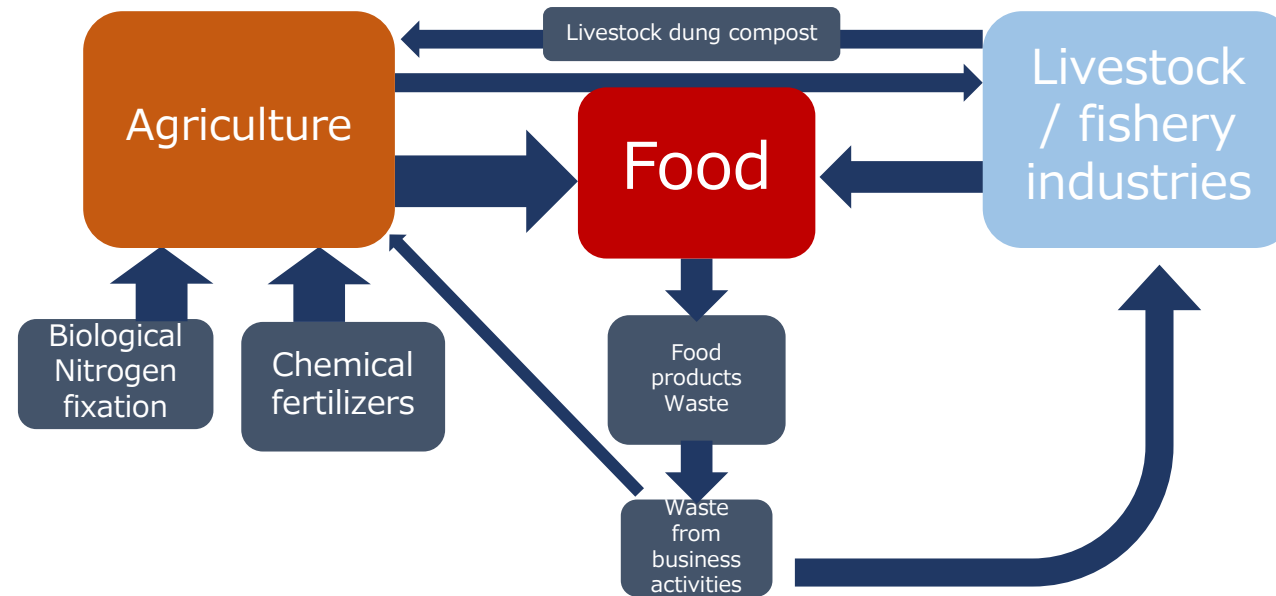


# The global population: 6.6 billion in 2010

8.6 billion in 2050



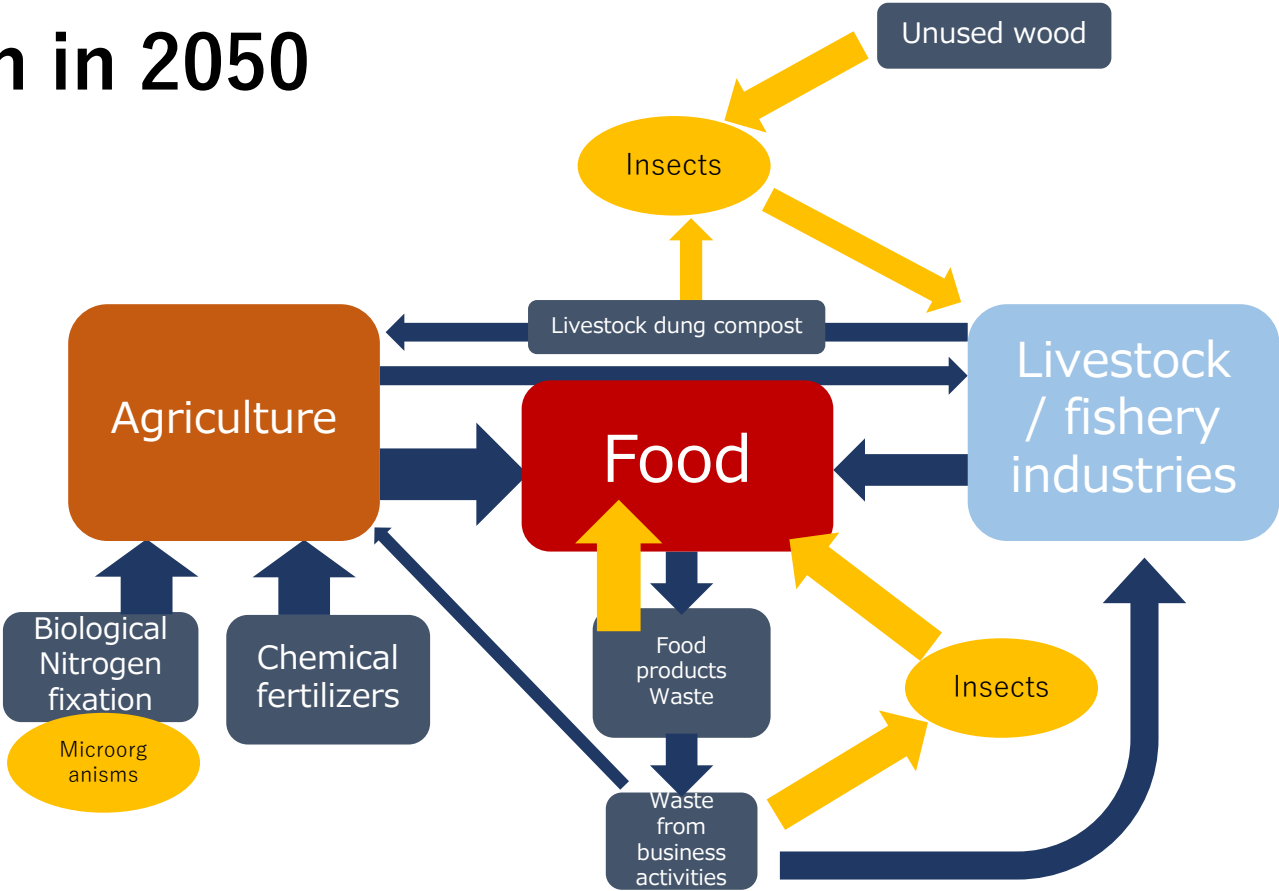
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# The global population:


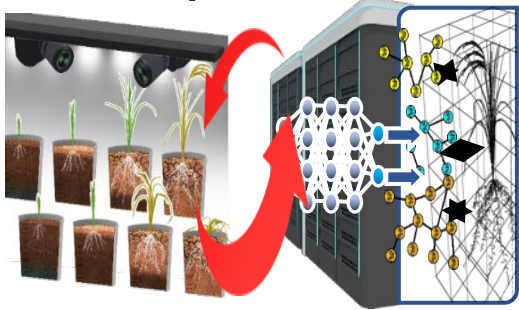

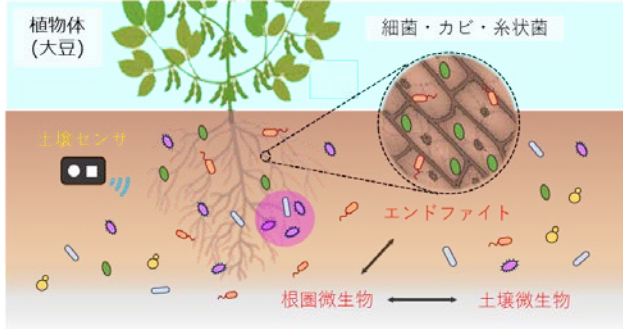
6.6 billion in 2010

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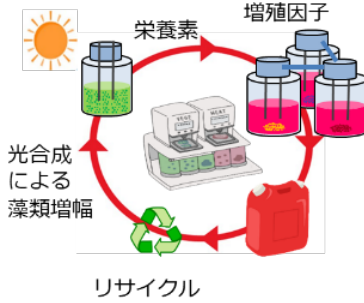

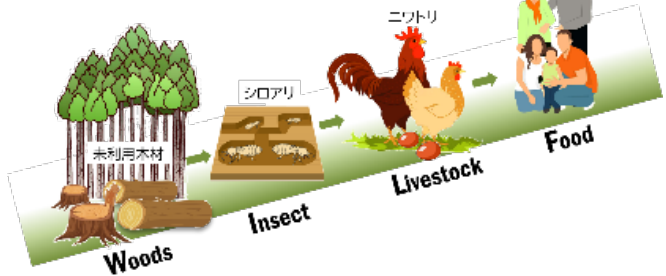
# Overview of the project and project manager (PM)

## 1. Aims to establish a food production system, which enables not only the food supply to be enlarged but also the global environment to be reserved (6PMs)

Project manager (PM)	Overview and objectives of the project
<p>Professor OHSAWA Ryo at University of Tsukuba</p> 	<p><b>1) Achieving zero food risk by improving crop resilience using cyber-physical systems</b> <b>-- Development of new varieties using new crop design technology --</b></p>  <p>Developing a cyber-physical system (CPS) to design crops in cyber space and to develop crop varieties with high resilience to stressful environments</p>
<p>Professor TAKEYAMA Haruko at Waseda University</p> 	<p><b>2) Building a platform for sustainable farming by environmental control based on the microbe atlas of the soil ~</b> <b>-- Elucidation and demonstration of microbial functions in soil --</b></p>  <p>Development of a model to diagnose soil health by analyzing the interaction among the microbes in the soil, crop growth information and environmental factors</p>

# Overview of the project and project manager (PM)


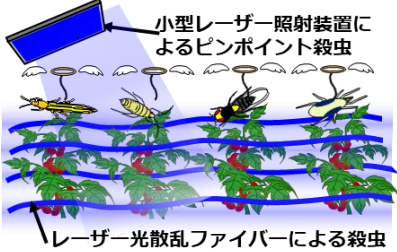

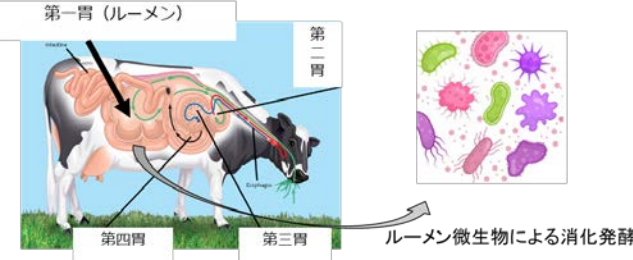
(continued from 6 PMs, designated as a FS-like project)

Project manager (PM)	Overview and objectives of the project
<p>Professor SHIMIZU Tatsuya at Tokyo Women's Medical University</p> 	<p><b>3) [FS-like project] Bio-economical food production system based on circular cell culture using algae, plant and animal cells</b> -- Food production through cell culture, etc. --</p>  <p>Development of food production technology by circular cell culture and three-dimensional tissue fabrication using algae, plant and animal cells</p>
<p>Professor MATSUURA Kanji at Graduate School of Kyoto University</p> 	<p><b>4) [FS-like project] Termites' destructive wood-decomposition ability to convert unused wood into feed and food</b> -- Feeding of termites with unused wood, etc. --</p>  <p>Development of methods for mass proliferation of termites using leftover woods and for their conversion to livestock feed</p>






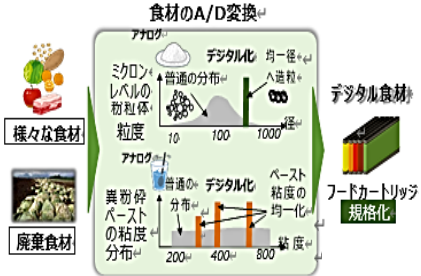
# Overview of the project and project manager (PM)

(continued from 6 PMs, designated as a FS-like project)





Project manager (PM)	Overview and objectives of the project
<p>Professor HINOMOTO Norihide at Graduate School of Kyoto University</p> 	<p><b>5) [FS-like project] Realization of zero pest damage agriculture by making full use of advanced physical methods and unused biological functions</b></p> <p><b>-- Pest control that does not rely on chemical pesticides --</b></p>  <p>Development of pest control technology using advanced physical (Blue semiconductor laser light) and biological methods (symbiotic microorganism)</p>
<p>Professor KOBAYASHI Yasuo at Graduate School of Hokkaido University</p> 	<p><b>6) [FS-like project] Realization of a new livestock production system for 80 % reduction of methane emission by complete control of the cattle rumen microbiome</b></p> <p><b>-- Reducing methane emission and improving animal productivity --</b></p>  <p>Development of a production system capable of reducing methane emission and improving animal productivity through complete control of the microbiome in the cattle rumens</p>

# Overview of the project and project manager (PM)

## 2. Developing a food production system enabling both issues, enlargement of food supply and global environment reservation to be solved (4 PMs)

Project manager (PM)	Overview and objectives of the project
<p>Professor YURA Kei at Ochanomizu University</p> 	<p><b>7) Development of a circulatory food production system supported by crickets to solve global food problems and to prepare for human expanding to space</b></p> <p>-- Conversion of insects into food and feed using food residues --</p>  <p>Development of a new food production system by breeding new breeds of crickets, and using wasted food to produce crickets as food and feed</p>
<p>Specially-appointed professor NAKAJIMA Mitsutoshi at University of Tsukuba</p> 	<p><b>8) Development of innovative food solutions that simultaneously reduce food loss and improve QoL</b></p> <p>-- Manufacture food cartridges with a long shelf life for 3D printers from food residues --</p>  <p>Powder and paste made from food residues can be preserved in food cartridges with a long shelf life</p>

(continued from 4PMs, designated as a FS-like project)

Project manager (PM)	Overview and objectives of the project
<p>Associate professor KANEMOTO Keiichiro at Research Institute for Humanity and Nature</p> 	<p><b>9) [FS-like project] Development of a method for identifying food loss and waste on a global scale</b>  <b>-- Understanding the global situation of food loss and waste --</b></p>  <p>Development of an application software for farmers and consumers to reduce food loss and waste by uncovering food loss across the global food chain</p>
<p>Professor TAKAHASHI Shin-Ichiro at Graduate School of University of Tokyo</p> 	<p><b>10) [FS-like project] Creation of next-generation food supply industrial chains based on natural capitalism society</b>  <b>-- Development of the Food of the Future through AI Nutrition --</b></p> <p>                 ✓ 未利用生物資源                  ✓ 未来型食品プロトタイプ             </p>  <p>Development of futuristic foods by evaluating the effects of food nutrients on human/animals as scientific evidence</p>

# It is difficult to spread research seeds into the social community.

Clinging to one's own research seeds is prone to keep everyone away from him/her.

There are similar methods and products on the market; in such a situation, too much confidence is put in the strength of them but not in weakness.

Future customers are unknown.

The value of the futures market is unknown.

Poor planning of securing funds necessary up to the realization

**“Any invention or new technology is not always innovation”.**

# Policies for promoting challenging R&D

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Recognize the inherent **restrictions** of conventional R&D methods and clarify **innovation, strengths, and newly-created values of new proposals.**

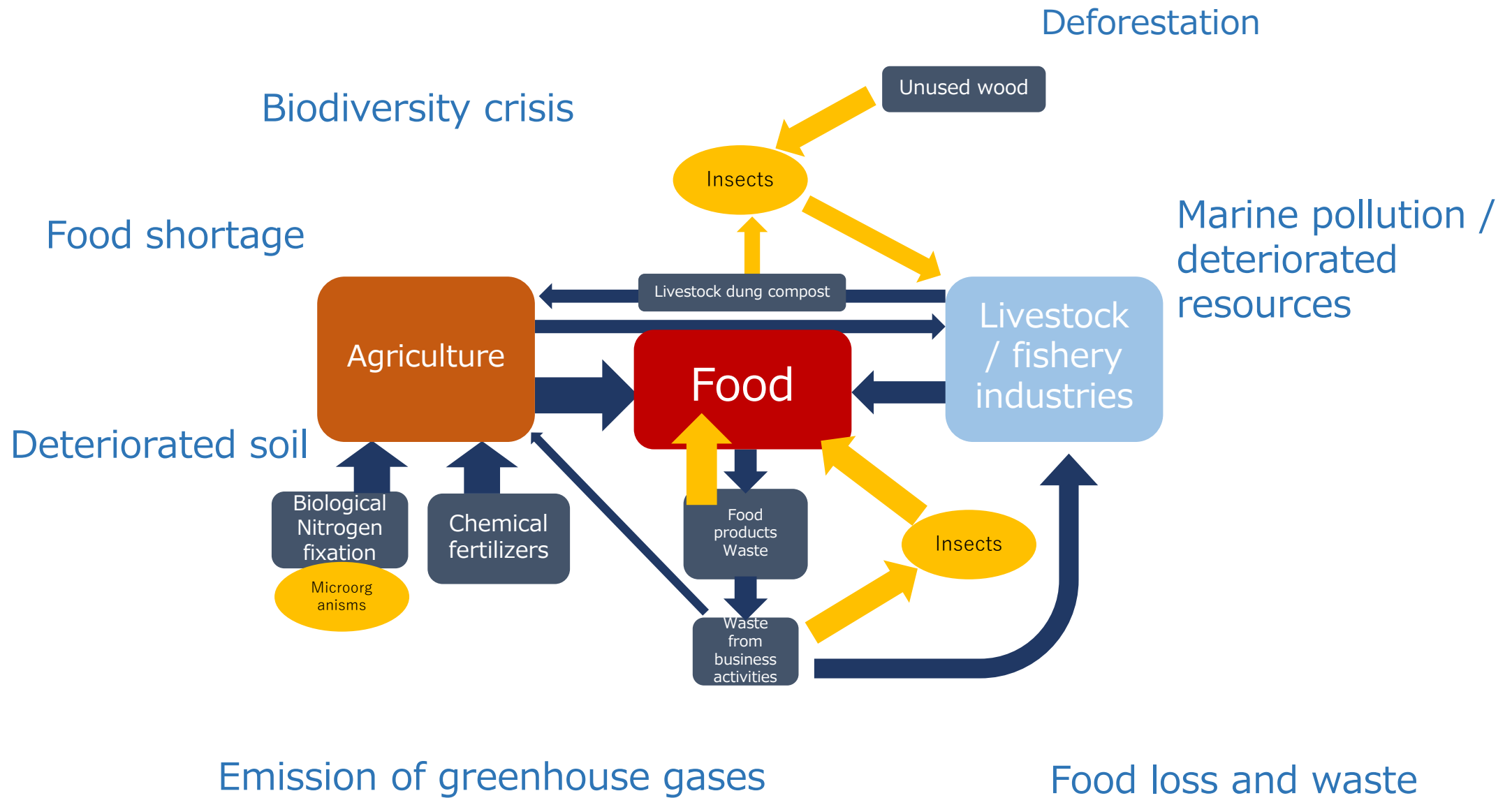
**In response to the needs of the future society, a scheme for accelerating R&D is planned through starting a business and commercialization.**

**Feasibility of establishing a system for promoting R&D and business development taking use of private funds and investment**

**Recognition of problems and methods for solving them, and clarification of the differences from and superiority to similar methods and other existing methods**

**Possibility of leading business development of the R&D proposed herein**

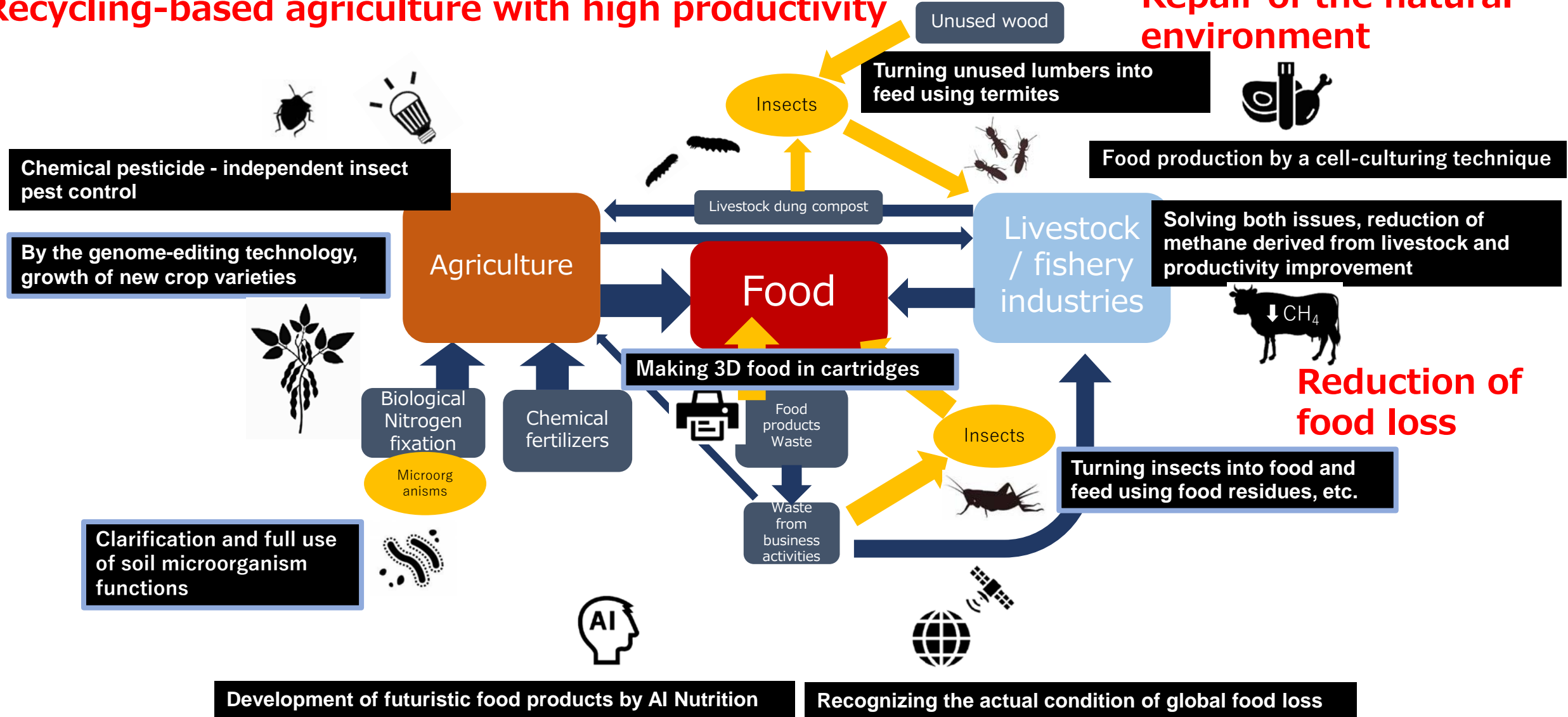




# Diversified protein supply sources

## Recycling-based agriculture with high productivity

## Repair of the natural environment



Development of futuristic food products by AI Nutrition

Recognizing the actual condition of global food loss

# Food and nutrition toward ensured human and global health

# What type of role should Japan play?



Based on re-recognized strengths and weaknesses in Japan,

**Improve the food production environment,**

**Promote health through a balanced diet,**

**Establish an inclusive society,**

**Toward ensured food security,**

**Promote businesses adaptable to a smart society (Society 5.0)**



# Criteria for value important in a future society

**Recognizing that our own activities greatly contribute to global warming and food heavy problems**

**-- Improving not only our lifestyles but also setting goals of assigned tasks and how to proceed with them --,**

aiming to ensure the contribution of new technologies and information to the whole society,

governance, and contribution to solving environmental problems and building a better social system are evaluated as the criteria for value

to pick up talents, who are able to select out important challenges and lead innovation and

promote challenges by startup businesses focusing on the future market

Thank you for your attention!