5th Nov 2020

Development of a Data-driven System for Forecasting Crop Growth to Support Efficient Agricultural Operation and Reduction of Food Loss

Hisatomi Harada

Director-General, NARO Development Strategy Center,
National Agriculture and Food Research Organization
(NARO)

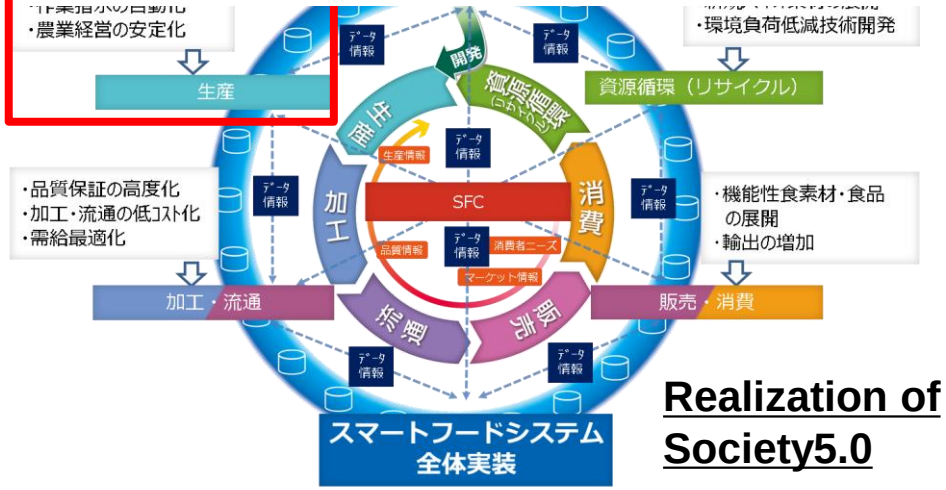
R&D Goal: Reduction in 30% working hours and 10% food loss

Consequently, it contributes to post-COVID-19 social challenge, food security, by improving and stabilizing farm profitability.

Social background and challenges

- ✓ Agricultural worker population in 2030 will decrease to 63% compared to 2015. Social challenge to be settled is "stable food production and supply despite the decreasing worker population.
- ✓ Labor saving and productivity improvement are mandatory at agricultural sites.

Smart production unit of SIP smart bio-industry and agriculture



Realization of Society5.0

Research theme

① Labor saving by intelligent agricultural machinery that can be monitored remotely and travel among fields autonomously.

② **Production efficiency improvement through data-driven production of field crops and vegetables.**

③ Establish a management model that leads to a profitable farm operation.

Smart food system initiatives to reduce food loss by 10%

Stage	Amount	Cause	Technical solution
Production	2.1 ×10^6 t (Estimated by difference between harvest and shipment of vegetables and fruits)	・Unable to forecast harvest timing appropriately, inadequate operation plan ・Low market price, not possible to sell profitably ・ Poor alignment with the customer	・Supply and demand control based on precise forecasts ・Production of high-quality agricultural goods ・Shipment control by cooperation among production districts
Distribution	Unknown	・Quality deterioration during transportation ・ Failure in sales / delivery	・ Maintaining freshness and differentiating by optimizing the transportation environment
Retail / Processing	3.4×10^6 t	・Failure in selling all the stocked products	・Supply and demand control based on demand forecast
Home	2.9×10^6 t	・A lot of leftovers	・Providing varieties with excellent shelf life and high quality

Data-driven production of leafy vegetables

Challenges at the production site and efforts for solution

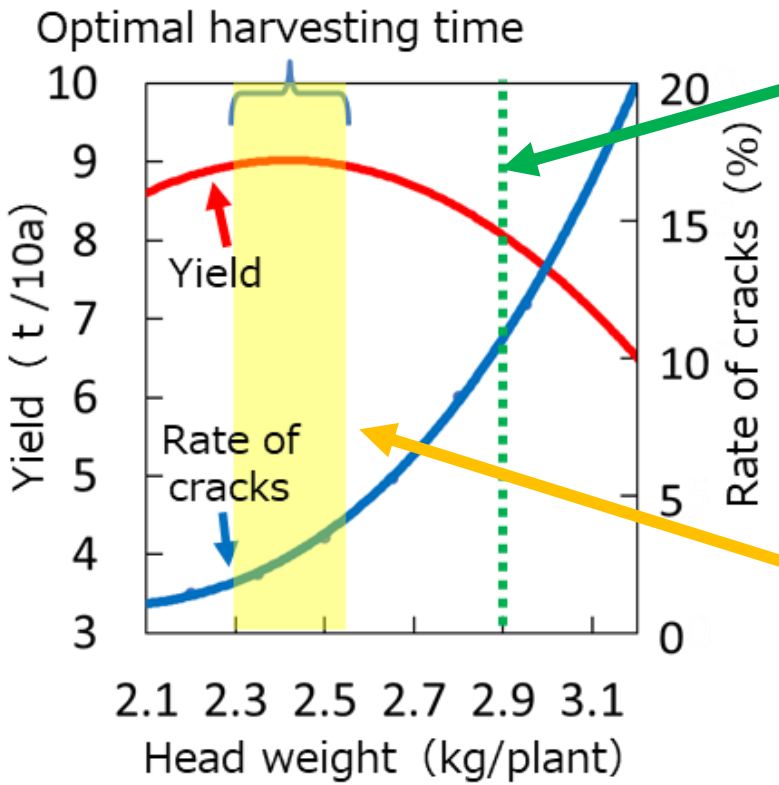
- ✓ Field disposal often occurs due to overlooking the optimal harvest timing or insufficient preparation for harvesting. It is difficult to oversee large number of fields and predict best timing for harvesting.
- ✓ Accurate forecast model to grasp growth status of each field can reduce field disposal. Reduction of field disposal will increase farm profits.

When cabbage heads become more dense and heavier, number of cracked heads increases.

↓

Leading to field disposal, lower yield

Cracked cabbage heads

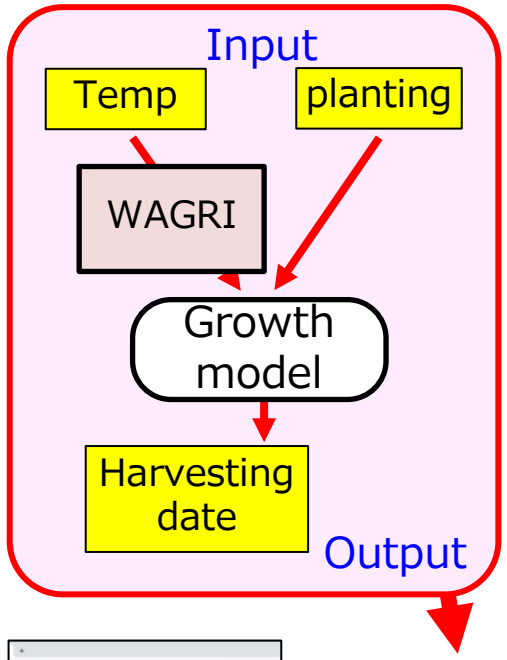


Current status:
forecast accuracy of ± 11 days 2 weeks before

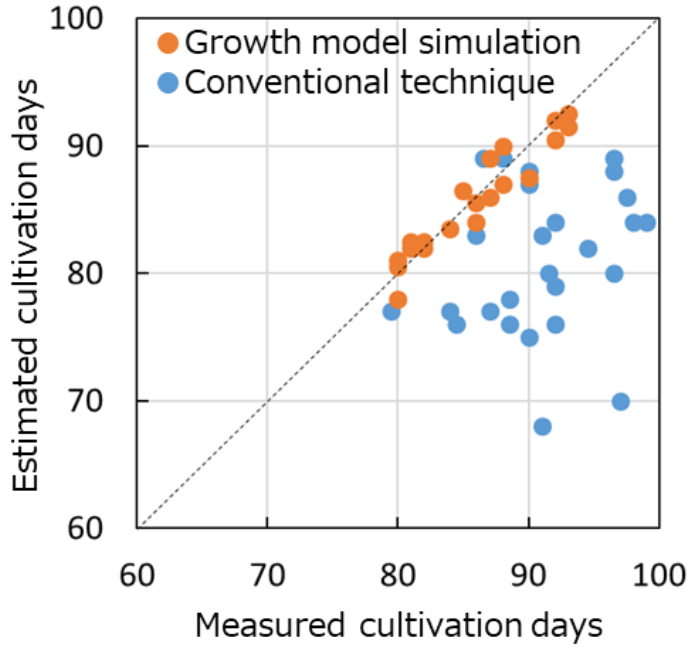
Achievement goal:
・Establishment of growth forecast prototype system (yield forecast accuracy ± 10%)

・Demonstration of 50% reduction in field disposal and impact on farm profit

Development of growth model to forecast harvesting date

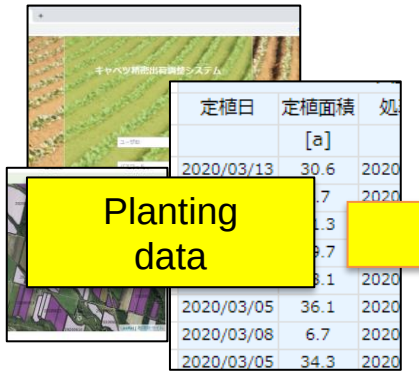


Developed growth model prototype that can forecast the harvesting date with an accuracy of ± 1 day 2 weeks in advance while ± 11 days with conventional forecasting method



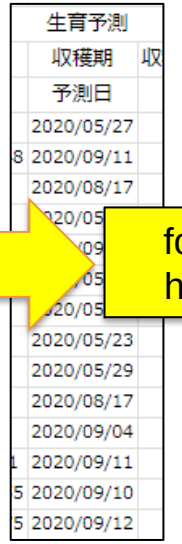
Relationship between estimated days 2 weeks in advance and measured days

Incorporate growth model into precision shipping forecasting system

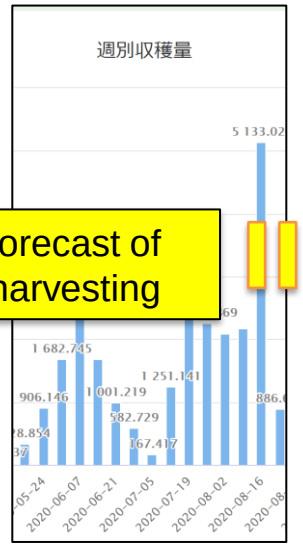


Planting data

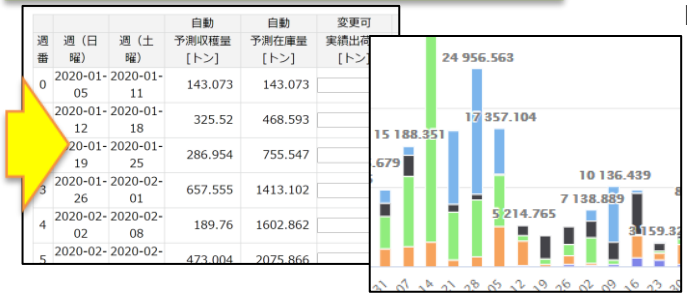
Model



forecast of harvesting



Matching between supply and demand



System to forecast harvest timing

We plan to establish yield forecast model.

Demonstration of technology introduction effect

Demonstration at Shikaoi Hokkaido

Flow of demonstration experiment

Forecast optimal harvest timing by system a month in advance

↓

Plan harvesting based on forecast information up to a week in advance

↓

Harvest in line with the plan

Impact of introducing forecasting system

Item	After introduction	Before introduction	Impact
Yield（t/ha）	86	82	5% up
Gross revenue	22,300	21,200	5% up
Expenditure	18,300	17,600	4% up
Profit（10^4 yen)	**4,000**	**3,600**	**10% up**

Food loss occurrence was avoided by appropriate harvest planning and operation. The yield increase is due to the harvest at the right timing.

Future Plan

- Continuous impact verification
- Demonstration of food loss reduction impact by supply and demand adjustment

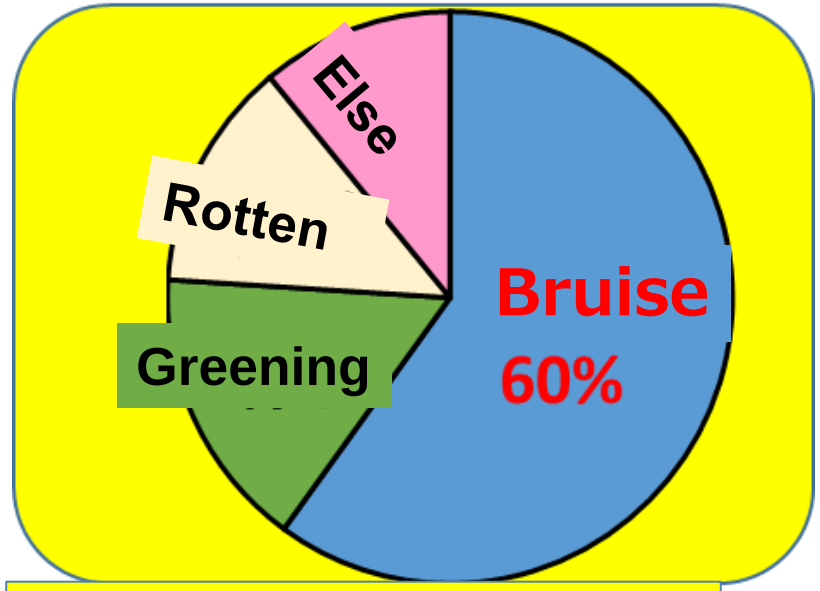
Data-driven production of field crop

Challenges at the production site and efforts for solution

- ✓ In potatoes, bruising during harvesting constantly causes about 7% food loss during processing. The development of countermeasure technology has been delayed due to multiple factors such as weather, soil, and harvesting operation.
- ✓ Accurate forecast model based on environment data will reduce bruises rates by supporting appropriate harvesting operations. This leads to higher profits.

Environmental factors added to physical impact at harvesting, the inside of potatoes turns brown and the process suitability is significantly reduced.

Left: Discarded by bruise
Right: No bruise



Bruise is an important obstacle.

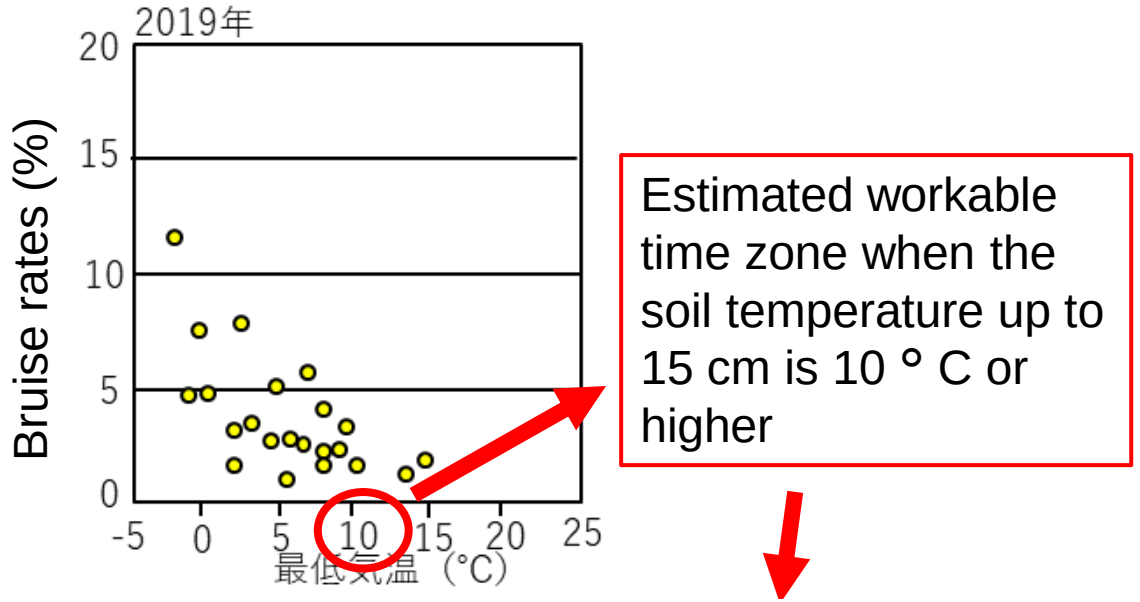
Current status:
Occurs in about 7% and causes food loss

Achievement goal:
Demonstration of halving bruise and presentation of economic impact by support system prototype for appropriate harvest operation

Establishment of a bruise risk reduction API based on mesh weather forecast

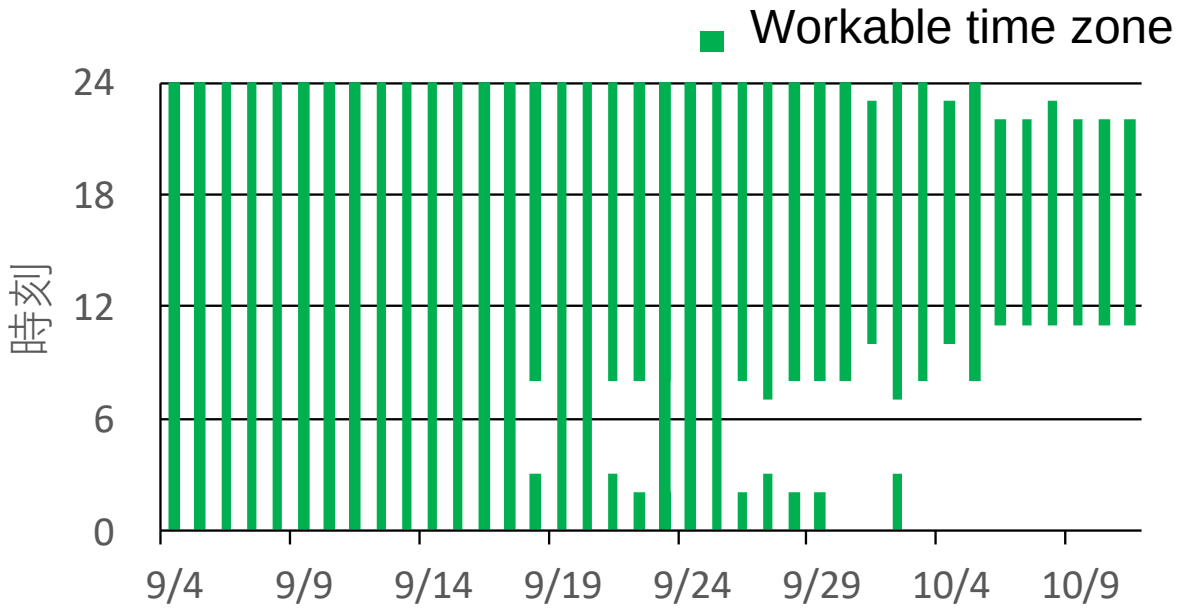
① Clarifying the temperature range to reduce the bruise risk due to low temperatures.

Elucidation of temperature that is critical to increasing the bruise incidence when the harvest timing is late.



② A bruise risk reduction API based on mesh weather prediction was established.

Utilizing WAGRI's mesh weather forecast, established an API that can show workable time zones to reduce risk based on soil temperature forecast.

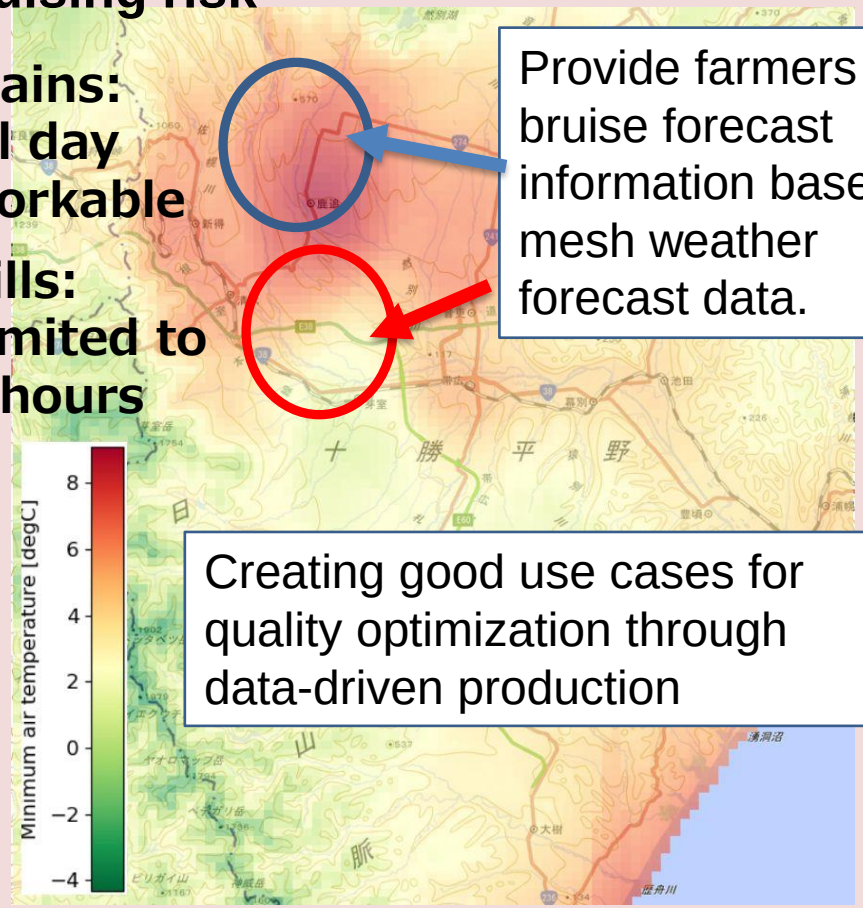


Purpose of the data-driven potato production system

Image of support system usage for appropriate harvest operation to halve bruising risk

Plains: all day workable

Hills: Limited to 7 hours



Provide farmers with bruise forecast information based on mesh weather forecast data.

Creating good use cases for quality optimization through data-driven production

Improvement forecast accuracy in support system

Collect records the work trajectory, time, etc. of tractors and determine field and crops automatically

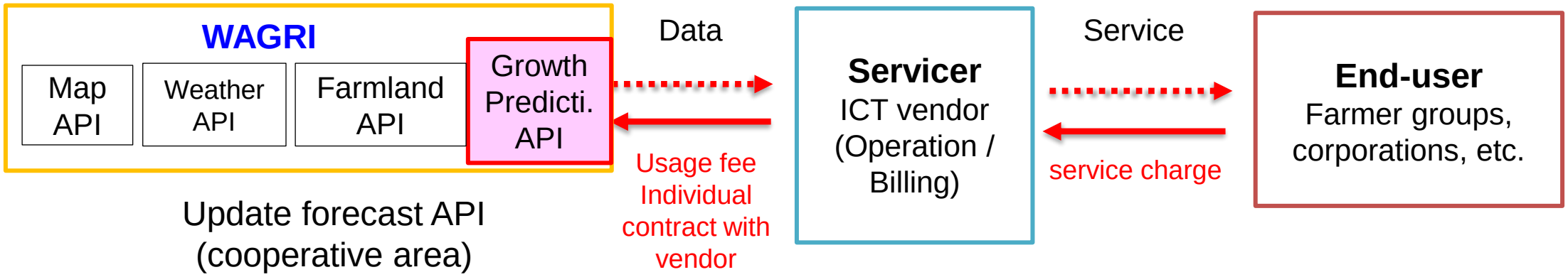
Clarify the bruising cause by linking with harvest operation data

Future plan

Establish the support system prototype, which halves bruising risk, and estimate the impact of food loss reduction and profit improvement using it.

Establishment of a business model aiming to implementation in society

- ✓ The precise shipment forecast system for leafy vegetables and the work support information providing system for potatoes are both planned to be introduced by utilizing WAGRI data platform.
- ✓ Further, we will proceed studies of improving distribution efficiency by sharing supply and demand information among production and distribution players.



We may consider establishment of a data-driven production / distribution system that also utilizes intelligent agricultural machinery as a future evolution of the smart food chain.