Japan's Smart Agriculture towards Sustainable Society

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Vehicle Robotics Laboratory (VeBots)

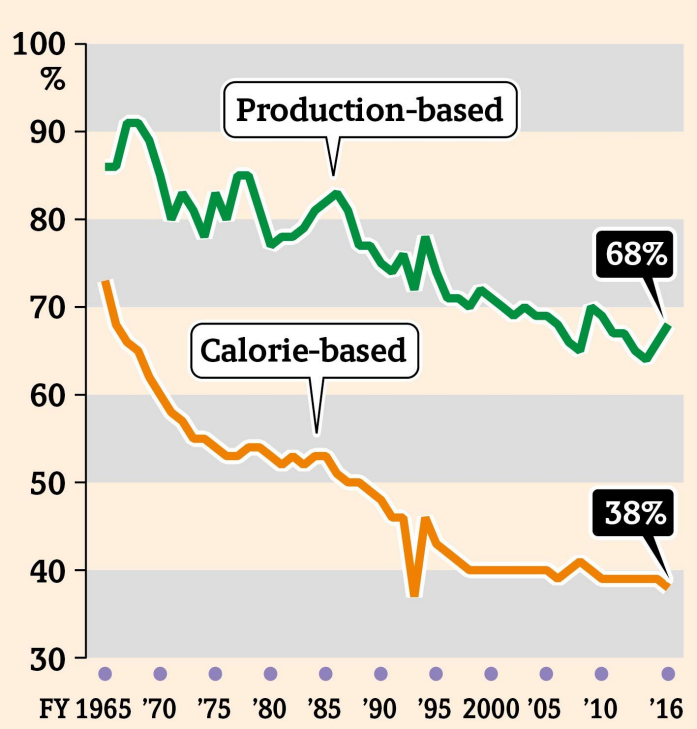
- Unmanned Ground Vehicle
- Unmanned Surface Vehicle
- Unmanned Aerial Vehicle
- Satellite Vehicle

VeBots
Laboratory of Vehicle Robotics
HOKKAIDO UNIVERSITY, SAPPORO, JAPAN

Smart Agriculture comprised of Cyber space and Physical space

Smart agriculture in Japan

Low food self-sufficiency



Serious labor shortage

Declining of core persons mainly engaged in farming
(1.75 million, 15% decrease in 5 yrs)

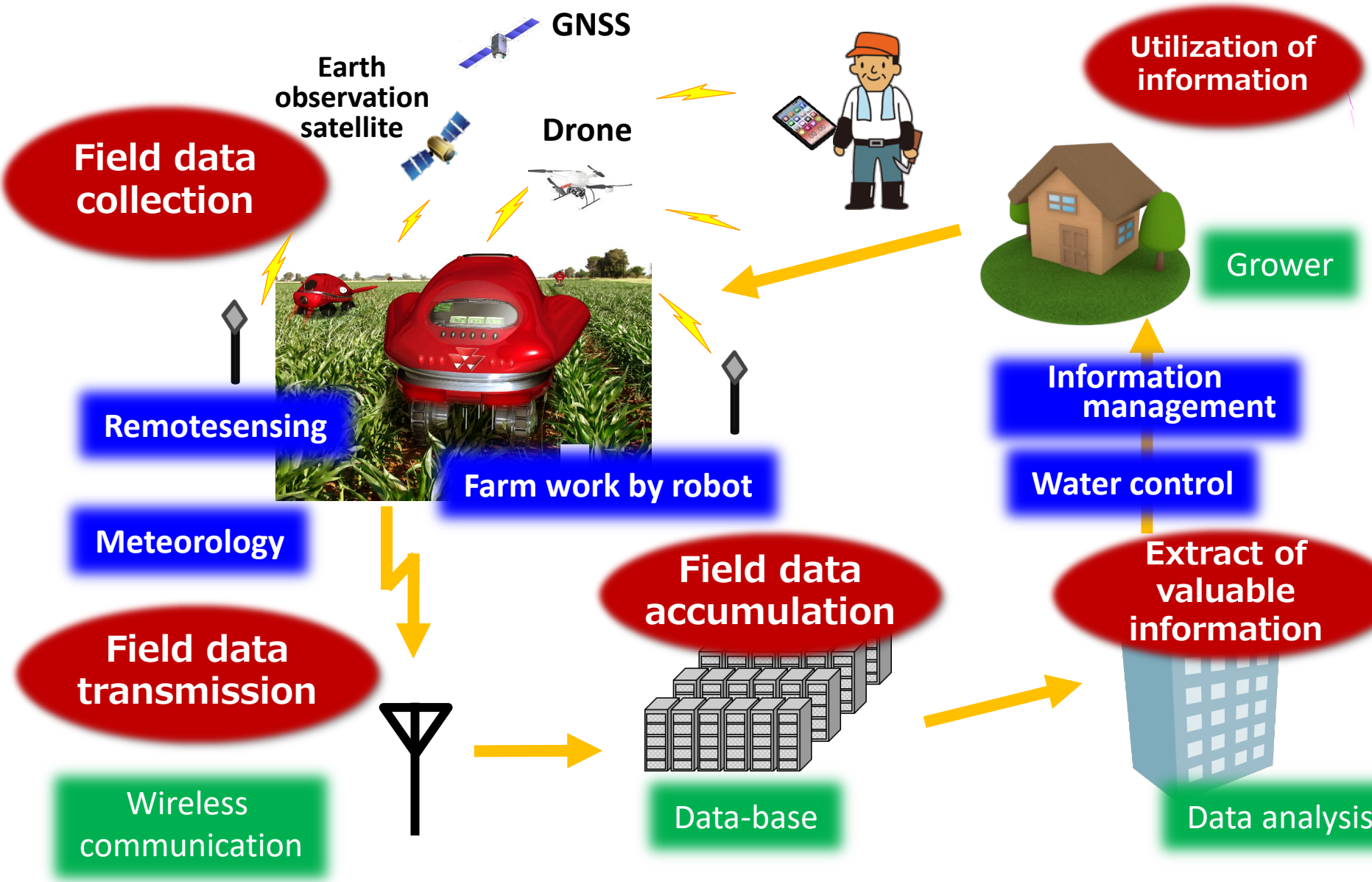
Aging of core persons mainly engaged in farming
(65 yrs-old or older accounts for 65%)

Functions of smart agriculture

- Data-driven agriculture
- Automation and robotics

Japan government has set a policy goal of have a majority of farmers practice data-driven agriculture by 2025. The smart use of data and robots is being heavily promoted in agriculture across all of Japan.

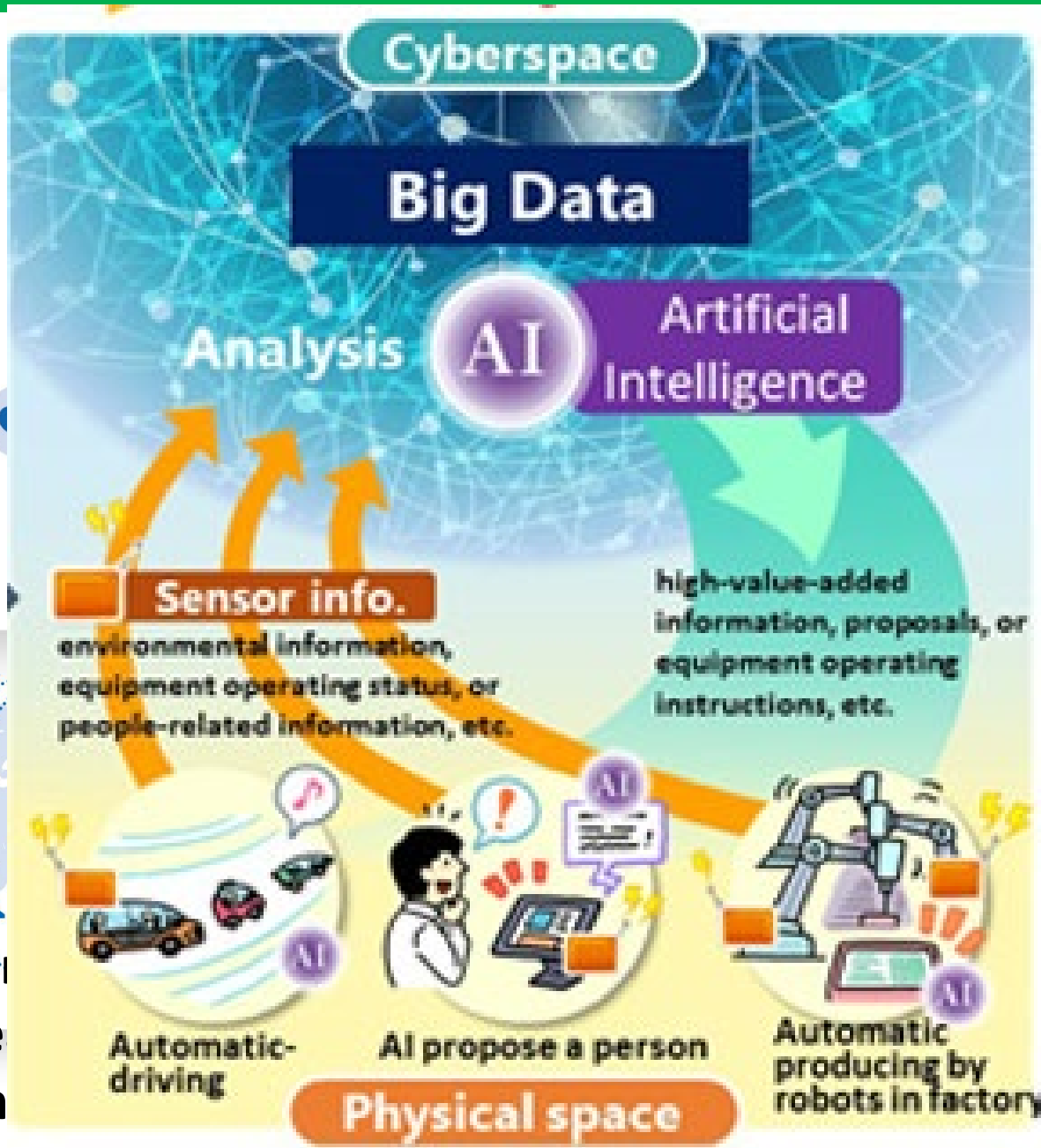
Overall goal of smart farming system



What is “Society 5.0” ?

What’s next?

5.0



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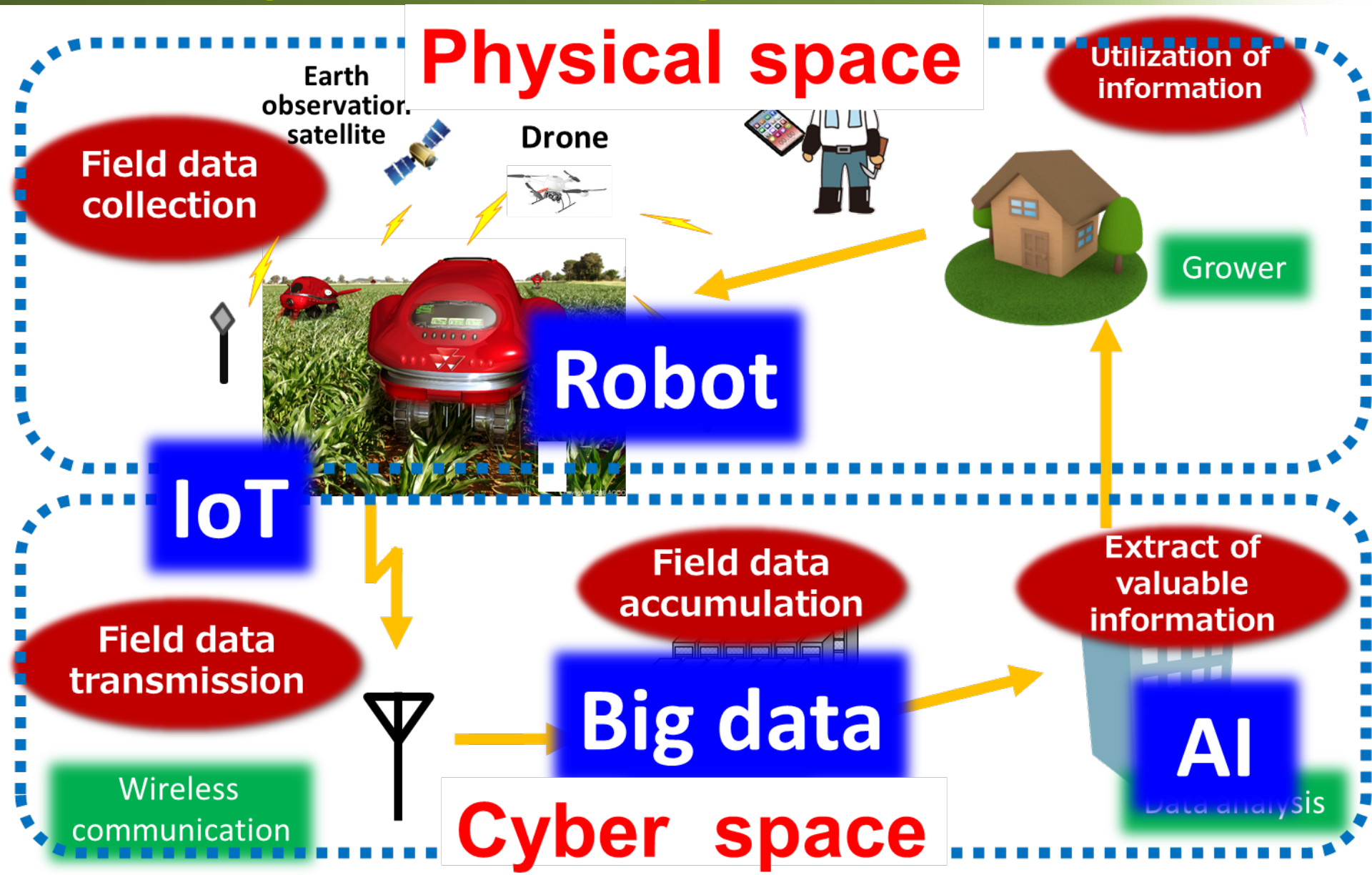
Overall goal of smart agriculture



Smart agriculture is "Society 5.0" in agricultural sector

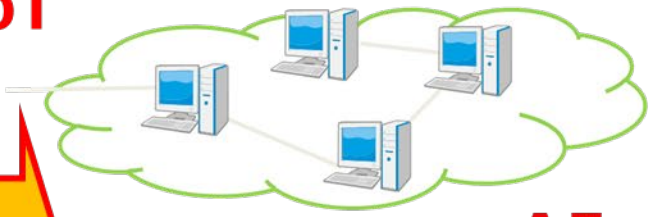
Smart vegetable production

Remote-sensing by drone

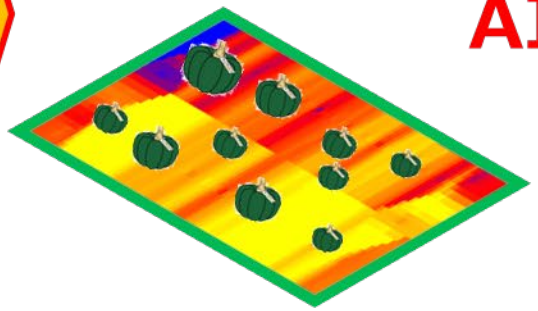
- Growth modeling
- Early detection of disease and bugs
- Location of fruits

IoT

Bigdata



AI



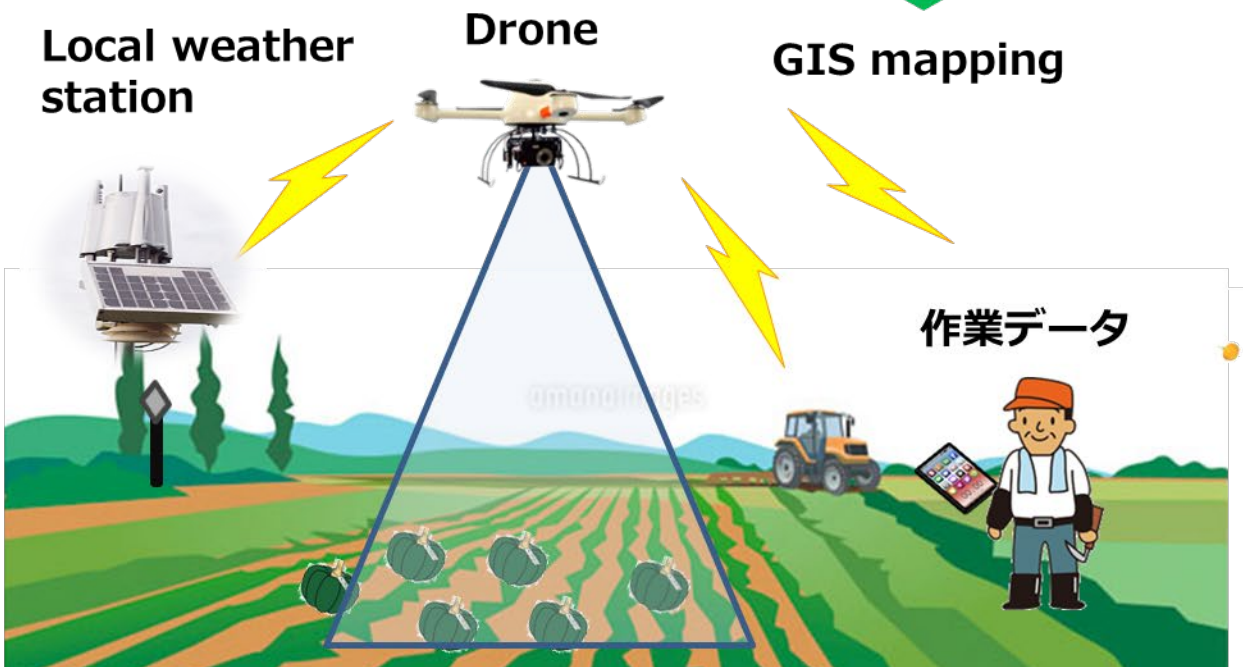
Visualization of crop status and optimal management

- Optimization of crop management
- Prediction of optimal harvest time and yield

Robot

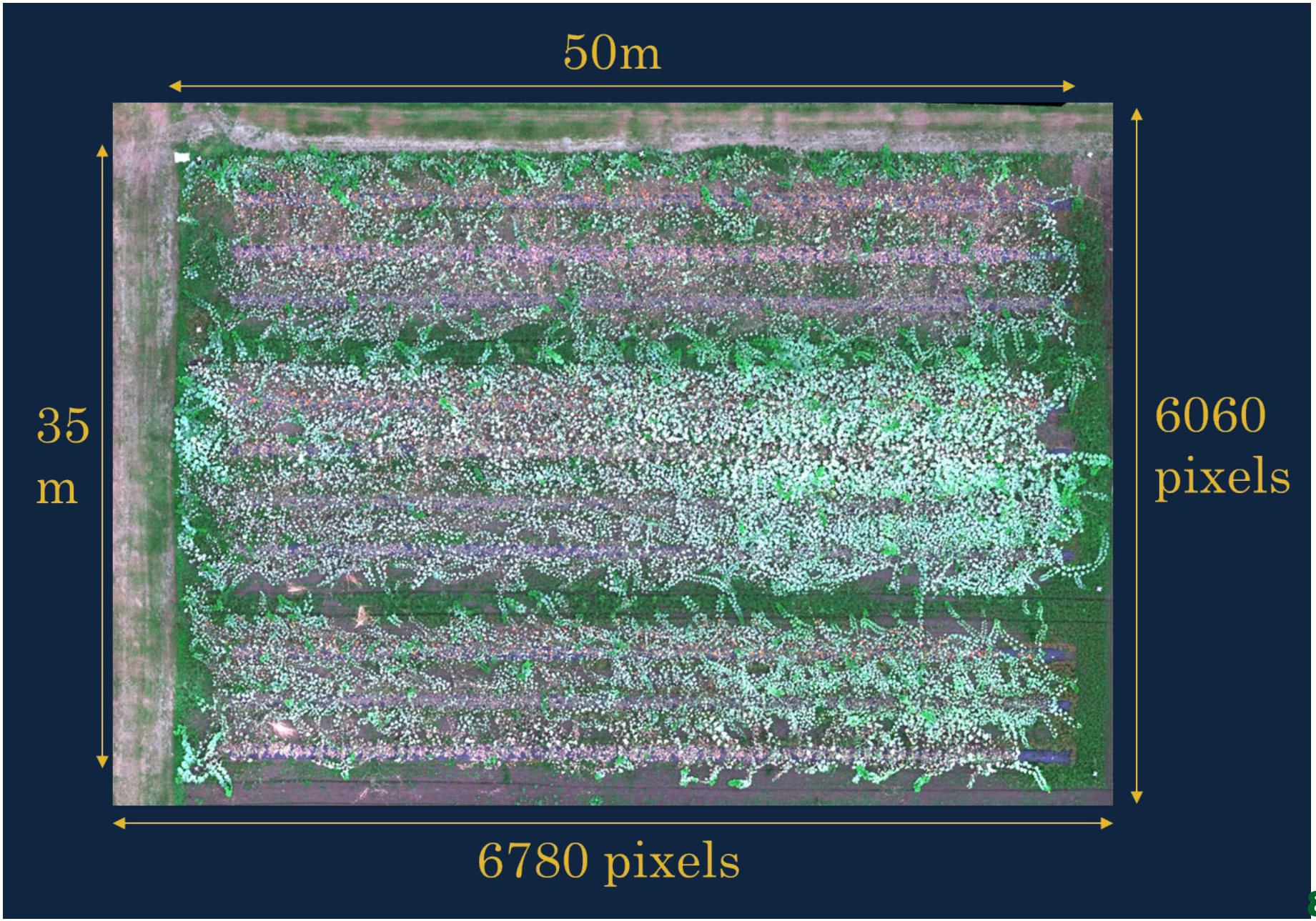
Automated harvest

- Robot harvest
- Selective harvest
- Night harvest

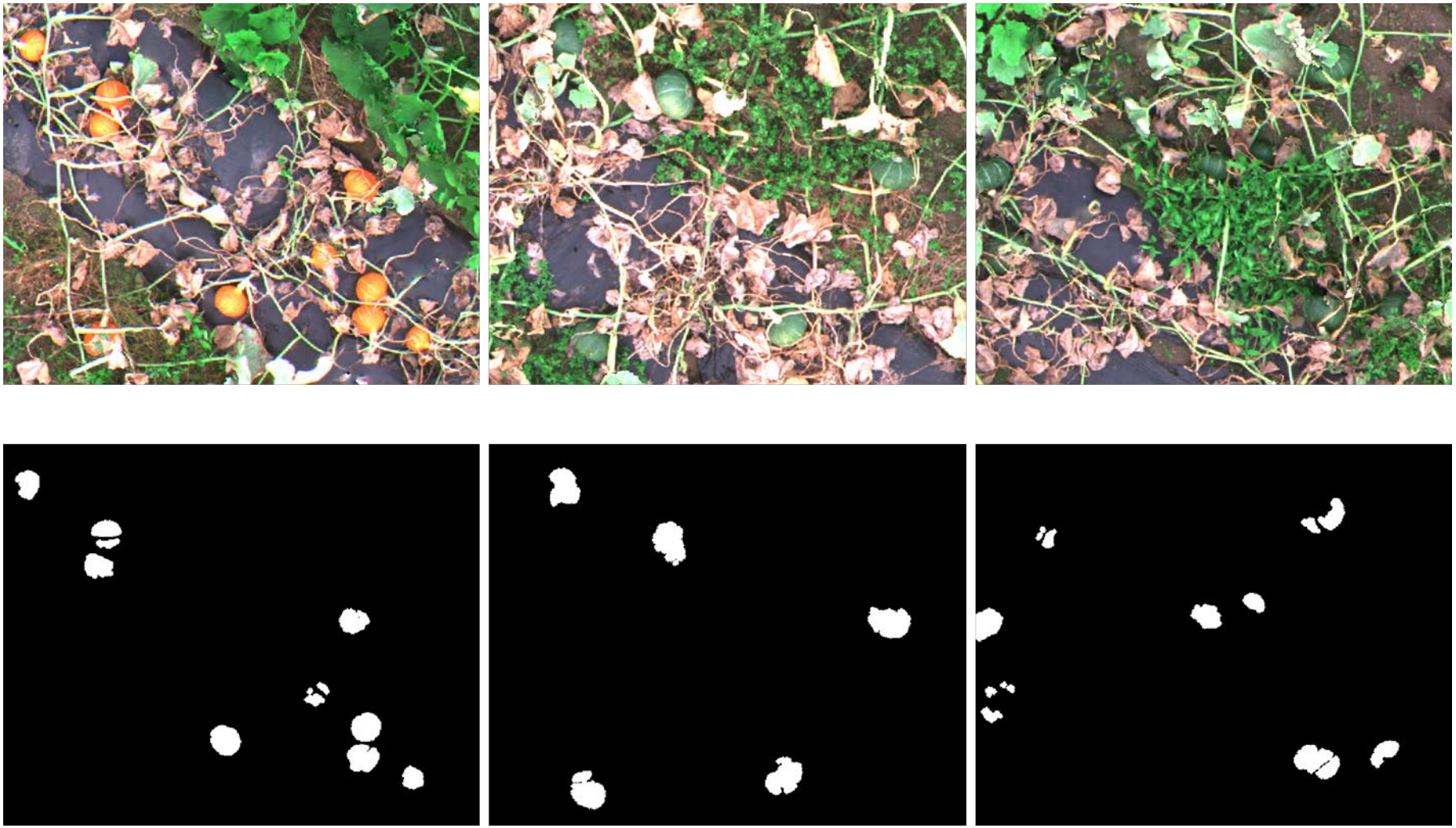


Robot

Pumpkin yield estimation using drone



Variety adaptability of pumpkin detection algorithm



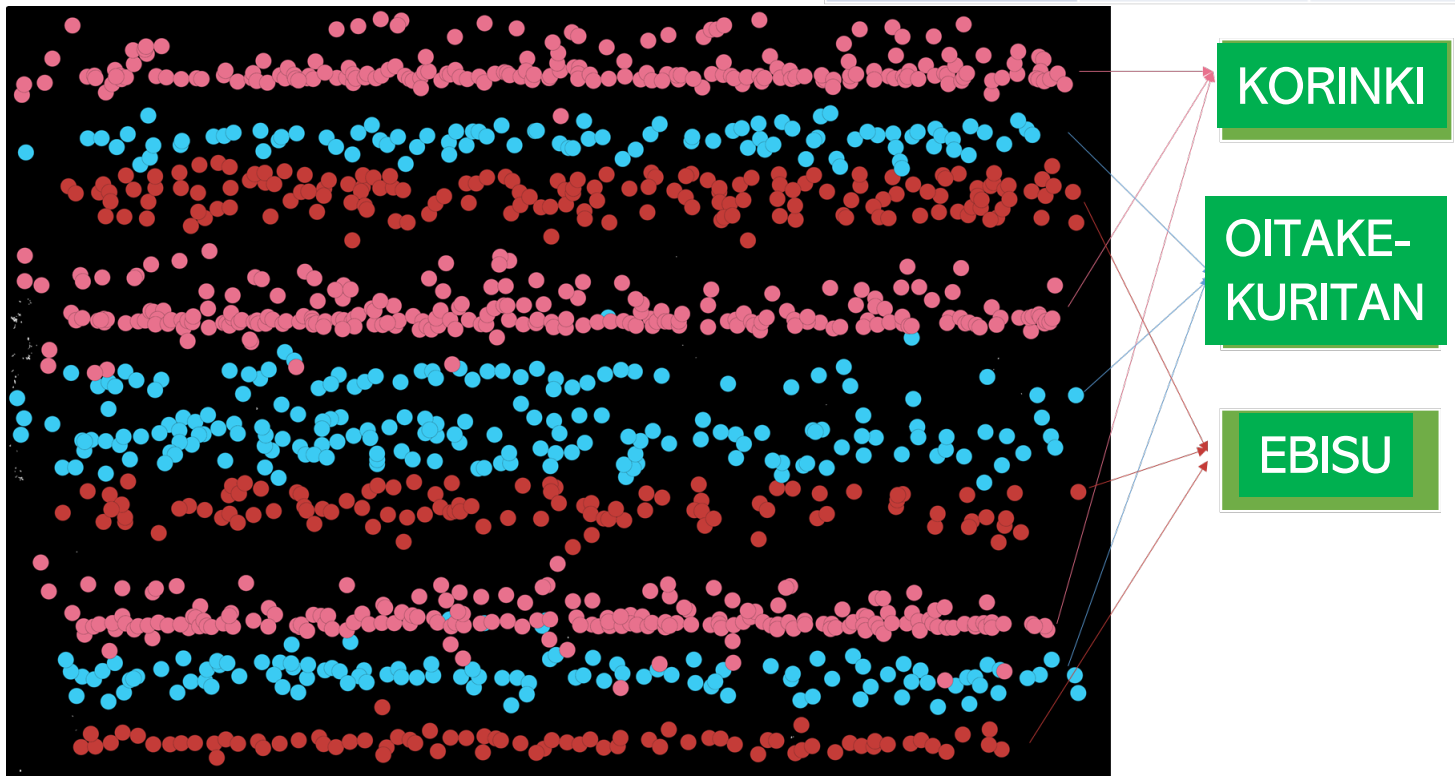
KORINKI OITAKE-KURITAN EBISU

Accuracy of detection algorithm

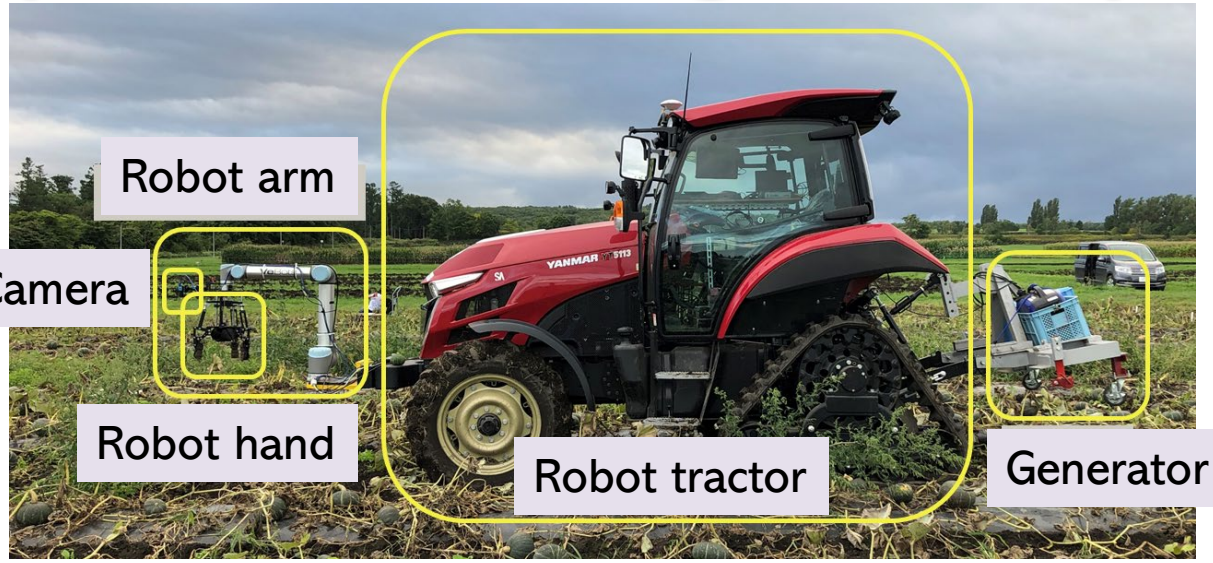
Advantages

- Yield estimation before harvest
- Highly stable quality and yield
- Appropriate shipping plan

Variety	Altitude	Adaptability
KORINKI	5m	94.8%
	20m	98.8%
OITAKE-KURITAN	5m	92.1%
	20m	93.5%
EBISU	5m	94.3%
	20m	97.0%



Pumpkin harvesting work by robot



Detection by machine learning（Yolo ver.4）

Pumpkin harvest

Topics of Ag robot

- Agricultural robot tractor
- Vegetable harvesting robot
- Fruit cultivation robots

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Laboratory of Vehicle Robotics
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Roadmap of launching Agri-robots in Japan

Declining of core persons mainly engaged in farming
(1.75 million, 15% decrease in 5 yrs)

Aging of core persons mainly engaged in farming
(65 yrs-old or older accounts for 65%)

Serious labor shortage

Formal Prime Mister Shinzo Abe directed to get robots working in Japanese agriculture by 2018 in "Public-private dialogue towards future" held in March 4.2016.

Auto steering

Robot tractor associating with human-drive tractor

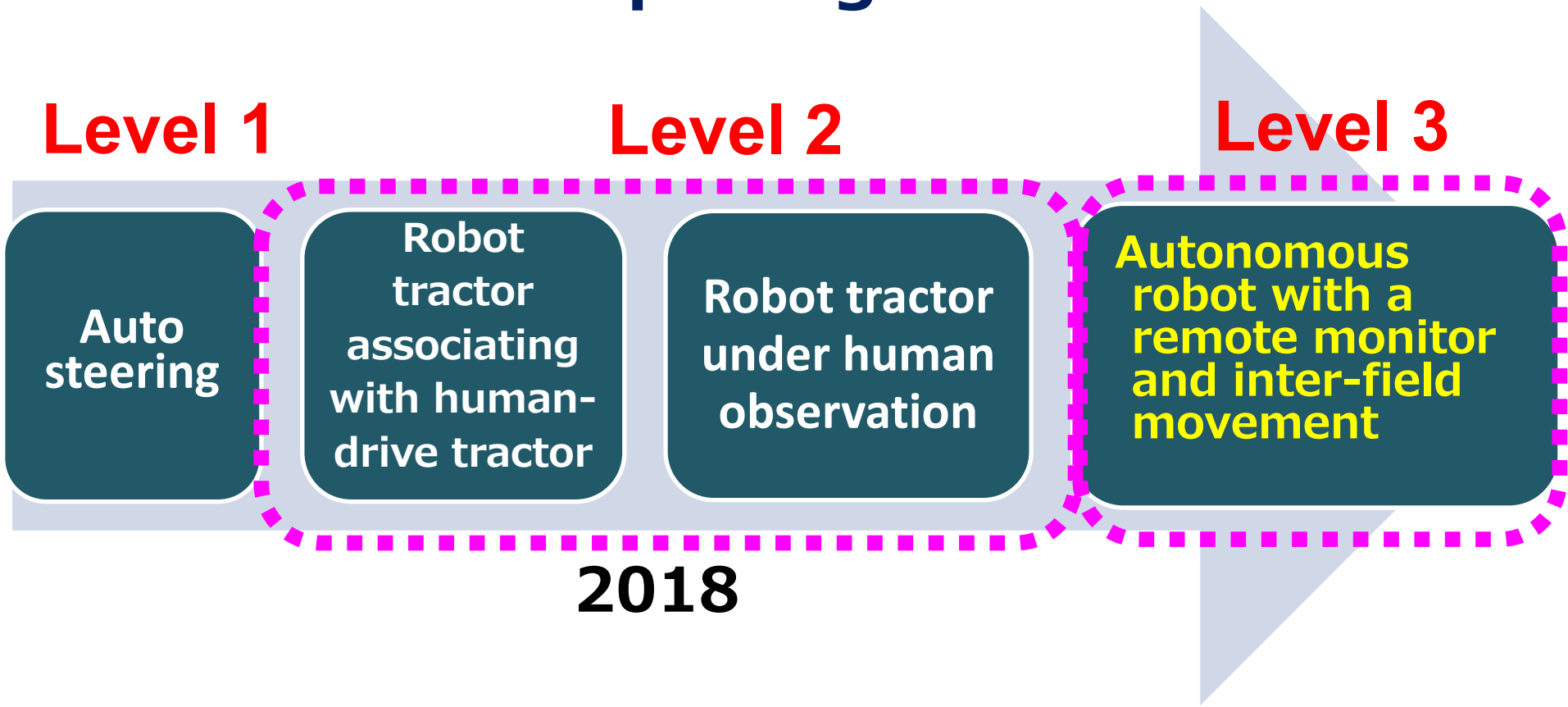
Robot tractor working near human

Autonomous robot with a remote monitor and movement between fields

2018

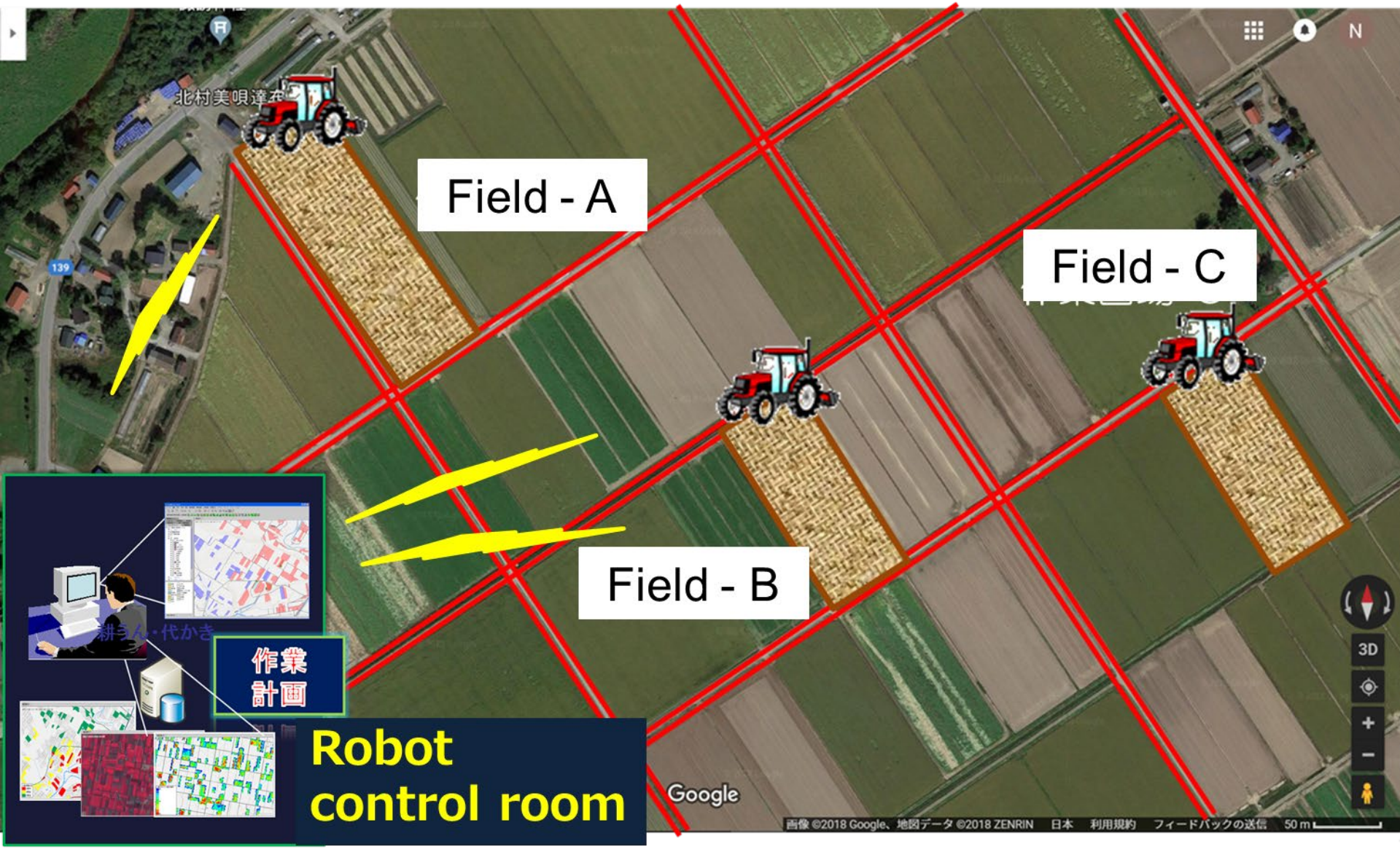
Direct visual observation

Roadmap of launching Agri-robots into Japan agriculture



GOAL: Implement super labor-saving technologies into agriculture sectors.

Efficient field work for distributed farm land



Automatic inter-field movement

5G utilization

Front image

Transmitted image by 5G

Image resolution

Full-HD (1920×1080pixels)

Ground res.: 2mm/pixel(min)

Latency : 300ms

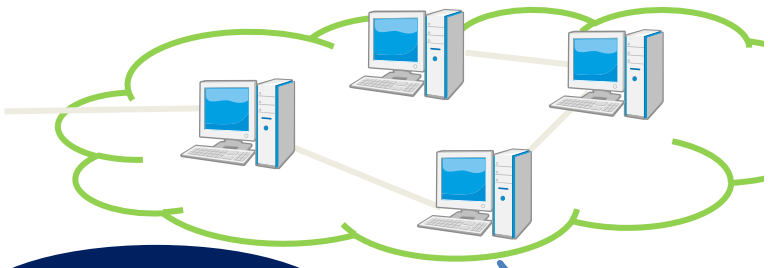
Rear image

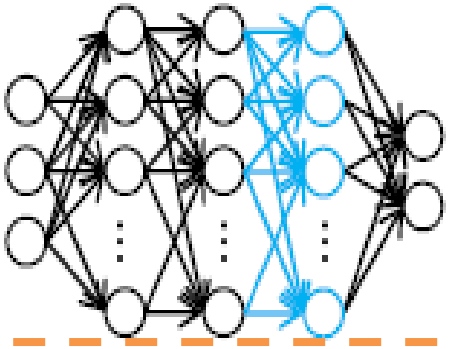
No limit of distance between a control room and a field

Obstacle detection under a road run using AI

Predictive detection of pests and disease

AI analysis platform





Output

Diagnosis

Prescription

Edge cloud

5G

Real-time feedback

Variable rate spot spray

Merit

- Efficient acquisition of huge amount of precise image data
- Real-time feed back from AI analysis platform
- Low-cost AI system

Robot control room

- Remote monitoring four robot tractors same time.
- Emergency stop by detecting human by AI.

Soil compaction

Current system: Compaction

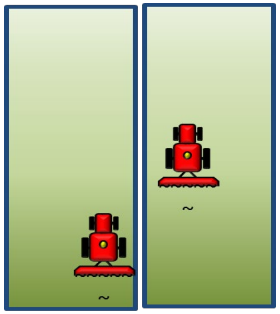
- Up to 90% of the energy going in to cultivation is there to repair the damage caused by large machines
- Up to 96% of the field area compacted by tyres in “random traffic” systems
- If we do not damage the soil in the first place, we do not need to repair it
- Move towards light machines

Climate change

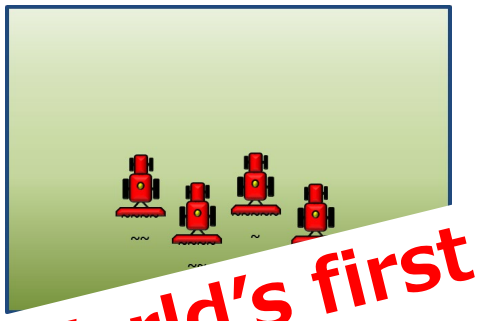
Sustainable farming using multiple small robots

- ✓ Working efficiency dramatically improve by increase of number of robots.
- ✓ Multiple small robots can reduce soil compaction with same power of a large tractor. And, small robot is good for safety.
- ✓ Multi-robot has potential users even in large scale faming regions such as Australia, USA, Brazil, and EU.

Multi-robot tractor



Multi robot system can be used from small farm land to large farm land.



World's first

Multiple small lands

Large land

Benefit

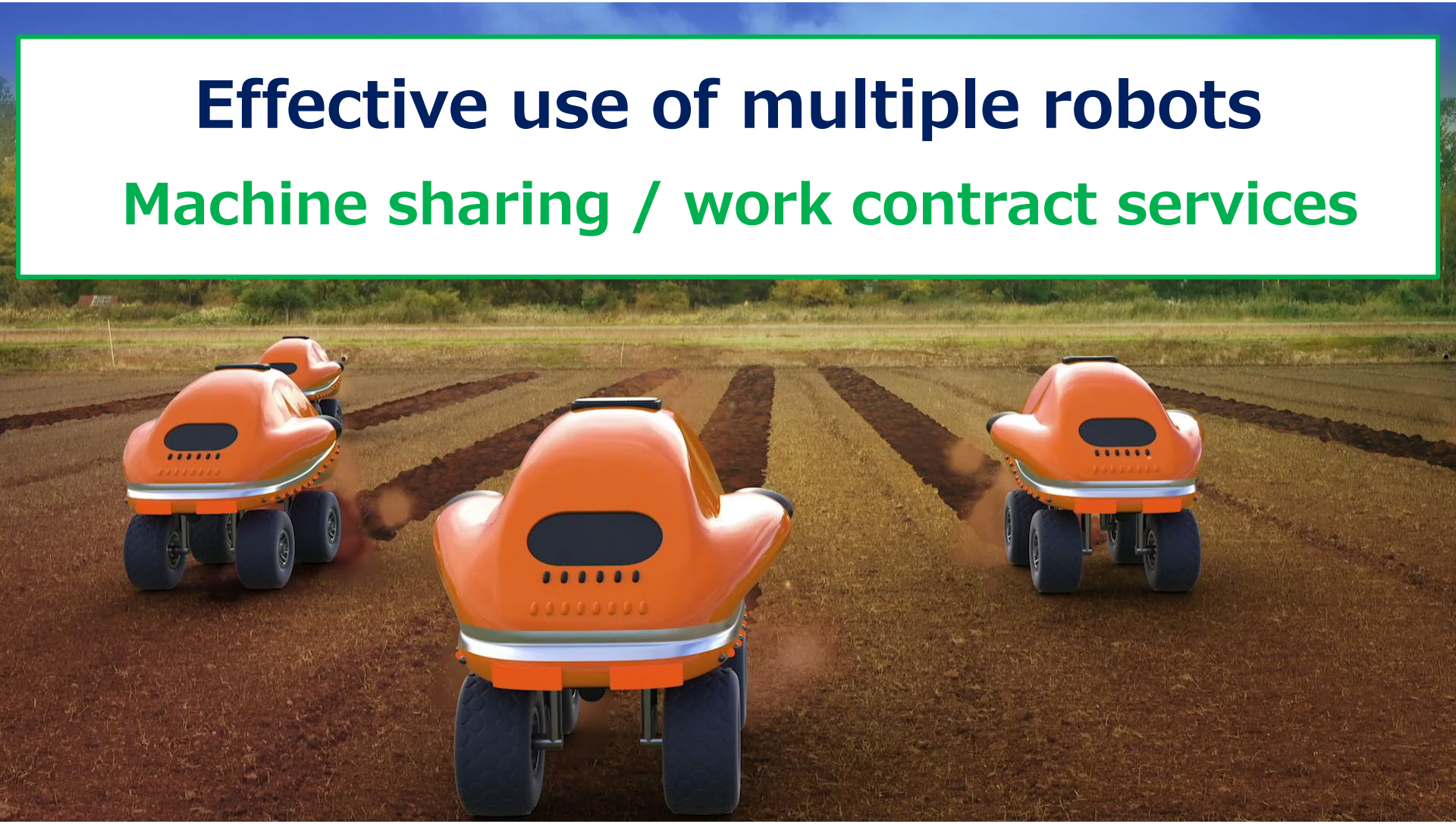
Farmers borrow a small robot tractor each other, and make a flexible and efficient work.

FOUR multi-robot tractor demonstration

(Experiment farm, Hokkaido University, Japan)

Measures for further efficiency - many connections

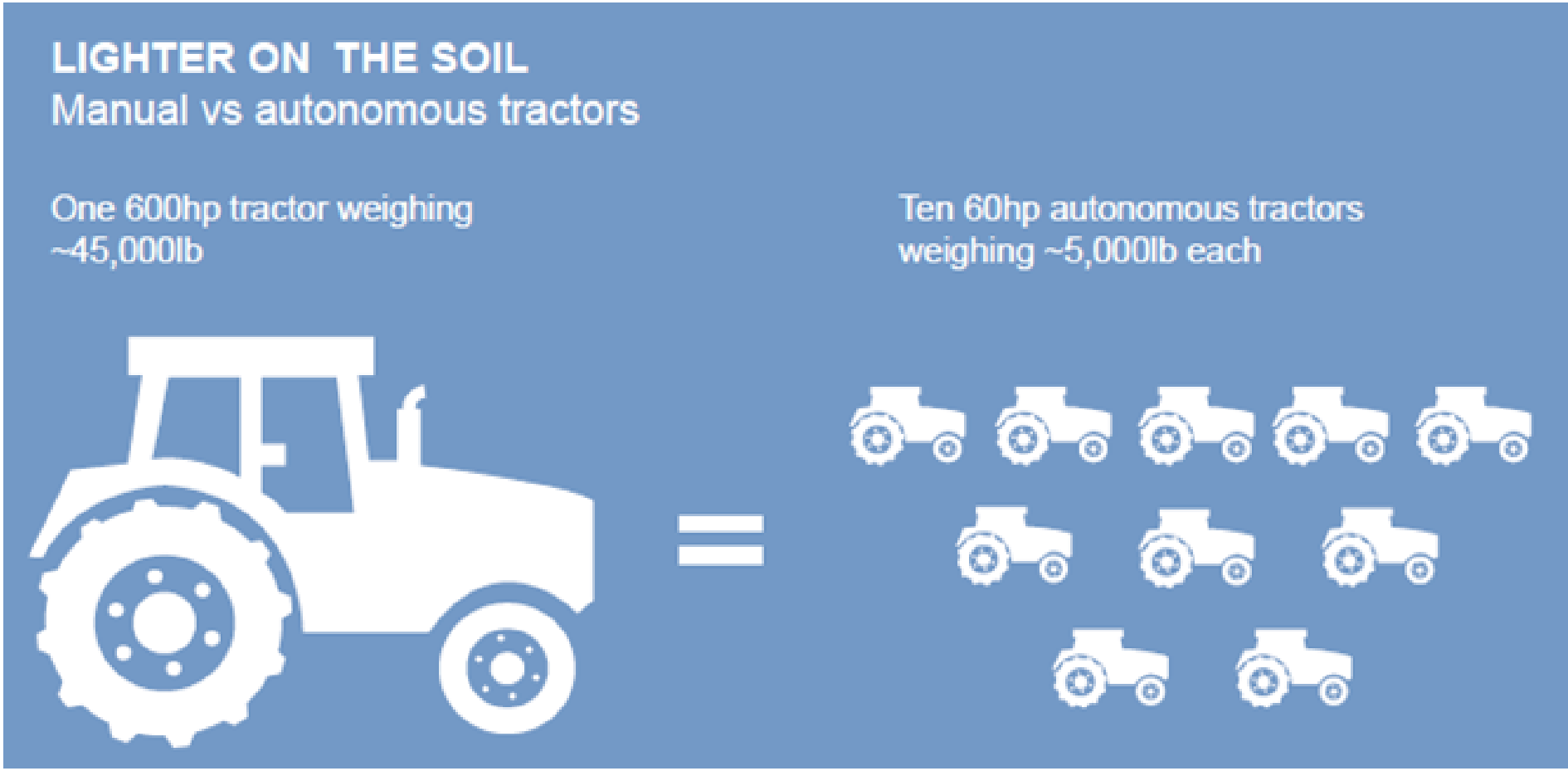
One operator monitors the work of robot tractors



Effective use of multiple robots

Machine sharing / work contract services

Possibillty of small-sized AG robots in the future



Goldman & Sachs (July,2016):
A market worth $240bn by 2050

Topics of Ag robot

- Agricultural robot tractor
- Vegetable harvesting robot
- Fruit cultivation robots

Asparagus harvesting robot

INAHO Inc.

Green pepper harvesting robot

AGRIST Inc.

Tomato harvesting robot

Panasonic Corporation

Strawberry harvesting robot

定置型収穫ロボットの動作

National Agriculture and Food Research Organization (NARO)

Topics of Ag robot

- Agricultural robot tractor
- Vegetable harvesting robot
- Fruit cultivation robots

Smart EV robot for orchard

AI platform
Growing condition
Work scheduling

Robot monitor room

Observation
Robot status
Ensuring safety

GOALS
- ✓ Substitution of human labor
- ✓ Data-driven farming
- ✓ Greenhouse gas emission reduction

Drone of observing bird and beast damage

Wind power generation

Transport robot

Weeding robot

Chemical spray robot

Worker

Harvesting robot

Pruning robot

Scouting robot

Orchard smart robot system

VeBots
Vehicle Robotics Laboratory
Hokkaido University, Japan

Vehicle Robotics Laboratory
Hokkaido University, Japan

Smart Electric Vehicle Robot for Orchard

Summary

- ✓ It is expected that **smart agriculture** solve labor shortage of Japan agriculture.
- ✓ Smart agriculture is Society 5.0 of agriculture sector. It comprises **data-driven farming and AG robots**.
- ✓ The third-generation automated machine which includes **capabilities of remote-control and autonomous movement between fields** has been developing in Japan.
- ✓ Smart robots for **vegetable production and orchards** have been focused recently.

Thank you for listening!!!

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The Power of Local 5G. To Revitalize Regional Areas

Japan is building small, closed, secure and stable local 5G networks to transform its rural regions.

https://www.reuters.com/brandfeature/the-power-of-local-5g-to-revitalize-regional-areas