Kingdom of the Netherlands

ICT, Robotics and Biobased Economy

Agricultural Innovations in Japan

Market Report 2017

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Summary

1. Use and application of big data and ICT in agricultural marketing;
2. Sensors, GPS, robotic technology, IoT, and connectivity;
3. Food innovation (hub): The roles of governments and public institutions;
4. SWOT analysis for innovation in the food industry;
5. Market entry by businesses (trends in Fujitsu and Hitachi as well as Mitsubishi and other trading firms): Relations with JA (Agricultural Cooperative Associations);
6. Opportunities for foreign businesses and knowledge/research organizations to form alliances; Agricultural innovation programs led by foreign businesses, examples of projects in which Japan invests, those of joint research and development with foreign partner companies and associations, and the like.

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1 Present condition of and challenges for agriculture in Japan

- Challenges for agriculture include (1) the ageing of those engaged in agriculture and lack of those who support agriculture, (2) direct factors such as increase in land that is not cultivated or is abandoned, (3) concern about growing imports of low-priced agricultural products, (4) anxiety about the safety and security of food such as the false labeling of places of origin and agrochemical problems, and (5) decline in food self-sufficiency. A sense of crisis toward agriculture is growing as the country faces a mountain of problems.
- As agriculture continues to decline, the government is shifting its policy to the slogan "strong, aggressive agriculture." It is working to take measures for "attractive, profitable agriculture" such as revising the Agricultural Land Law, announcing its intention to participate in the Trans-Pacific Partnership (TPP) agreement, and discontinuing the acreage reduction program.
- The government (Cabinet Office) and its Ministry of Agriculture, Forestry and Fisheries announced their policy goal of increasing exports of agricultural products to ¥1 trillion in 2020, making it easy for other industries to enter the agriculture sector by taking measures such as the revision of the Agricultural Land Law.
- The greatest challenge is decrease in the number of those engaged in agriculture and their ageing. During the decade from 2005 to 2015, the number of those engaged mainly in agriculture fell from 2.56 million to 1.68 million with their average age up from 59.6 to 66.7 years old. Under these circumstances, in order to revitalize agriculture in the country, the government aims at optimizing the conditions to cultivate agricultural products making the most of ICT and establishing technology to create data on the techniques and know-how of exemplary good farmers with a high level of production technology, make them visible, and enable their application. Through these efforts, farmers are expected to produce agricultural products that meet consumer needs and add more

value to them by improving productivity and working together to provide information on all processes from production to consumption.

- In its Declaration to Build the World's Most Advanced IT State, the government announced that it will work to establish a new production system that can be utilized in a multi-faceted way by accumulating and analyzing many data that are obtained mainly through measurement at farming sites to ensure that the knowledge of exemplary good farmers with a high level of production technology is shared and used effectively among many management entities, including small farms, for human resources development and higher profitability. Initiatives to build a traceability system that connects all people from farms to the dining table through data are also under way. The government aims at establishing the Japan brand, which signifies safe food that one can eat with a sense of security, by building a value chain to add more value to products and bring synergistic effects.
- In fact, there are still many challenges that should be met to apply IT to agriculture. One full year is required to demonstrate that IT can be applied to agricultural products. If strong farms are built through low-cost, easy-to-use systems and many services appear that contribute to the "made-in-Japan" growth strategy, it can be expected that Japan's agriculture will be invigorated.

From the viewpoints mentioned above, there is room for market entry by advanced Dutch businesses with agricultural expertise and know-how.

2 Use and application of big data and ICT in agriculture marketing

Effective use of data in the agricultural sector: National Strategy Office of Information and Communications Technology, Cabinet Secretariat. In terms of innovation in agriculture, in order to realize a new type of agriculture (smart agriculture) to achieve super labor-saving, high-quality production making the most of robotic technology and IT, in November 2013 the Ministry of Agriculture, Forestry and Fisheries organized a study group to realize smart agriculture with the cooperation of organizations such as IT firms and businesses advanced mainly in using robotic technology. The study group met several times to consider measures for pushing this initiative, and in March 2014, it disclosed an interim report on the results of discussions.[1]

The gist of the report is as follows[2]:

In Japan, agriculture is currently faced with difficulties such as the ageing of existing farmers and the lack of those who become newly engaged in agriculture. In order to enhance the competitiveness of agriculture, make agriculture an attractive industry, and create an environment that makes farmers motivated to work harder and enables them to display their abilities to the full, it is important to innovate in agricultural technology such as saving and reducing labor, refining agricultural production, and using information technology.[3]

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[1] Source: http://www.kantei.go.jp/jp/singi/it2/senmon_bunka/data_ryutsuseibi/detakatsuyo_wg_dai6/siryou3.pdf

[2] Report: http://www.maff.go.jp/j/kanbo/kihyo03/gityo/g_smart_nougyo/pdf/cmatome.pdf

[3] Source: Ministry of Agriculture, Forestry and Fisheries http://www.maff.go.jp/j/kanbo/kihyo03/gityo/g_smart_nougyo/

In other industrial sectors, effective use of robotic technology and ICT is progressing, and technological innovations lead to the enhancement of the sectors' competitive power. In the agriculture sector, too, technological innovations are expected to solve various problems and give agriculture the strong power that develops it into a growth industry. For this reason, with the cooperation of economic and other circles, the Ministry of Agriculture, Forestry and Fisheries organized a study group to realize "smart agriculture," a new type of agriculture that makes the most of advanced technologies such as robotic technology and ICT to enable super labor-saving, high-quality production, and the like. The study group has held its meetings for discussions and put forward the three items listed below as part of the policy to take measures for realizing smart agriculture in the future.

1. Vision (a new type of agriculture realized by introducing robotic technology and ICT)
2. Roadmap (goals to achieve in each phase and initiatives to achieve the goals)
3. Matters to note when carrying out such initiatives

2.1.1.1 Vision of future smart agriculture

In order to solve the problems that face Japan's agriculture and develop a new type of agriculture (smart agriculture), it is important to put forward an image of future smart agriculture in an easy-to-understand way and carry out initiatives to realize the vision while sharing it. To that end, the study group has organized the vision of the new type of agriculture brought by the introduction of robotic technology and ICT in five policies as follows:

1. Achieving super labor-saving and large-scale production: Overcoming the limits of scale by realizing the autonomous driving of agricultural machines such as tractors
2. Displaying the ability of crops to the full: Achieving high-yielding, high-quality production not attained before by making the most of sensing technology and past data to ensure carefully thought-out cultivation (precision agriculture)
3. Freeing farmers from hard, dangerous work: Reducing heavy labor such as loading and unloading harvests using assist tools and automating the work of weeding mainly at the ridges between rice fields
4. Making agriculture one that anyone can work on: Creating an environment that enables even inexperienced labor to work on agriculture mainly by making devices to assist the operation of agricultural machinery available and developing databases of cultivation know-how
5. Providing security and confidence to consumers and end users: Connecting producing centers to consumers and end users mainly by providing cloud systems for productive information

3 Smart agriculture

3.1 Outline of smart agriculture

In order to overcome challenges for Japan's agriculture, it is necessary to make the most of ICT (such as AI and IoT). These items reorganize and explain these initiatives. It is effective for overseas businesses to participate in these sectors.

This is the Cabinet Office's summary of future initiatives to step up efforts to realize "smart agriculture," create new value not only at production sites but also in the entire supply chain, and develop agriculture into a viable industry by applying AI, IoT, big data, and robotic technology, the platform technologies in the fourth Industrial Revolution, to the agricultural sector. It analyzes on an item-by-item basis the possibilities of applying AI and IoT to solve problems that face Japan's agriculture.

<Vision of future smart agriculture>

◇Impact of the fourth Industrial Revolution◇

All information will be converted to electronic data mainly through sensors and connected to networks, enabling free exchange of such data (IoT).

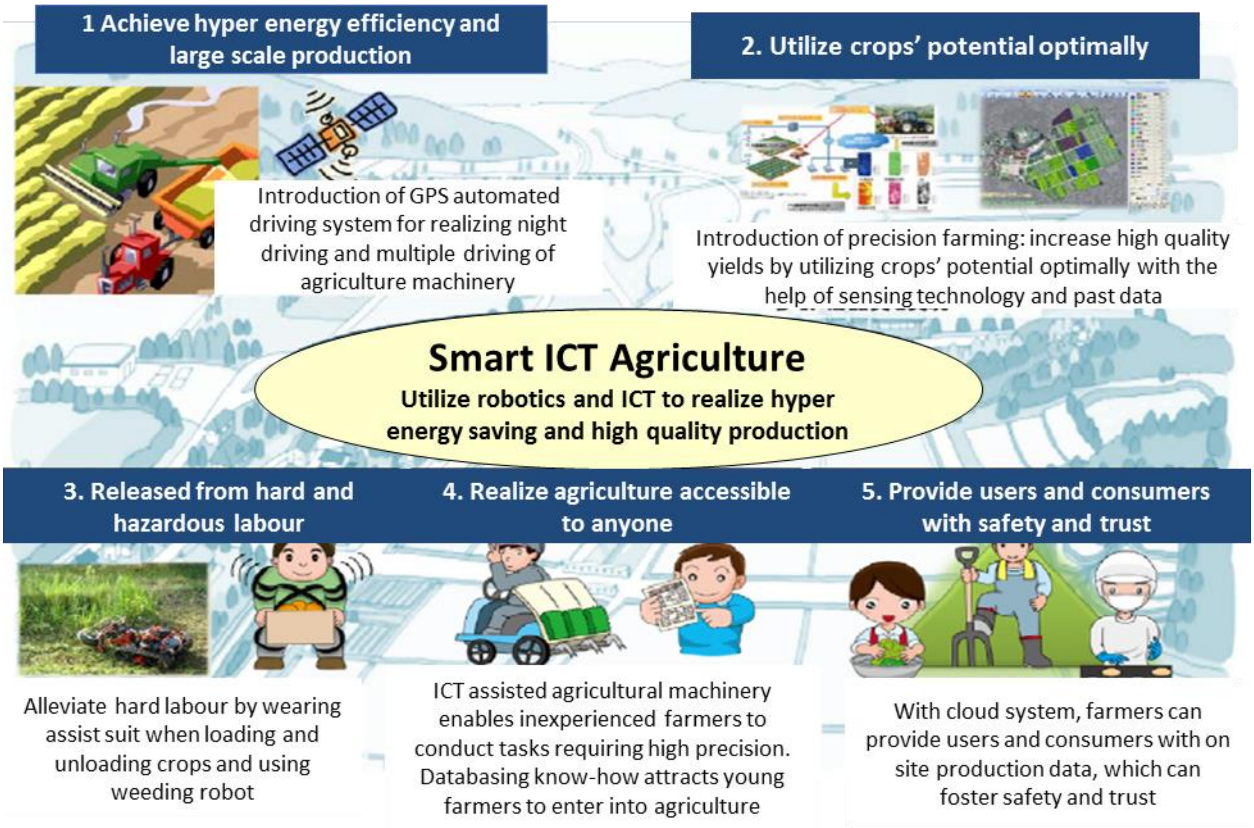
The large volumes of data collected will be analyzed in real time and can be used in a way that creates new value (big data).

Machines will learn autonomously and become able to make decisions at a high level that exceeds human beings (AI).

Even varied, complicated work can be automated (robotic technology).

Application to the agricultural sector

Realize smart agriculture early and create new value by achieving goals such as dramatic improvement of productivity and optimization of the entire supply chain



Source: Materials from the Ministry of Agriculture, Forestry and Fisheries' study group for smart agriculture

3.2 Challenges for agriculture: Possibilities of applying AI and IoT

- In Japan, the fact is that much progress has not been made in using IT for agriculture, and the country's agriculture is in the stage of development in which farmers are working to push initiatives to increase productivity by applying AI and IoT to address the problems listed below.
- There are great opportunities for Dutch businesses to enter the Japanese agricultural market, but the challenge is which businesses they should select as their alliance partners (those which have know-how or technology in solving the problems).

Problems with which Japan's agriculture is faced	**Agriculture that makes the most of AI and IoT**
<Decrease in the number of those engaged in agriculture and lack of supporters of agriculture> ・**Increasingly serious lack of supporters of agriculture (labor)** Much of agricultural work, including hard one, still depends on manpower. Lack of manpower makes it difficult to maintain production in certain areas (abandoned farm land) ・**Agriculture that relies on intuition and experience** Much of work relies on experience and intuition, and it takes a tremendous amount of time for new farmers to acquire agricultural techniques.	→**Automated super labor-saving agriculture in which robots are used** AI and IoT enable use of robots for or remote control of work that has relied on manpower as well as autonomous driving of agricultural machinery, achieving substantial labor saving →**Agriculture that anyone can work on** AI and IoT make agriculture approachable to anyone mainly through systems that allow people to learn skilled farmers' know-how in a short period time and analysis of images of insect pests
<Maintaining profitability> ・**Sluggish productivity** Productivity growth such as yields has reached a ceiling because of uniform management that is applied irrespective of differences in the area of cultivated lands.	→**Improve productivity by making free use of data and science** Analysis of big data clarifies causal relations among soil, weather, crops, and other factors, enabling farmers to identify the optimal cultivation management methods for cultivated lands and the like and improving yields.
<Surfacing of unknown risks> ・**Various new risks such as global warming arise** Agriculture is faced with risks such as abnormal weather and new insect pests which have not been experienced before	→**Enabling farmers to predict new risks such as global warming and cope with them** Realizing a new type of agriculture that enables farmers to predict weather and growth with high accuracy based on big data and anticipate and cope with risks
<Establishing cooperation among, and achieving greater efficiency in, production, logistics, and consumption> ・**Changing and diversifying demand** There is a limit to the ability of product-out type agriculture, in which farmers only produce, to meet changing and diversifying demand. ・**Production and logistics part of which is still left inefficient**	→**Realization of market-in type agriculture** Enabling farmers to strategically produce and sell products to meet a wide range of needs making the most of big data on markets, logistics, and management as well as to achieve greater management efficiency →**Achieving greater efficiency through sharing of operations and information** Achieving greater efficiency mainly through cooperation among production, logistics, etc. and

Lack of cooperation among players in production, logistics, etc.	sharing of materials, human resources, logistic centers, etc.

3.3 Examples of use and application of AI and IoT to agriculture, and required technology

3.3.1 Effects of AI and IoT

Based on big data, AI and IoT enable a high level of crop growth management, yield improvement, and productive stability. Learning how to perform agricultural work enables introduction of robots for the type of work that is difficult to mechanize. AI and IoT also enable diagnostic imaging for insect pests and livestock diseases. Automation of agricultural machinery such as image recognition and autonomous driving can also be expected.

3.3.2 Examples of application and its effects

Optimal cultivation management based on big-data analysis	Various sensing technologies allow farmers to obtain data on micro-weather, soil, growth, etc. in each tract of cultivated land in real time, making the condition of the land visible, and this enables its data-based precision management. Furthermore, big-data analysis enables clarification of complicated causal relations that have hitherto not been understood and ensures optimal land management so that the highest yields and the best product quality are achieved.
Use of artificial intelligence to apply robots to complicated work	The function of learning movements allows robots to be used for complicated work such as harvesting fruits and vegetables which has hitherto not been mechanized. Image recognition enables robots to harvest only red ripe tomatoes and other crops which should be reaped.
Early detection of signs of disease caused by insect	Accumulation of images of damage caused by various insect pests enables detection of signs of disease caused by insect pests through image recognition.

pests through image recognition	Combining with predictions of occurrence of insect pests based on meteorological and other data allows farmers to take actions early.
Automation and sophistication of agricultural machinery based on autonomous decisions	Image recognition enables agricultural machines in operation to detect obstacles, people, and other objects and automatically avoid them or stop operation. Combining with autonomous driving technology allows farmers to realize a high level of unmanned work systems.

Present situation of use of IT for agriculture in Japan

・Use of IT is mostly in the stage of testing to solve various problems.

・Some agricultural management entities and corporations have introduced IT in an advanced way, but the overall impression is that there is still a long way to go before agriculture is industrialized (The two fundamental problems with which Japanese agricultural management entities are faced are the small scale of production and the ageing of those engaged in the industry.

・The key to success is encouraging agriculture to work with businesses in the secondary and tertiary industries is to introduce know-how and IT equipment/systems suitable for coping with these problems. For the time being, the shortest way to enter the market is to do so through greenhouse horticulture rather than cultivated land (In this field, overseas businesses are able to enter the market effectively).

3.3.3 Required technology

The objectives of applying AI and IoT to agriculture, examples of such application, and specific technologies required can be summarized as shown in the diagram below.

Projected direction	Concrete examples	Required technologies
Tackle declining farming population & labour shortage Cost effective ICT agriculture with the use of AI and IoT	• Harvesting robot for fruit and vegetables and fruit trees • Develop robotics for grading and packing at sorting facilities • Develop robtics for thinning and pruning • Develop automated and unmanned agricultural machines	• Robotics technologies to enable complicated tasks such as harvesting fragile crops • Improve image recognition technique to identify crops ready for harvesting/sorting • Improve of image recognition of crops which needs trimming and running (deformed, physiologically disordered, etc.) • Improve human detection function and avoidance technique to ensure safety of driverless farming vehicle
Realize agriculture which is accessible to anybody	• Make inventalisation of explicit knowledge and know-how of outstanding farmers • Realize early judgement of harmful insects, pests and livestock deseases	• Function to analyse high skills (activities and judgement patters) of outstanding farmers and make these explicit knowledge available for use by the others • Function to judge from the data image of a lesioned part or soil sensor the cause of pathological change
Secure profitability Improve productivity with optimal use of data and science	• Optimize crop and climate control by sending and using data • Optimize control of individual livestock • Streamline and shorten breeding	• Establish and provide optimal cultivation and climate control method by analysing complicated causality between yield and quality, by utilizing field's environment data, crop control data • Obtain and analyse operation status of agricultural machines, for proposal

		function for best practise in terms of operation cost • A function which gives a good judgement based on the outcome of human deeds • Obtain individual livestock data for optimal and efficient fattening and breeding based on optimal management of each individual condition • Improve monitoring technology for livestock management • Establish big data analysis technology, based on all sort of dta such as genome, phenome and environment. Streamline trait evaluation with data analysis technology
Reveal future risks Improve agriculture resilient to new risks such as global warming	• Pest extermination and crop management based on weather forecast	• Forecast of pest outbreaks by analysing weather data and pest occurrence data and based on this establish a function to make crop control data available
Improve linkage and efficiency in production, distribution and consumption Establish market-oriented agriculture Improve the efficiency through information sharing	• Formulate production, labour and shipment plans, based on production forecast (market demand forecasting) • High grade quality control by assuring traceability • Streamline the sharing of agricultural machines and truck transportaion between production sites, based on operational condition and forecast	• Create a function to forecast production output, work load and shipment timing by analyzing crops data, weather data and market trends • Enable automatic data acquisition of production record and establish fundamental platform for data linkage • Create a function to forecast operational conditions by analyzing crops and weather forecast data. Provide advice for optimal facility location and optimal utilization

3.4 Challenges for the application of AI and IoT

- In this summary of "data application in the agricultural sector," future challenges for the application of AI and IoT are divided into three major categories.
- In the future, it will be inevitable to apply and introduce AI and IoT in the agricultural sector of Japan. To that end, priority should be given to overcoming the challenges specified below.

As Japan's agriculture strives to overcome these challenges, Dutch businesses have great potential to participate in and enter the Japanese agricultural market. In particular, human resources become an important factor in the agricultural sector.

Challenges for the full, effective use of data and the formation of big data	･In order to effectively use data and form big data, it is necessary to standardize data formats and develop platforms. ･Japan has an underdeveloped environment to collect information through IoT by installing sensors and other devices in cultivated lands and the like. ･In order to bring the intended outcome, a system is required that enables users to obtain data from a wide range of processes from production to distribution processing in a carefully thought-out way and analyze such data. →In addition to formulate substantial standardization guidelines and put them into practice, it is necessary to develop platforms that enable data linkage and the like among different systems. In order to ensure that data owned by farmers are accumulated on the platforms, it is necessary to build systems to return benefits to farmers, confirm whom ownership belongs to, put rules of data use in place, and consider efficient methods of data collection. It is also necessary to reduce costs for sensors and other devices making full use of communications and other advanced technologies.
Create an environment in which the safety of robots is maintained	･It is necessary to analyze the conditions under which the safety of automation technology using robotics and artificial intelligence is ensured and lay down rules to determine where responsibility lies.

	→Along with considering the autonomous driving of vehicles to ensure the safety of autonomous driving of agricultural machinery, it is necessary to establish an environment to achieve automation by examining technologies to ensure safety, establishing information security technology, and laying down a set of rules in order to enable remote-controlled unmanned driving.
Lack of AI personnel in the agricultural sector	・The agricultural sector, whether private or public, absolutely lacks in AI personnel. ・It is necessary to develop personnel capable of integrate farms with AI and IoT systems. →It is necessary to promote joint research with the participation of AI researchers and other experts from organizations such as the National Institute of Advance Industrial Science and Technology, private research institutes, and universities. In order to encourage industries other than agriculture to enter the industry and maintain and develop their initiatives there, it is necessary to consider how to present the benefits of market entry. ・It is necessary to increase the AI and IoT literary of producers, too. →In order to ensure smooth introduction of AI and IoT at farming sites, it is necessary to advance research and development with the participation of farmers and train personnel so that they connect farmers to technology. It is necessary to protect farmers' technology, know-how, etc. as intellectual property (business secrets).

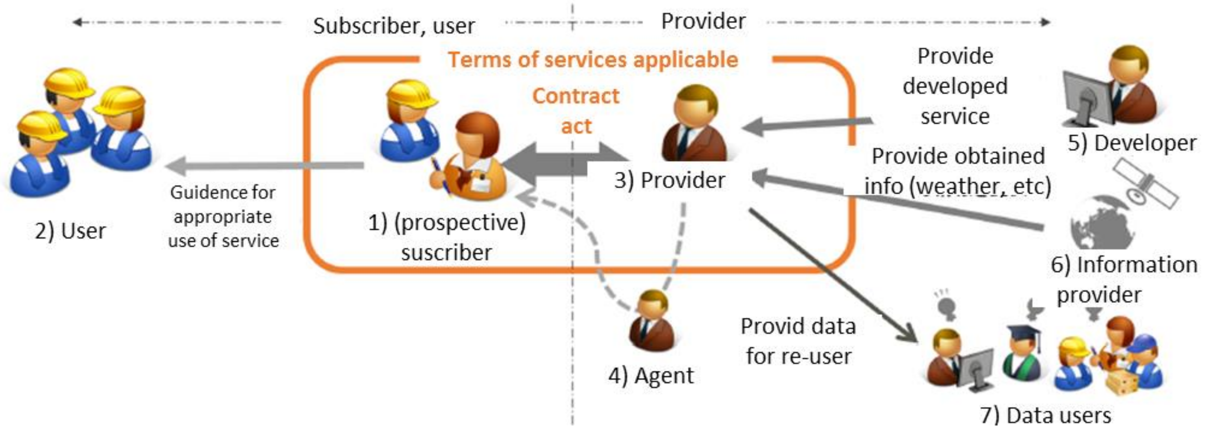
3.5 Outline of regulations for use of agricultural IT services

The Cabinet Secretariat's National Strategy Office of Information and Communications Technology gives an outline of regulations for use of agricultural IT services (details of contract), mentioning providers' and users' rights and obligations to pay attention to and confirm, as follows:

3.5.1.1 Outline of regulations for use

1. General rules	1. Positioning of the regulations 2. Effect of use regulations and their revision 3. Refusal and cancellation of service contracts
2. Details of services and their change or discontinuation	1. Details of services 2. Change of discontinuation of services
3. Responsibilities that accompany the use of services	1. Prohibitions 2. Exemption from responsibility 3. Warranty and liability for compensation
4. Handling of service-related information	1. Rights 2. Handling of data 3. Reuse of data
5. Governing law and agreed jurisdiction	1. Agreed jurisdiction 2. Governing law
6. Additional rules	

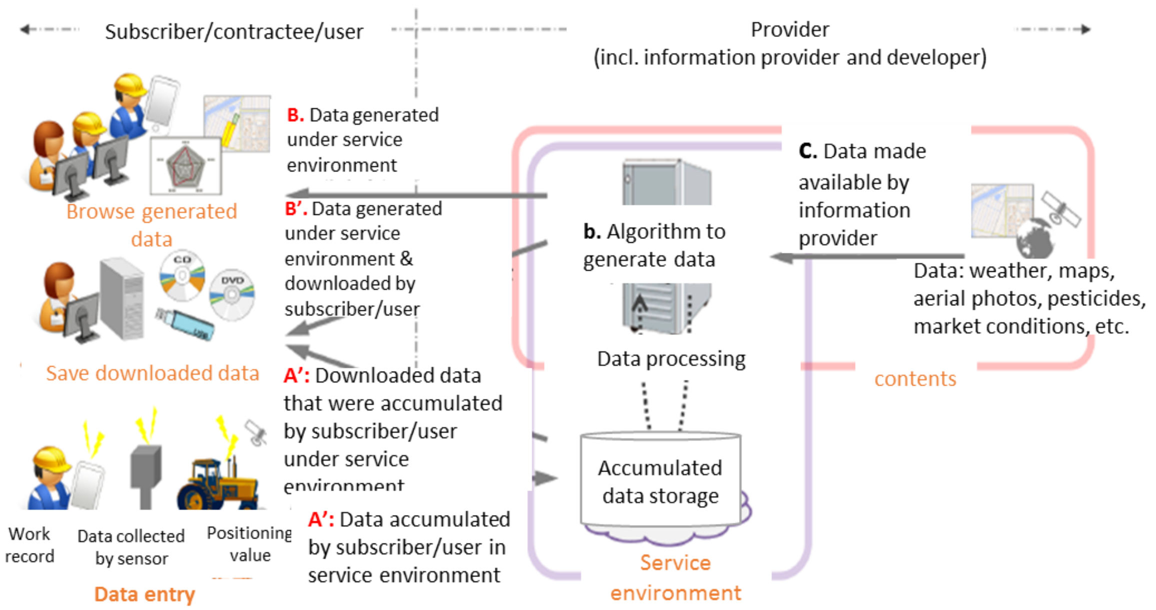
3.5.1.2 Stakeholders in agricultural IT services



① (Prospective) Subscriber	③ Provider
Is a person (entity) that concludes a subscription or purchase contract, for the use of agricultural IT service, with the service provider (③). Subscribers can also be identical to users (②) . Users can be subscribers due to lapse of time	Is a person (entity) that provides agricultural IT services on a commercial basis or for free. For (prospective) subscribers, providers are those who (will) conlude(s) contract(s). Providers are not the developers of agricultural IT services. Providers conclude contract with the developer for the use of his service.

3.5.1.3 Types and ownership of data related to agricultural IT services

- There are three main type of data in agricultural IT services
- Data A, A' and B' below belong to a contract party, while the owner of data B varies to contribution ratio of algorithm



This is an introduction to the next item, presenting an example of market entry by other industries: Toyota Motor Corp.

3.5.1.4 Examples of effective use of big data in the agricultural sector: Fujitsu Akisai (typical example) and Toyota Motor (entry from a non-agricultural industry)

- In Japan's agriculture, too, initiatives to increase productivity making the most of big data began four to five years ago (theses on using artificial intelligence effectively for the agricultural sector were put forward in 2012 and 2013).
- Since December 2013, Fujitsu's agricultural cloud service Akisai has provided services to offer the optimal cultivation calendars (schedules for managing the cultivation of agricultural products) making effective use of big data.
- Even before agricultural cloud services, there were attempts to record data on temperatures and humidity and details of work performed on cloud sites using sensors installed at farming sites, but farmers needed to prepare cultivation calendars themselves.
- There is a service of enabling even farmers lacking in agricultural know-how to increase productivity by allowing them to share cultivation calendars prepared in a way that suits particular varieties and regions through analysis of big data on cultivation methods used by high-yielding farmers.
- Among the industries other than agriculture, Toyota Motor has entered agricultural cloud services. The automaker announced its plan to make the most of big data through its rice-producing farmer support system "Hosaku Keikaku (heavy crop plan)."
- Nine agricultural corporations have participated in Hosaku Keikaku, and work results are shared on its cloud site. The objective is to clarify what conditions have to be met to produce a large amount of delicious rice at low cost by creating a database of location, soil, temperature, humidity, weather, varieties, fertilizers, work processes, etc. Costs are expected to be reduced, and product quality stabilized, by producing in a systematic way based on data. Thus, agriculture, which often relied on experience and intuition, will change to an industry that allows systematic production.

* The number indicates that of companies that participated in the project when the service was announced in 2015, and currently, about 20 agricultural corporations are members of the program.

4 Agricultural sector: Sensors, GPS, robotic technology, and IoT technology

4.1 Agricultural cloud services

So far, 30-40 companies have entered the agricultural cloud service-related field, and about ten of them lead the field.

4.1.1.1 Vendors which have brought major results in providing agricultural cloud services and the outline of their services

Corporate vendor "Service name"	Outline of services and their strong points and development
Fujitsu "Akisai"	▸ Overview: The aim is to develop services that connect producing centers, distributors, and consumers through a value chain by making the most of ICT at production sites. • Services cover outdoor cultivation, greenhouse cultivation, and stock farming, providing production control, business administration, and sales management in an integrated manner. Agricultural production control SaaS provides services such as production control, greenhouse horticulture environment control, soil analysis and fertilizing design, cultivated land sensing networks, plant factory growth control, and assessment guideline application support. Services for stock farming include cattle breeding support and beef production control. • Akisai aims at expanding business scale by producing on larger scales, industrializing agricultural production, and combining agriculture with secondary and tertiary industries. It also aims at applying corporate management to agriculture. It has been introduced mainly among agricultural corporations and producers.

NEC/Nepon "agrinet" agricultural ICT solutions	▸ Overview: "agrinet" covers all processes from management, production, and logistics. It works with Nepon's greenhouse environment control equipment. • Services aim at next-generation agricultural management, which provides optimization and control by collecting, visualizing, and analyzing information. agrinet offers functions such as production support (farming support, cultivated land monitoring and control, and GAP management), agricultural management support, and logistic support (supply demand matching and direct sales station support). • Characteristics: agrinet combines greenhouse equipment of Nepon, the leading manufacturer of warm air heaters for greenhouses in Japan, and cloud services to enable remote monitoring and automatic control of greenhouses.
Hitachi Solutions "GeoMation Farm"	▸ Overview: GeoMation Farm is an agricultural information management system that makes the most of geographical information systems (GIS). It is operated by Hitachi Solutions. It enables users to manage and effectively use various kinds of information on farming sites in an easy-to-understand way by linking it to maps. • With the cultivated land and soil information management system, which enables users to visually grasp the linkage of information by combining maps with agricultural information, as its core, GeoMation Farm offers applications such as effective use of agricultural land, field manuring, farming planning, productivity diagnosis, and farming guidance. • In addition to the GeoMation Farm agricultural information management system, Hitachi Solutions provides the AgriSUITE sales/production cooperation platform, cloud services for plant factory production support, and the like.
agricompass "AgriPlanner"	▸ Overview: AgriPlanner is a system that enables sharing and effective use of cultivation plans and production process information. • AgriPlanner is operated by agricompass. This system allows those involved in agriculture (producers, JA, agricultural corporations, distributors, processers, and retailers) to achieve efficient agricultural management by sharing cultivation plans and production process information. Users can not only record the history of cultivation but also compare recorded information with cultivation plans and share and effectively use the results of comparison as production process and overall management information.

	• Other functions include "tracenavi," which converts the history of cultivation into electronic data, and "agripoint," which manages collection and shipment operations in an integrated manner.
water-cell "agri-note"	▸ Overview: agri-note is an agricultural journal/cultivated land management tool, which uses Google maps and aerial photographs. • agri-note offers an online agricultural journal/cultivated land management tool, which uses Google maps and aerial photographs. It enables indication and recording of accurate locations using aerial photographs. Major functions include cultivated land management, work recording, traceability, collection of data on each tract of cultivated land, a database of agricultural chemicals and fertilizers, and conversion of growth records into graphs.
Sorimachi "facefarm"	▸ Overview: facefarm allows users to enter work and growth records on the spot while confirming them on the map and totalize all data automatically. • Users can confirm records of agricultural work and growth at cultivated land with Google Map's satellite photographs and enter them in the system on the spot for automatic totalization. facefarm is supervised and guided by the Japan GAP Foundation (conforming to JGAP's control points and standards). • facefarm works with Yanmar's SmartAssist to enable users to take positional information and automatically record machine operation journals. Discounts for use fees include membership discounts and discounts for reference from Yanmar.
PS Solutions "e-kakashi"	▸ Overview: e-kakashi collects and visualizes data from sensors installed at cultivated land. • e-kakashi enables users to easily collect and visualize sensor data on the cultivation of agricultural products. • e-kakashi consists of sensor nodes installed at wet and dry fields (child devices), the gateway which transmits data from child devices to cloud services (parent device), and Web applications to see the results of analysis of data collected on PCs and smartphones. The sensors measure temperature/humidity, sunshine, and soil water content/EC at multiple points, and plans call for expansion of product lineups in the future.

ESK “Hataraku Nikki”	▸ Overview: Hataraku Nikki is a smartphone-based application to record agricultural work. • This smartphone-based free application allows users to easily keep cultivation records and write up journals of agricultural work. Users can record daily work, the condition of crops, quantities, units, and the like (easy entry using voice input functions) and view such records. • Inputted data can be extracted using Excel formats. Hataraku Nikki is designed for small farmers, those newly engaged in agriculture, and light users such as those who enjoy kitchen gardens or gardening as their hobby, but professional versions of Hataraku Nikki, which can be used on a group basis or support shipment and traceability, are also available.
Kubota “KSAS”	▸ Overview: KSAS offers a service that combines cloud services and Kubota’s agricultural machinery. • KSAS provides cloud services that integrate ICT and other advanced technologies into agricultural machinery. In addition to making agricultural management visible, KSAS helps improve product quality and yields and reduce overall costs by working with Kubota’s agricultural machinery. • Services consist of basic ones and advanced ones. While the former provides cloud services to visualize agricultural management, the latter is linked to agricultural machinery. • The taste and yield sensors mounted on combines collect taste, water content, and yield data at the same time as crops are harvested. This system realizes next-generation smart agriculture mainly by automatically sprinkling the amount of fertilizers planned for each tract of cultivated land using the unit that electrically adjusts the amount of fertilizers.
Toyota “Honen Keikaku”	▸ Overview: Run by Toyota, Honen Keikaku manages cultivated land in an integrated manner, automatically preparing process plans so that a number of workers can perform agricultural work efficiently. It offers cloud services to rice-producing agricultural corporations. • Making the most of the principles of Toyota’s production systems, Honen Keikaku manages cultivated land scattered in wide areas in an integrated manner, automatically preparing process plans so that a number of workers can perform agricultural work efficiently.

	• It distributes work plans to the smartphones of workers who go to paddy fields, thus enabling them to share the progress in agricultural work and control it intensively. Users can also automatically keep work journals and compile work reports. • In addition to agricultural work, Honen Keikaku collects and analyzes various kinds of data, including rice drying and refinement processes, varieties, areas, fertilizers, weather, man-hours, and drying conditions. It is currently applicable to rice, wheat, and soybeans, but development is under way so that it can be applied to other crops in the future.

4.2 Sensor networks/environment control systems

4.2.1 Sensor networks (overview)

- A wireless sensor network refers to a wireless network with a number of wireless terminals with a sensor scattered in a particular space which enables collection of data on the environment and physical conditions by making them work together.
- The wireless terminals of a sensor network are called "nodes" each of which usually consists of one sensor or more, a wireless chip, a microprocessor, and a power sources (such as batteries).
- Sensor nodes not only have the function of transmitting sensor values but also provide ad-hoc functions and routing algorithms to send data from other sensor nodes to the central node (gateway). Another function of sensor nodes is that if communications between sensor nodes fail, they autonomously restructure another route to relay the communications, thus ensuring that data reach the central node. A group of nodes in the network sometimes performs distributed processing. Other functions include enabling the network to work for a long period of time without being supplied with electricity from outside as well as conserving electricity and generating power independently. In order to achieve these functions, it is necessary to ensure cooperation in a wide

range of areas such as wireless, networking, MEMS sensor, sensor interface, battery (self-power generation) technologies.

- Many of the sensor networks are used mainly to monitor energy conservation management, industrial instrumentation, health care, transport, and agriculture. The types of sensors installed and the formats of input used do not limit the types and formats of voltage, temperature, humidity, gas, luminous intensity, and serial data.
- These sensors are effective in grasping changes in the distribution of physical phenomena because they can measure at many points almost simultaneously. Sensor networks have progressed because it became easy to install sensors in various places such as motor vehicles and other mobile systems as smaller sensors with wireless communication functions were made available.

4.2.2 Agricultural sensor networks

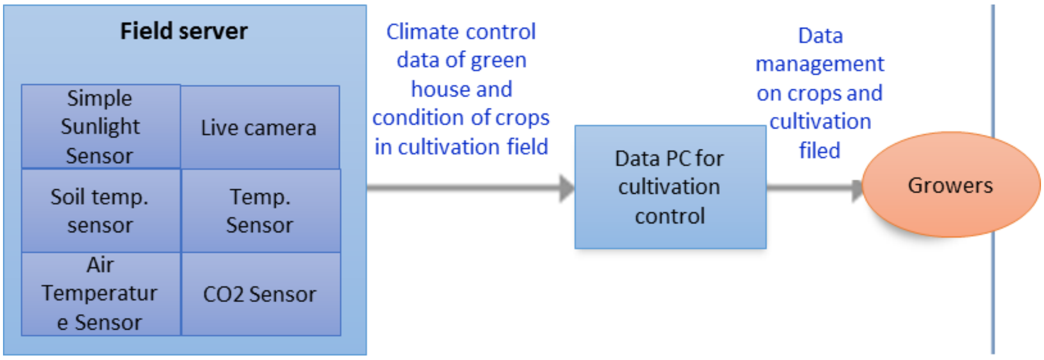
- One of the typical servers used for agriculture is agricultural field servers. A small, weather-resistant Web server for measurement purposes, the agricultural field server simultaneously obtains data on temperature, humidity, the intensity of solar radiation, water content in soil, CO2 concentration, etc. by connecting network cameras and other devices to environmental sensors. It also enables users to monitor weather conditions at farms, the growth of crops, and the like from a remote place and disclose the results of monitoring to consumers through the Web.
- At first, research institutes and agricultural corporations proactive in using IT used these networks, but based on M2M (machine to machine) technology, major IT vendors such as NEC and Fujitsu introduced them into the market as part of their cloud services, and this has prompted them to gain recognition.
- Development of the networks as a greenhouse horticulture or environmental control system: These networks automatically transmit data that are obtained by sensors installed in greenhouses (such

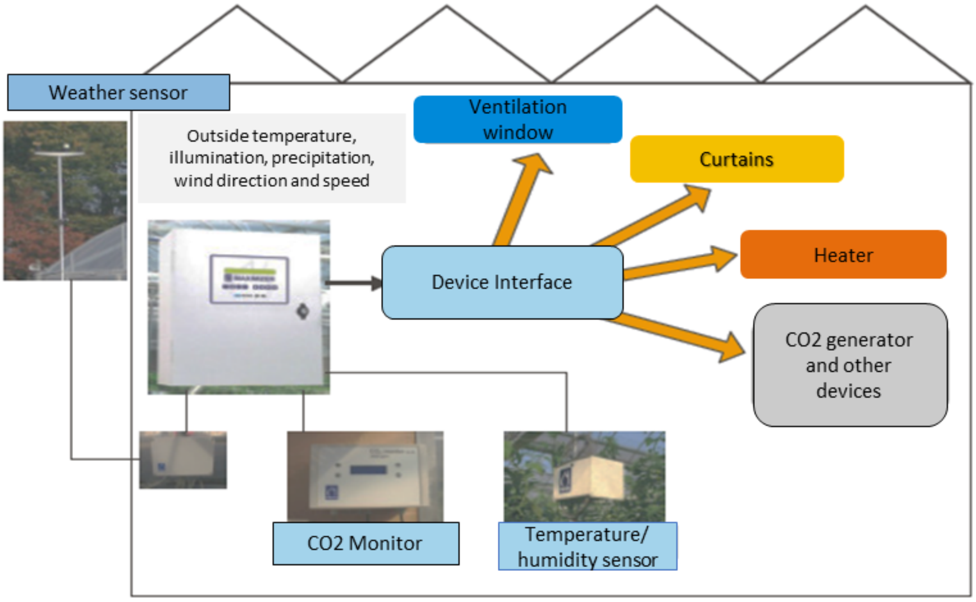
as temperature, humidity, and CO_2 concentration) and information on the operation of control equipment to clouds at certain intervals and accumulate such data and information there.

4.2.3 Environmental control systems

- Environmental control refers to measuring outdoor and greenhouse temperature, humidity, solar radiation, CO2 concentration, wind direction and velocity, precipitation, culture medium temperature, etc. and automatically controlling heaters, temperature-retaining and shading curtains, and ventilators in multiple ways so that the indicators are maintained at the optimal level. Currently, in greenhouse horticulture in Japan, multiple environmental control systems are mainly used, and priority is given to controlling temperature, humidity, solar radiation, etc.
- Recently, systems with environmental monitoring (recording), predictive control, and other functions have been developed, and initiatives for data-based logical cultivation have progressed. Furthermore, they have attracted public attention as ones that contribute to improvement of agricultural productivity because they provide cultivation control in real time by working with fertigation and other cultivation systems.

4.2.3.1 Functions of the field server and the configuration of an environmental control system in the greenhouse

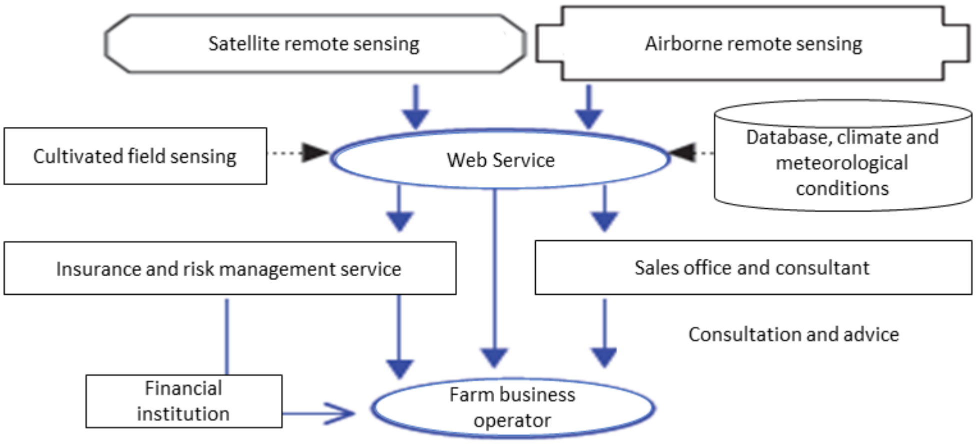


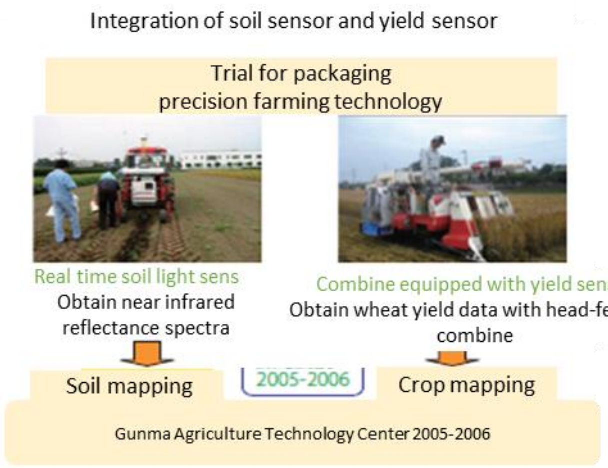


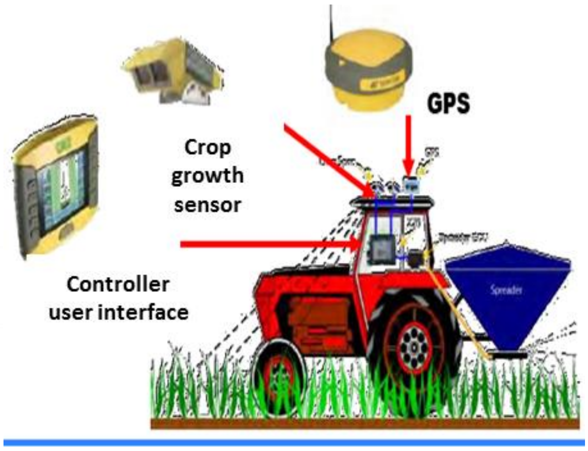
Source: Greenhouse Horticulture and Green Report

4.2.3.2 Conceptual diagram of sensor measurement in smart agriculture

Various sensors are installed to control cultivated land (soil, growth, and harvest). They monitor weather conditions (temperature and humidity), solar radiation, soil, growth, etc. Linked by a network, environmental control systems (field servers: sensor nodes) and sensors are managed through Web-based cloud computing.







4.2.3.3 Inhibitory factors for sensor networks

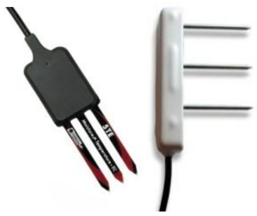
In terms of technology and cost, there are many factors that inhibit the spread of sensor networks.

Cost	Service providers are limited because these networks are used for particular purposes. These networks are costly because they are built for each business, and it is unclear how costs are shared. Sensor terminals are relatively expensive (produced in small lots), and initial costs are high.
Technical and functional	These networks need to be developed so that they fit data interfaces that vary from one application to another. Data obtained are not effectively used to the full. Some areas may be affected by radio-frequency and electromagnetic interference.
Environmental and other	It is necessary to develop easy-to-use terminals that can be used even by elderly persons. There are no killer applications. Guidelines, laws and ordinances, and the like are underdeveloped.

4.2.4 Major sensors

The following is a list of companies that provide major sensors used for smart agriculture (such as cultivated land and greenhouse horticulture), their prices, etc.

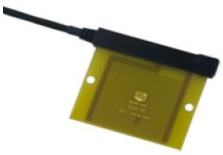
<Temperature/humidity sensors>   	**Price: ¥500 at the device level; thousands of yen to ¥10,000-30,000; ¥100,000 for a set of modules** Sensirion Co. Ltd.: Sensirion AG, Switzerland, the world's leader Digital temperature/humidity sensors SHT1x/7x/2x Series: ¥500 Global Electronic Corp. (IST AG, Switzerland): Temperature/humidity sensors Rotronic (Shinyei Technology Co., Ltd.): Temperature/humidity sensor probe HC Series Data loggers, plant environmental growth monitoring (greenhouse environmental monitoring) Handy type thermometer/hygrometer HP Series, temperature/humidity data logger HL Series Honeywell Japan Inc.: Temperature sensors, humidity sensors Shinyei Technology: Temperature/humidity RHI Series, humidity sensor CL Series KN Laboratories, Inc.: Hygrochron temperature/humidity loggers (Temperature/humidity sensors with built-in memory chips) ¥12,000 Fieldpro, Inc. (former T&F Inc.): Small temperature/humidity sensors, temperature sensors, multiple weather sensors, pyranometers, barometers, water level and turbidity sensors, soil moisture meters, pH sensors, ORP sensors, FC sensors, etc. Shibaura Electronics Co., Ltd.: Indoor temperature sensors, ground temperature sensors (level sensor: liquid level detection) Chino Corp.: Temperature sensors (thermocouples, resistance temperature detectors) Omron Corp.: Temperature sensors, temperature/humidity sensors Azbil Corp.: Temperature/humidity sensors Nippo Co., Ltd.: Agricultural control equipment, New Sensor II, controllers, solar radiation sensors Panasonic Corp., Alps Electric Co., Ltd., and other manufacturers

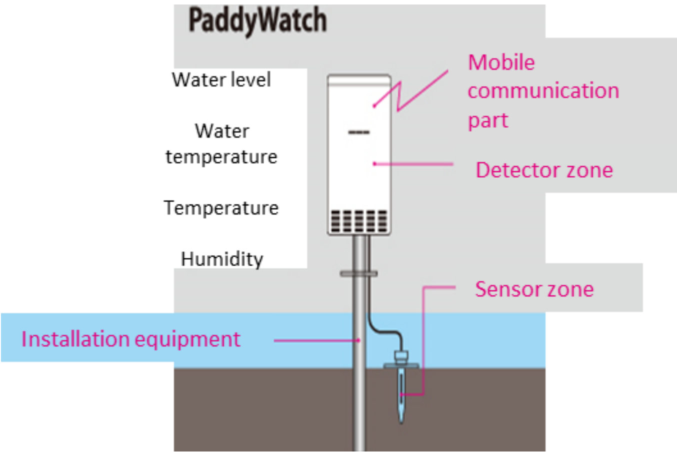
	Many sensors can be used for agricultural purposes, and Seiko Instruments Inc., Sankyo International Corp., and other companies provide temperature sensors.
<Soil moisture sensors> 	**Price: ¥10,000-30,000; In the higher price range, a set of modules is priced at ¥100,000-150,000.** Gadegaon (United States; Gadegaon's sensors are used in almost all tests in Japan) Crossbow (Sumitomo Precision Products Co., Ltd.): ES1101 soil moisture sensors Ondotori (NARO research centers, development) Daiki Rika Kogyo Co., Ltd. Clima-TEQ
<pH sensors, moisturemeters>  <CO2 sensors> 	DKK-Toa Corp.: pH/ORP meters; pH Electrode Series priced at ¥90,000-120,000/150,000 per set Horiba, Ltd.: pH meter D-50 Series (S010 pH sensor: ¥9,000) ("pH and electric conductivity," "pH and ions," "pH and dissolved oxygen") ¥40,000-150,000 including pH electrodes Decagon (Decagon Devices: The product name is Echo Probe EC5 priced at ¥15,000) Hanna Instruments Japan Corp. Sato Keiryoki Mfg Co., Ltd.: Pocket-sized pH meter SK-631PH Shiro Industry Co.: Various pH/moisture meters, EC sensors YY Corp.: Agricultural CO2 sensors (These sensors are used to control agricultural greenhouses and vegetable/fruit storages so that they are maintained in the optimal environment) Sankyo International Corp.: Agricultural CO2 sensor SH-VT250, made in South Korean and priced at ¥100,000 Tsuruga Electric Corp. (SenseAir AB, the largest manufacturer of CO2 sensors): NDIR CO2 sensor Nippo Co., Ltd.: Agricultural CO2 controller NP1011 Tekhne Co., Ltd.: CO2 sensor/transmitter EE82CO2 specializing in agriculture (6) Miyama Giken Co., Ltd.: CO2 sensor module MG-CS (developed jointly with the National Institute of Advanced Industrial Science and Technology and priced at ¥25,000)

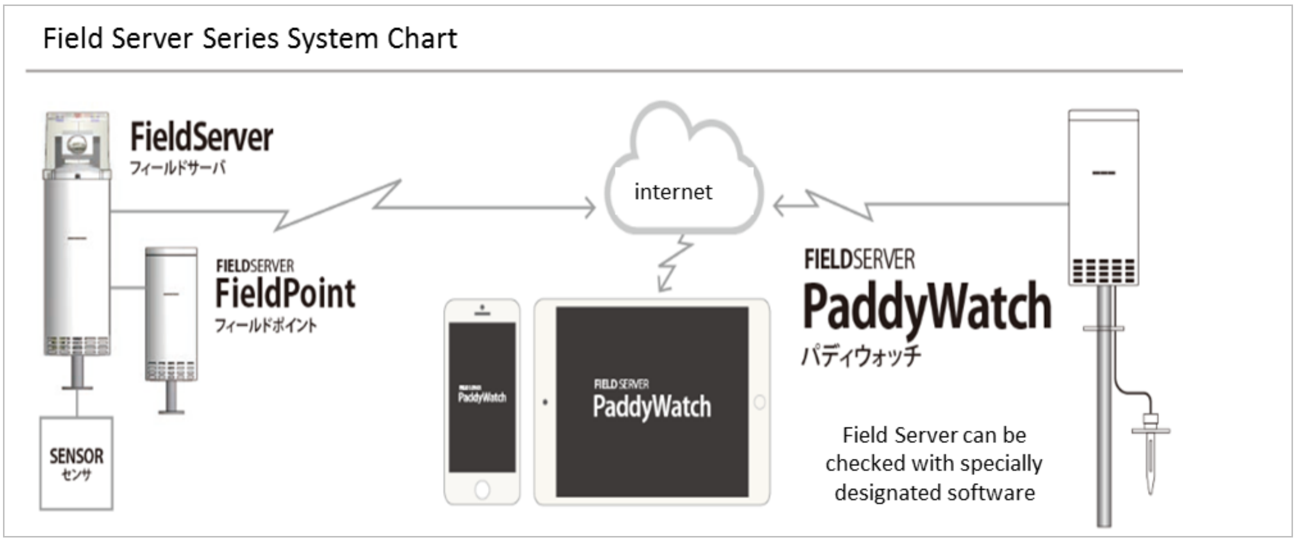
	◇Joint tests with Murata Manufacturing Co., Ltd. and Toda Corp. are conducted for development, and the results of the joint testing will be used for agricultural purposes.
Other Wet leaf sensors	Clima-TEQ and AINEX Co., Ltd. (Decagon Devices Inc.): ¥20,000-30,000 Sumitomo Precision Products Co., Ltd. (Crossbow): Leaf surface wet sensor (¥28,000) Crop navi (produced by Asuzac Inc., Shinshu University, and the Nagano Experimental Station on a trial basis) Developed by the NARO research center (syringe coil type and temperature sensor application type) Flat electrodes (made by Campbell)

Wet leaf sensor

Paddy field sensor







4.2.5 Use of GPS guidance

▸ GPS guidance system: The global positioning system (GPS) was originally developed by the United States for military purposes. In May 2000, the U.S. armed forces authorized use of GPS signals for private purposes, making it possible for private citizens to use them free of charge. GPS has widely permeated various aspects of people's lives as typified by car navigation systems and mobile phones.

- The GPS guidance system receives signals transmitted by GPS satellites that circle the earth through antennas installed on tractors and other agricultural machines, grasps the present location of such machines accurately, and displays it on the monitor for the driver's seat, thus guiding and supporting the autonomous driving of such machines and agricultural work such as fertilizing.
- Using GPS effectively is considered as one of the key technologies to promote precision farming and smart agriculture. The present position of tractors in cultivated land can be confirmed, and agricultural work performed through navigation and guidance, by making the most of signals from the satellite. Agricultural work can efficiently be performed without much duplication by setting routes, and this helps reduce work time and fuel consumption. Benefits include reducing operators' working hours and fatigue.

4.2.5.1 Market overview and trends

- Guidance systems using GPS and similar systems started to spread in Europe and North America around 1998, and in Japan, they began to be introduced about ten years later, in 2007 and 2008. Auto pilot systems, which run straight through route guidance, have been commercially available since 2009, and their introduction is currently under way.
- The number of agricultural GPS guidance systems shipped in Japan in 2014 was 1,080. Among them, GPS guidance systems shipped to Hokkaido accounted for 90.7%, at 980 units. A total of 510 auto pilot systems were shipped, and 480 of them (94.1%) were destined for Hokkaido.
- The cumulative numbers of GPS guidance systems and auto pilot systems shipped during the seven years from 2008 to 2014 were 4,510 (4,100 or 90.1% for Hokkaido) and 960 (890 or 92.7% for Hokkaido), respectively.
- In 2015, the number of GPS guidance systems shipped to Hokkaido was estimated at 1,050, an increase of around 8%, and that of auto pilot systems at over 500, an increase of a little more than 5%.
- In 2014, the market for GPS guidance systems and auto pilot systems was estimated to be worth approximately ¥1 billion (1,590 units) with the average unit system price at ¥650,000.
- Currently, the number of agricultural management entities in Hokkaido is about 40,000. The number is expected to decrease to 30,000 in 2020 and 26,000 in 2025. As the consolidation of agricultural land and the shift to a larger scale of agriculture progress due to the development of stronger, more aggressive agriculture, there will be growing needs for GPS guidance, auto-pilot, and similar systems in the future.
- The market penetration rate for GPS guidance, auto pilot, and similar systems in 2020 is forecast to be 15-17% (6,000 units used by 3,000 management entities).

- In addition, large farmers are expected to increasingly introduce ICT systems to achieve greater efficiency using auto pilot, sensor network, and other systems (such as cultivated land management and effective use of smartphones).

4.2.5.2 Challenges and future prospects

- Complicated, troublesome initial settings: Hokkaido has underdeveloped infrastructure as exemplified by multipath propagation among neighboring farmers, crossed wireless lines and interference, and the small number of base stations. Infrastructure development is under way as budgets are appropriated to aggressive agriculture policy. The satellite system is shifting to one of four quasi-zenith satellites, but there is lack of machines that receive signals from quasi-zenith satellites. How to determine service fees (such as opening satellites to the public free of charge and licensing fees) is also cited as one of the problems.
- One example of development in Honshu is the progress in precision agriculture in regions such as Kyushu. In Hokkaido, systems for more experienced farmers are being introduced, and many of them have an auto pilot system built in it. In Honshu, entry models are coming into wide use. As cooperation with manufacturers of agricultural machinery is progressing, it is expected that development will shift from testing to implementation.

4.2.5.3 Records of introduction/market share

- In addition to five major companies, which provide GPS guidance and auto pilot systems, MSK Farm Machinery Corp., a Mitsubishi affiliate, imports and markets similar systems from Germany’s ND SatCom GmbH. In most cases, manufacturers of agricultural machinery sell these imported systems together with their farm machines and implements (Kubota: KSAS+GPAS).

- The number and value of GPS guidance systems shipped in FY2015 and the cumulative number of such systems that have been delivered since 2010 are available as surveyed by the agricultural policy division of the Hokkaido government.
- The holder of the largest market share is Nikon-Trimble, which has sold 3,110 units (69%). Nikon-Trimble is followed by Geosurf, which has marketed 620 units (13.7%) and Kuroda Noki, which has shipped 530 units (11.8%). If GPAS (manufacturers of agricultural machines and tools such as Kubota) and all other models are included, the market is estimated to have seen the shipment of 5,500 units.
- In the future, GPS guidance is expected to work as an essential system for large-scale agricultural management as the consolidation of agricultural land progresses, and with the development of domestically produced quasi-zenith satellites, the introduction of GPS guidance systems is projected to peak around 2018 and 2019, when high-accuracy positional information can be obtained for 24 hours a day.

4.2.6 Robot utilization in the smart agriculture sector

The utilization projects shown on pp. 21-28 are subsidized by MAFF. The PDF file from p.28 shows surveys by SEED.

MAFF is engaged in various demonstration projects for support and technology development purposes to promote the use and application of robots in agriculture, forestry and fisheries.

The following are some of the R&D projects for robot utilization as well as introduction and demonstration projects for robot technology:

4.2.6.1 R&D for farm strengthening

Title of research project	Name of consortium or research institution
Development of a small weeding robot for steep slopes in hilly and mountainous areas	Small weeding robot development consortium
Wider use and sophistication of wearable farming robot suits	Wearable farming robot suit development group
Development of a precision feed management system using milking robots with the multi-sensing of nutritional physiological functions	Milking robot precision management consortium

4.2.6.2 Robot utilization in agriculture, forestry and fisheries as well as the food industry: priority areas

Title of research project	Name of consortium or research institution
Development of a distributed cooperative harvesting robot system for high-quality shipment of strawberries	Utsunomiya University (the Japan-brand strawberry export strategy consortium)
R&D of an automatic harvesting robot system for head leafy vegetables	R&D consortium for innovative vegetable harvesting robots
R&D of a system for detecting peaches damaged by the peach fruit moth	Yamanashi University / Yamanashi Pref.
Development of a robot for bulb planting/harvesting operations Robotization of bulb planters/harvesters and the development of taking-in/taking out robots	Development committee for tulip bulb net planting machines
R&D of a speed control robot designed to maximize the growth speed with integrated environmental control	The study group on integrated environmental control and greenhouse horticulture
Development of an operation-sharing robot tractor that reflects farmers' experiences	Yanmar Co., Ltd
Development of an automatic tea harvester that will help to cut production costs and expand the production scale	The research consortium for commercializing a tea tree management robot that utilizes ICT

Development of a tomato harvesting robot with a 3D sensor	Panasonic Corporation
Development of sorting robot technology for packaging boxed meals	Musashino Co.,Ltd.
Development of robot technology for arranging food in boxed meals	Musashino Co.,Ltd.
Development of a harvester with the capability of assessing log quality as well as an associated information sharing system	Harvester sophistication joint venture consortium
R&D of a wearable robot suit designed to reduce the workload of afforestation operations	Consortium for researching and developing wearable forestry robot suits
Development of a safe and energy-saving autopilot system for the development of robot fishing boats	Consortium of research institutions for the development of a safe and energy-saving autopilot system for the development of robot fishing boats
Sea bream filleter	Tadashi Machinery Co., Ltd

4.2.6.3 Projects for the development and demonstration of robot technology in agriculture, forestry and fisheries: introduction and demonstration

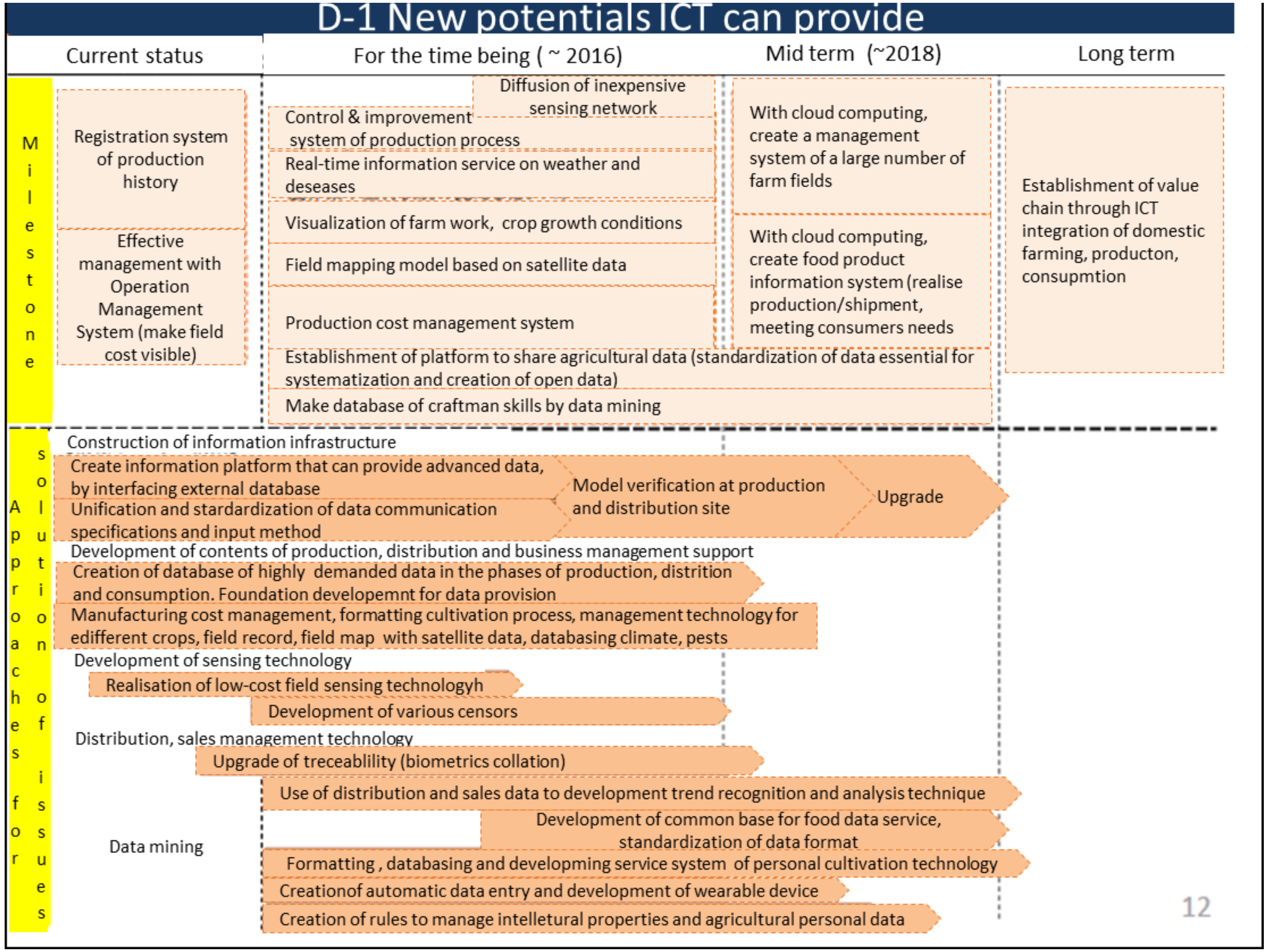
Name of implementing entity	**Specific technology**
GPS supporters' association (Nakasatsunai-mura and Sarabetsu-mura, Hokkaido Pref.)	Tractor autopilot system (for dry field farming; wireless adjustment-based)
Urahoro-cho council for introducing and demonstrating robot technology (Urahoro-cho, Hokkaido Pref.)	Tractor autopilot system (for dry field farming, sweet corn, and feed and forage crops; wireless adjustment-based)
JA Sarabetsu (Sarabetsu-mura, Hokkaido Pref.)	Tractor autopilot system (for dry field farming, Chinese yam, and feed and forage crops; wireless adjustment-based)
JA Shintoku (Shintoku-cho, Hokkaido Pref.)	Tractor autopilot system (for dry field farming; Internet adjustment-based)
ISOPP Corridor PF business entity (Kitami City and Ozora-cho, Hokkaido Pref.)	A tractor autopilot system and yield monitoring combines (for dry field farming; Internet adjustment-based)

JA Tokachi Shimizu (Shimizu-cho, Hokkaido Pref.)	A tractor autopilot system and variable fertilizer distributors (for dry field farming; Internet adjustment-based)
JA Shikaoi (Shikaoi-cho)	A tractor autopilot system and variable fertilizer distributors (for dry field farming and vegetable farming; Internet adjustment-based)
JA Kitamirai (Kitami City, Kunneppu-cho, and Oketo-cho)	A tractor autopilot system and GPS-guided land levers (for dry field farming; wireless adjustment-based)
Kitami GPS study group (Kitami City and Oketo-cho)	A tractor autopilot system, GPS-guided land levers, and variable fertilizer distributors (for dry field farming; Internet adjustment-based)
Tokachi group for promoting dry field farming robot technology (Shihoro-cho)	Robot tractors (for dry field farming, vegetable farming, and feed and forage crops; wireless adjustment-based)
Tokachi consortium for promoting robot tractor technology (Otofuke-cho, Memuro-cho, Obihiro City, and Shimizu-cho)	Robot tractors (for dry field farming and vegetable farming; wireless adjustment-based)
JA-Otofuke (Otofuke-cho)	A tractor autopilot system (for spraying digested slurry over pastures; wireless adjustment-based)
The robot tractor consortium of the Nagasaki prefectural council for demonstrating smart agriculture (Nagasaki Pref. Isahaya City)	Robot tractors (outdoor vegetable farming)
Tobetsu-cho consortium for the robot technology introduction and demonstration project (Tobetsu-cho)	A tractor autopilot system (for paddy farming in large plots for Hokkaido; wireless adjustment-based)
Fukui preternatural council for demonstrating smart agriculture (Fukui City, Sakai City, and Eiheiji-cho)	Robot tractors (for paddy farming in standard plots for Honshu; wireless adjustment-based)
Iwamizawa area consortium for robot technology demonstration (Iwamizawa City)	Robot tractors for paddy farming in large plots for Hokkaido; wireless adjustment-based)
Consortium for demonstrating technology for sophisticated operations for large-scale crop rotation in paddy fields in Kashiwa City, Chiba Prefecture (Kashiwa City, Chiba Pref.)	Robot tractors (for paddy farming in large plots for Honshu; wireless adjustment-based)

Iseki & Co., Ltd., as well as 10 municipalities across Japan (Minamisoma City, Narita City, Niigata City, Kanazawa City, Nishio City, Ryuo-cho, Okayama City, Toon City, Itoshima City, and Satsuma City)	Variable fertilizer-distributors/rice-transplanters equipped with a soil sensor
Toyama prefectural federation of dry persimmon shipment associations (Nanto City)	Full-automatic persimmon peeling robots
Meat production technology research association (Soo City)	Automatic pork leg deboning robot
Athena Inc. (50 locations in many prefectures from Hokkaido to Kagoshima)	Cultivation patrolling robot
Innophys Co., Ltd; Iwaizumi council for demonstrating smart dairy farming (Iwaizumi City and Tanohata-mura)	Air-powered robot suit, dairy farming
Consortium for introducing and demonstrating wearable farming robot suits (13 prefectures: Aomori, Yamagata, Kanagawa, Mie, Wakayama, Okayama, Kagawa, Tokushima, Ehime, Yamaguchi, Tottori, Oita, and Nagasaki)	Motor-powered robot suit (fruit farming and vegetable farming)
Innophys Co., Ltd (Uwajima City, Ehime Pref.)	Air-powered robot suit (fruit farming)
The robot suit consortium of the Nagasaki prefectural council for demonstrating smart agriculture (Sasebo City, Unzen City, and Isahaya City)	Air-powered robot suit (fruit farming and vegetable farming)
JA Ooigawa (Fujieda City)	Robot for automatically distinguishing damaged mandarin oranges
JA Anan (Anan City)	Robot for automatically distinguishing damaged tomatoes
JA Higashiuwa (Seiyo City)	Robot for automatically distinguishing damaged yuzu
Aichi council for environmental control and sophistication for greenhouse horticulture (Toyohashi City, Obu City, and Nishio City)	Environmental control system for greenhouse horticulture (tomatoes and cucumbers)
Kumamoto prefectural council for environmental sophistication for greenhouse	Environmental control system for greenhouse horticulture (tomatoes)

horticulture (Yatsushiro City, Ozu-machi, and Mashiki-machi)	
Consortium of research institutions for high-performance, automatic-running forestry machine	Automatic running forwarder
Consortium of research institutions for precision robots for silvicultural operations	Precision robot for silvicultural operations
QI Inc.	Ship bottom cleaning robot
Consortium of research institutions for demonstrating robots for cleaning the bottoms of water tanks for producing seedlings	Robot for cleaning the bottoms of water tanks for producing seedlings
Consortium of implementing institutions for demonstrating robots for under-water cleaning of tuna farming nets	Robots for under-water cleaning of tuna farming nets
Robot promotion council for robots for agriculture, forestry and fisheries for regional revitalization	Study for commercialization, matching of engineers, analysis of operations, etc.

4.2.6.4 Potentials to be unlocked by ICT (Agricultural ICT milestones identified by the Cabinet Office)



4.2.6.5 IT utilization cases

- In an effort to position agriculture as the sixth industry, since 2012 the Ministry of Agriculture, Forestry and Fisheries has utilized IT, which has enabled increased efficiency and productivity of agriculture, forestry and fisheries industries, revitalization of rural areas, and more. The following are some examples of such efforts.

* Sixth industrialization (primary industries x secondary industries x tertiary industries = 6th industry)

As shown below, IT utilization in agriculture will bring benefits to extensive areas.

Productivity, energy-efficiency and cost-reduction	•Able to address the issues of aging and successor shortage in the farming community and improve crop revenue.
Data Sharing	•Makes skilled farmers' tacit knowledge into explicit knowledge as a foundation for innovation.
Evaluating farming knowledge objectively to covert it into intellectual property.	•By objectively evaluating the tacit knowledge of skilled farmers, such knowledge can be protected as intellectual property. •Such intellectual property will be used defensively or offensively, e.g. for export.
Ensuring the general versatility of farming technologies and fertility management technologies, etc.	•Ensure the general versatility of a technology to be used to promote new farmers. •Contributes to the development of high value-added agriculture in the future.
Ensure the immediacy and simultaneity of data processing.	•Introduction of a POS check out system allows grasping consumer needs. •Such accumulation of POS data and big data are used to support new entrants to agriculture.
Ensure traceability	•Marketing with increased reliability of producer's data, achieving a high added value.
Screening in combination with advanced technology and ingredients analysis.	•Screening with ingredients analysis using a non-destructive sensor achieves high added value and differentiation of produce.

4.2.6.6 IT leveraged operations in FY2012 and FY2013

Prefecture	Project name	Principal running organization	Surveyed FYf
Hokkaido	Precision farming practices	Isopp agri systems Inc.	FY2013
	The POS checkout system, which utilizes two-dimensional barcodes, was adopted at farmer's markets.	Farmers market "Pipamart"	〃
	Established JGAP-ready bookkeeping system for farming management.	Kounousya Inc.	FY2012
	Established a system to reduce chemical fertilizer with variable fertilization management in production of crops such as potatoes.	Techno Farm Ltd.	〃
	Established a wheat harvest support system using satellite remote sensing data.	Shihorocho Agricultural Cooperative Association	〃
	Introduced a GPS control system for tractors.	Nakade farm	〃
Aomori	Increased revenue for fishermen with a traceability system for fresh scallop farming.	Noheji machi Fisheries Cooperatives	FY2013
	Revitalization of a community with farmland management website	Goshogawara Agricultural Forestry High School	〃
	Utilization of a calculation system, which separates sales amount according to producers and ranks of produce during collective sorting.	Nougyo Shien Inc.	〃
Iwate	Increased work efficiency by introduction of milking robots, and data management of individual animals	Matsubara ranch	〃
	Digitaly-controlled soil chemical management for greenhouse production	NCXX Group Inc.	〃
Miyagi	Use of estrus detection system for increased conception rate	Ishikawa Farm	〃

	Developed an automatic-control system for cultivation conditions for greenhouse production of strawberries.	GRA Inc.	〃
	Developed a simple and affordable system for greenhouse production of tomatoes.	Agrifuture Co. Inc.	〃
	Developed a production management system for rice, wheat and soybean production.	Sanbongi Green Services Inc.	〃
	Developed a production history management system for a stable supply in the fruit and vegetable market.	Ishinomaki Seika Co.Inc.	〃
Ibaraki/Saitama	Developed a patrolled information registration system with a cellphone camera and sensor networks for understanding environment data.	Aeon Agri Create Co., Ltd.	FY2012, 2013
Tochigi	Formatted highly-skilled farming technology information for green-house production of tomatoes	Sun Farm Oyama Ltd.	FY2012
Chiba	Farming journal recorded, using a smart phone app.	Kaga orchard	FY2013
	Developed marketing support system, using a tablet.	Lawson Farm Chiba, Inc.	FY2012
Kanagawa	Growing vegetables in dome-shaped greenhouses, using sunlight.	Grandpa Co. Inc.	FY2013
	Collected and analyzed data obtained from greenhouse production of tomatoes.	IDE Tomato Farm	〃
	Studied effectiveness of a sensor network, which allowed the farm to "be seen", and a "remote control" system as an application of the network.	Meiji University Kurokawa Farm	FY2012
Yamanashi	Adopted a labor-saving milk feeding robot	Nakata Ranch	FY2013
	Developed a growth management system using various sensors in grape production	Okunota Budoshu Co., Ltd.	FY2012

	Developed a temperature and humidity control system in sweet corn production	Nishi-Yatsushiro-gun Agricultural Cooperative Association	〃
Nagano	Developed a cloud computing system for remote monitoring for wildlife and pest control.	Kita-Onoueda ward, Siojiri City	FY2012
Shizuoka	Conducted a test to use IC tags for greenhouse production of melons.	Daiwa Computer Co., Ltd.	FY2013
	Conducted a test to use sensors for greenhouse production of melons.	Nagura Melon Farm	FY2012
Niigata	Developed a system which uses aerial maps for farm-land management and cultivation history management.	Souen Farm, Narumi Nousan Agricultural Association Ltd., Ishi Farm	FY2012
Gifu	Introduction of POS checkout system to the farmer's market.	Michi-no-eki "Clair Hirata"	FY2013
Aichi	Introduction of POS checkout system and a sales management system to the farmer's market.	Michi-no-eki "Fudegaki-no-sato Kota"	FY2013
Shiga	Introduction of a POS checkout system and a traceability system to the farmer's market	Biwako dainaka Aisaikan	FY2012
	Developed a farmer training system for rice production.	Fukuhara Farm Co. Inc.	〃
Wakayama	Developed a system to collect and use cultivation records of mandarin orange production to tell proper time of farming.	Sowakajuen Co. Inc.	FY2012
Okayama	Maintenance of forest information by utilizing GIS, robotic sensors, etc.	Maniwa City	FY2013
	Development of a remote monitoring system for dairy farms.	Senoo Ranch	FY2012
Ehime	Conducted practical experiments of production and distribution methods.	Sunrise Farm Saijyo Co., Ltd.	FY2013
	Introduced a POS checkout system and a traceability system to the farmer's market.	Uchiko Fresh Park KaRaRi Co., Lnc.	FY2012

	Developed a system for production management and sales management for vegetable seedlings production.	Berg Earth Co., Ltd.	〃
	Developed a system that links a virtual farm to a real farm.	TELEFARM Inc.	〃
Fukuoka	Accumulated and analyzed data obtained in greenhouse production of tomatoes.	Tominaga orchard	FY2013
	Introduced a new POS checkout system and conducted information sharing to acquire new customers.	Agricultural producers' cooperative corporation Kahho Magohei	〃
	Introduction of POS checkout system to the farmer's market.	JA Fukuoka City	〃
Saga	Branded high-quality teas from outstanding orchards, which were selected from satellite images.	Faculty of Science and Engineering, Saga University	FY2013
Nagasaki	Collection and management of weather data for tea production	Nagata Seicha LLC.	FY2013
	Efficient products management by utilizing email	Saiki Co. Ltd.	〃
Kumamoto	Quality control of melons by a new general purpose optical sensor	Shichijou-machi Tokusanhin (regional produces) Center Co. Inc.	FY2013
	Collected environmental data of greenhouse production (sandponics) of tomatoes	Arena Farm Co., Ltd.	〃
	Development of automatic feeding system for sows	Seven Foods Ltd.	〃
	Developed a customer purchase history system for egg sales	Cocco Farm., Ltd.	FY2012
	Developed a system to automatically control the growing environment for shiso farming.	Aoshiso Farms Co., Inc.	〃
	Developed an environment control system for greenhouse production of tomatoes (farmed in pots).	JR Kyushu Railway Company	〃

Kumamoto	Developed a system to manage farming processes in greenhouse production of tomatoes	Yatsushiro region Agricultural Cooperative Association	FY2012, 2013
Oita	Collected and analyzed data obtained from greenhouse production of tomatoes.	Tomato School	FY2013
	Developed a body temperature monitoring system for cows to prevent accidents during delivery of a calf.	Furusawa Ranch	〃
	Utilized sensors to measure the environmental conditions for greenhouse production of strawberries.	ACT Strawberry farm Co., Inc.	FY2012
	Development of an automatic environment control system for greenhouse production of tomatoes.	Sunny Place Farm Co. Ltd.	〃
Miyazaki	Developed an environment control system, using energy-efficient drapes.	Fukuyama Orchard	FY2013
	Low-cost solar light vegetable factory, utilizing natural energy.	Himuka Yasai Kobo Co., Lnc.	〃
	Knowledge management using sensors on outdoor vegetable cultivation	Shinpukuseika Co., Inc.	〃
	Collected and analyzed data obtained in greenhouse production of miniature tomatoes.	Miyazaki Taiyo Nouen Co. Ltd.	〃
	Development of an auction system using tablets & smart phones.	Miyazaki Chuo Kaki Floriculture Auction Co., Ltd.	〃
	Development of an auction system by sharing harvest information through SNS.	Uomasa Co. Inc.	〃
Kagoshima	Efficient utilization of aquatic resources and fishing by sharing information on fishing grounds.	Kagoshima Prefectural Fisheries Technology and Development Center	FY2013
	Introduced a farming management system to outdoor vegetable production.	Sakaue Co., Ltd.	〃
	A risk aversion system for livestock farming and tea production.	Aozora Agricultural Cooprrative Association	〃

	Collection and analysis of data in tea production	Kagoshima Horiguchi Seicha Co., Ltd.	〃
	Collection of data by using an automatic control device for measuring materials.	Yamasamokuzai Co., Ltd.	〃
	Development of an environment evaluation system for greenhouse production of tomatoes.	Agri Co.Ltd.	〃
Okinawa	Production of high-quality vegetables in a vegetable factory	Gushiken Co., Ltd.	FY2012
	Production of high-value-added vegetables in a vegetable factory	Internationally Local & Company	〃

4.2.6.7 Introduction of IT to agriculture

Numbers are from May of 2016

The chart will help the companies in the Netherlands to determine what systems are to be implemented or migrated, as well as the method to be used.

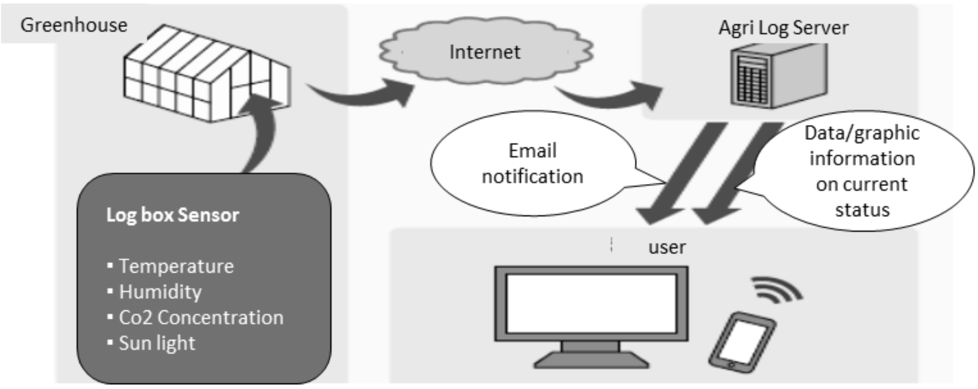
Advancement of agriculture through IT application is a critical policy for the Japanese government. Many companies offer various services; however, as you may see in the examples, very few farmers have introduced the technology.

Agri-log: next-generation greenhouse monitoring

Source: IT kobo-Z Website

Price: 50,000 to 60,000 yen, logging service fee

Sold: around 50 sets

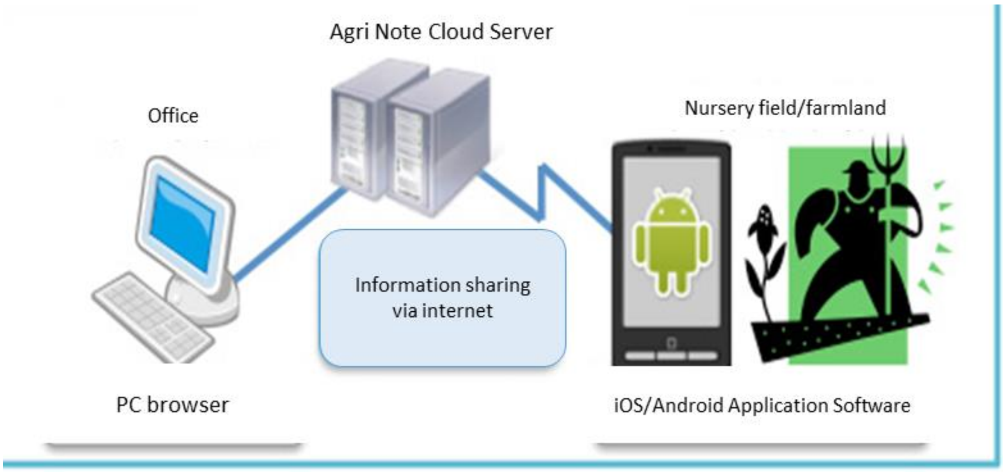


Agri-note: cloud-based agricultural production tool

Source: Water Cell Website

Price: 6,000 Yen / user / year

Sold: 800 to 1,000 ID



e-Kakashi PS solutions Corp.

Price: one system set starts at 749,600 yen

Sensor family: high-humidity sensor, sun-light sensor, soil condition/EC sensor, multi-location temperature sensor

Sold: over 70 sets

The number of applications exceeded 100.

Farm lands management system "OGAL Monitor"

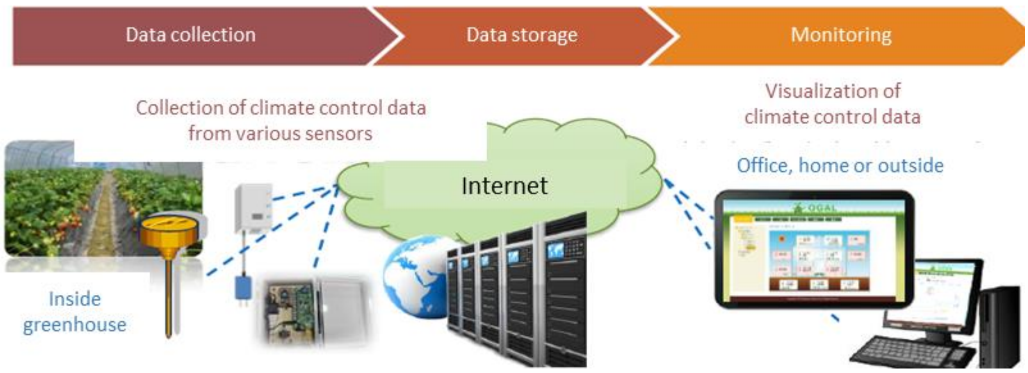
Source: KEYWARE solutions website

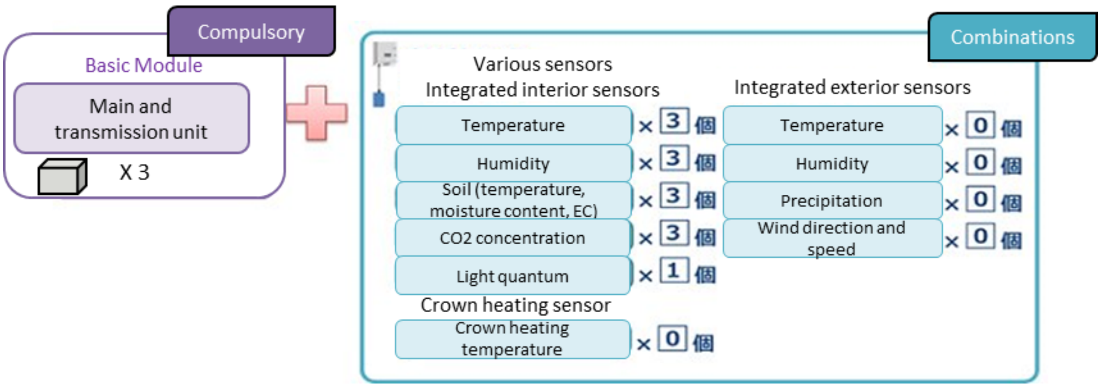
Price: one system set, 2000,000 Yen

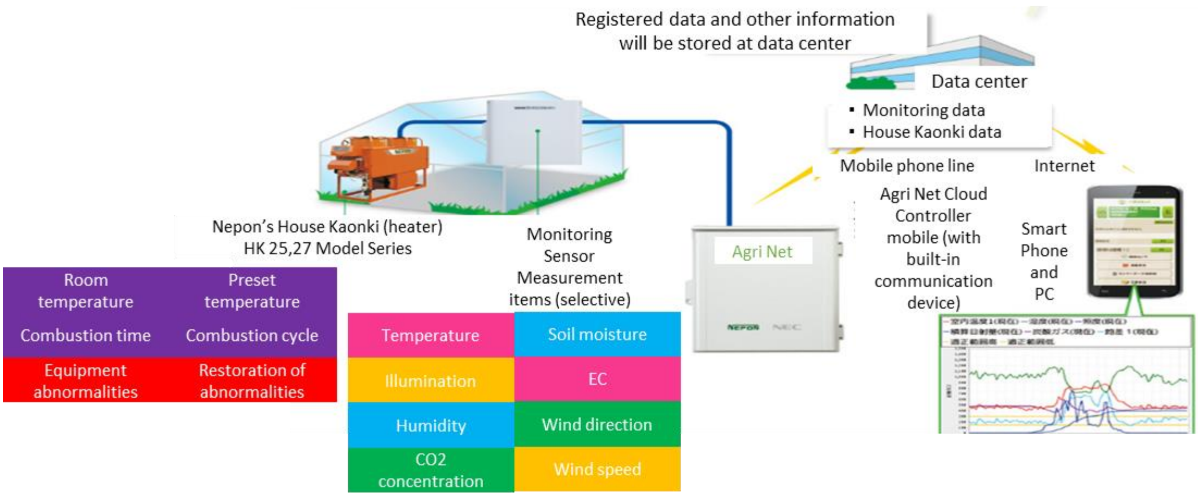
5,000 yen per license/month

Sold: around 20 sets, 100 licenses,

The goal is 100 million yen.







Agrinet, Source: Nepon and NEC

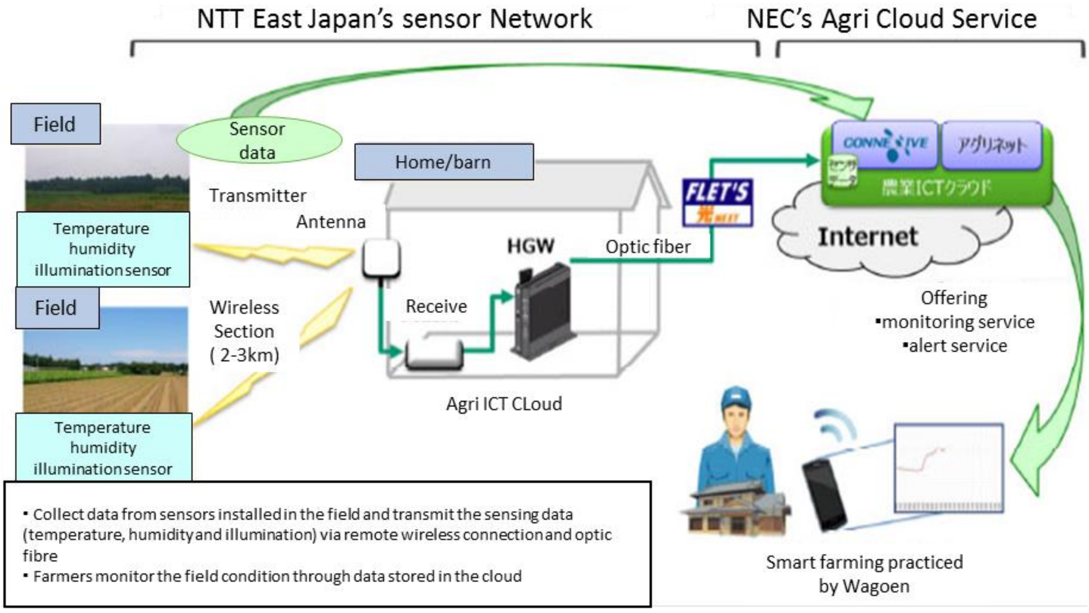
Price: Control box: 1580,000 Yen

Monitoring service: from 2980 yen/month

Sold: 1500 users

NTT East, NEC (agricultural zones, Niigata Prefecture)

Sold: demonstration test in progress



KSAS mobile Source: Kubota website

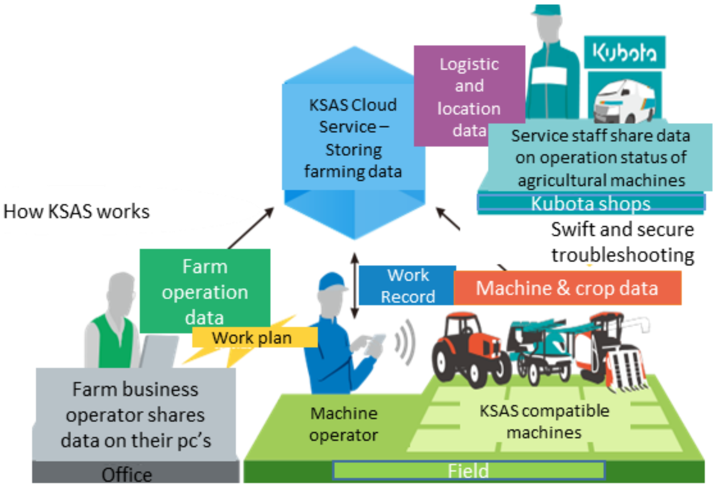
Price: Basic course 3,500 yen/month

Professional course 6,500 yen / month

Additional mobile fee: 83,200 yen

Sold amount: 1000 managing establishments

4000 units of agricultural machinery



GPS Guidance/Autopilot

Source: Nikon Trimble website

Price: one guidance set, 2.5 to 3.0 million yen

Sold amount: total of 4000 units or more

5 Farming sector food innovation (hub): the role of government and public institutions

The National Agriculture and Food Research Organization operates as a government institution and a hub for the agro-food sector. (NARO)[4]

5.1 About NARO

- NARO was established as an "Agricultural Technology Research Organization" in 2001, integrating and streamlining 12 national research institutions. Such institutions were: Agricultural Research Center, Fruit-trees Experimental Station, National Research Institute of Vegetable, Ornamental Plants and Tea, Institute of Animal Health, Livestock Experimental Station, National Grassland Research Institute, Hokkaido National Agricultural Experimental Station, Tohoku National Agricultural Experimental Station, Hokuriku National Agricultural Experiment Station, Chugoku National Agricultural Experiment Station, Shikoku National Agricultural Experiment Station, and Kyushu Agricultural Experimental Station.
- The midterm goal period of phase IV, from 2016 to 2020, has NARO working on 4 priority items and pillars: "1. Production enhancement and strengthening management capabilities", "2. Strong agriculture and creation of new industries", "3. Creation of high-added-value farm products/foods and ensuring safety and reliability", "4. Solutions for environmental problems and capitalization of local resources".
- By striving to meet such midterm goals, NARO would contribute to the resolution of various problems in domestic food, agriculture and rural areas and accomplish building a society which people in Japan hope to live in.

[4] Website: http://www.naro.affrc.go.jp/introduction/profile/index.html

5.1.1.1 Outlines of the organization

- Number of staff in NARO is approximately 3,300 people (in which researchers are approximately 1,900), and its annual budget is 60.9 billion yen (2017).
- The organization has headquarters in Tsukuba Ibaraki prefecture, in addition to many other institutions throughout Japan, including Agri-Food Business Innovation Center, Hokkaido Agricultural Research Center, Northeast Agricultural Research Center, Central Region Agricultural Research Center, Western Region Agricultural Research Center, Kyushu Okinawa Agricultural Research Center, Institute of Fruit-Tree and Tea Science, Institute of Vegetable and Floriculture Science, Institute of Livestock and Grassland, National Institute of Animal Health, Institute of Rural Engineering, Food Research Institute, Institute of Agrobiological Sciences, Institute of Crop Science, Institute of Agricultural Machinery, Institute of Agro-Environmental Sciences, Advanced Analysis Center, Genetic Resources Center, Center for Seeds and Seedlings, and Bio-oriented Technology Research Advancement Institution.

5.1.1.2 Organization/Research sectors/Institutions

Research Centers	
Agri-Food Business Innovation Center	Agri-Food Business Innovation Center conducts R&D, which accommodates needs of the private sector and agricultural corporations, and promotes development licensing and development of advanced methods to create agri-food business opportunities.
Center for Seed and seedlings	Center for Seed and Seedlings conducts cultivation trials pertaining to the registration of plant varieties, inspects seeds of farm produce, and produces and distributes potato and sugar cane seedlings (breeder's seeds).
Bio-oriented Technology Research Advancement Institution	Bio-oriented Technology Research Advancement Institution supports external research groups through the provision of research funding.
Regional agricultural research centers	
Hokkaido Agricultural Research Center	It conducts trials and research for the regions of Hokkaido, such as development of leading large-scale production systems for rice production, field crops production and dairy production, and R&D to accommodate environmental conditions, cool summers and severe winters.
Tohoku Agricultural Research Center	It conducts trials and research to contribute to the agricultural development for the Northeast region's rich natural resources.
Central Region Agricultural Research Center	It strives to address issues faced by farmers in Kanto, Tokai and Hokuriku areas, and performs research and technological development and dissemination to live up to the expectations of the communities.
Western Region Agricultural Research Center	It conducts R&D of technologies in order to solve issues arising due to versatile farming practices in rural areas, and the semi-mountainous and hilly areas which are characteristic of the Kinki, Chugoku and Shikoku regions, as well as revitalize its rural areas.
Kyushu Okinawa Agricultural Research Center	The center conducts trials and research for development of agriculture and farming community that are in harmony with the natural conditions and social conditions of the regions, for an increased overall agricultural production with produce that matches consumer needs and is high quality.
Research Institutions	

Institute of Fruit Tree and Tea Science	Institute of Fruit Tree and Tea conducts tests and technology research, as well as investigation, analysis, appraisal and training in relation to fruit trees and tea industry.
Institute of Vegetable and Floriculture Science	The institute conducts tests and technology research, as well as investigation, analysis, appraisal and training in relation to vegetables and floriculture.
Institute of Livestock and Grassland Science	The institute conducts tests and technology research, as well as investigation, analysis, appraisal and training in relation to livestock and grassland.
National Institute of Animal Health	It conducts: 1. Tests and research on animal health technologies, investigates and examines animal diseases, and researches preventive measures and treatments. 2. Manufacturing and distribution of serum and chemicals designated for livestock and poultry. 3. Analysis of technologies for animal health, appraisal and training.
Institute of Rural Engineering	Institute of Rural Engineering conducts tests and technology research in relation to rural engineering (excluding agricultural machineries), as well as investigation, analysis, appraisal and training.
Food Research Institute	The Food Research Institute conducts: 1. Tests and technology research in relation to food industries, as well as investigation, analysis, appraisal and training. 2. Distribution of processed food and its ingredients which were used for the tests and research, etc.
Institute of Agrobiological Sciences	Institute of Agrobiological Sciences conducts basic investigation and research for the development and application of biological resources to agriculture and its related industries, in addition to analysis, appraisal and training associated with them.
Greater Emphasis Research Center	
Institute of Crop Science	Institute of Crop Sciences conducts tests and technology research for rice, field crops and barley, in addition to investigation, analysis, appraisal and training associated with them.
Institute of Agricultural Machinery	Institute of Agricultural Machinery promotes agricultural mechanization, and conducts testing and research of innovative mechanization technology and work systems, and efficient collecting and utilization of agricultural information.
Institute of Agro-Environmental Sciences	Institute of Agro-Environmental Sciences conducts basic tests and technology research, in addition to investigation, analysis, appraisal and training in relation to agricultural ecosystems.

Research Foundation Organizations	
Advanced Analysis Center	Advanced Analysis Center conducts analysis with advanced analysis equipment, which is required for testing and research associated with agriculture and food industry technologies, and provides support related to this service.
Genetic Resources Center	Genetic Resources Center conducts: 1. Tests, research and investigation for enhancement and applications of agricultural genetic resources, and support related to the services. 2. Operations related to Agricultural biological resources, such as the genebank project 3. Operations associated with foundation stocks of silkworm and scion of Mulberries, and production and distribution of Mulberry seedlings.

NARO conducts R&D concerning food, agriculture and rural development; many researchers from abroad have participated in the projects. Many research departments and centers have collaborative research with private sectors.

Research accomplishments are announced annually at the headquarters. Other events, including such announcements, are planned at various places in Japan. NARO is a place where leading technologies in an agricultural sector are shown, as well as a place that is equipped with hub functions for Japan's agriculture.

6 Agriculture: SWOT analysis of the food industry innovation

SWOT analysis of the current Japanese food industry agriculture is shown below.

IT application in the agriculture sector will lead to the development of new markets. Also, IT-supported production and cultivation management may become a powerful tool for the sector, thus it is an ideal target for the Netherlands to introduce its advanced technologies.

IT, supported by entrants and integration of various industries, is indispensable for building a powerful agriculture. Many opportunities exist for the Netherlands to deploy its know-how.

<table>
<tr><td rowspan="3">Critical Success Factor CSF</td><td rowspan="3">•Principles of customer value creation
Stable food supply, sustainable agriculture
Supplying safe and secure food by IT support
•Principle of core competence
IT information suitable for management maturity
Development of a security management system
•Principles of selections and focuses
Effective use of farmland, development of agricultural human resources
•Principles of optimal resource allocation
Promotion of strategic initiatives for a stable food supply</td><td colspan="2">External environment</td></tr>
<tr><td>Market Opportunities O</td><td>Threat T</td></tr>
<tr><td>•Improvement of food self-sufficiency and food supply stability
• Stronger agriculture and greater value-added agriculture
•Rural revitalization through promotion of interactions between various communities
•Food education to promote consumption of domestic food products</td><td>•Effects of global warming to food production
•Shortage of food supply due to an increase in world population
•Distraction to food safety and security</td></tr>
</table>

Internal environment	Strengths S	• Production of high-quality agricultural products • Japanese food has a good nutritional balance • Worldwide boom in Japanese food	**Expansion and enhancement: OS** • Ensuring and increasing food self-sufficiency for unforeseen situations through land and water development • Development of successors and supporters • Improvement of agricultural technology standards.	**Differentiation strategies TS** • IT-leveraged technological enhancements in production management, sales management, management of production, and logistics tracking • IT-leveraged search and management of intellectual property and rights, etc. for seeds and other products.
	Weaknesses W	• 60% of food is imported • 2.7 times of the domestic agricultural farmlands in foreign countries • • Aging farmers and lack of successors	**Development of new markets OW** • IT to support development of new sales channels for agricultural products • IT to help develop a system to find farming-desiring-retirees to match with farms	**Withdrawal strategy: TW** • Decrease dependence on foreign food (successfully ensure food supply)

Source & reference: summaries and quotes from DBA Onose's thesis

7 Companies entering into the agricultural sector

Agriculture is considered one of the most important new IT strategic measures aimed at by the country. Thus, it has been budgeted abundantly for implementation of agricultural policies and projects.

As a result, companies with IT and IoT technology, such as general electric manufacturers (e.g. Fujitsu, Hitachi, Toshiba, Mitsubishi Electric, and Panasonic), general trading companies with food sectors (e.g. Mitsui & CO., Mitsubishi, Marubeni, Toyota Tsusho), and other heavy electric machineries companies and general contractors (for plant factory construction and operation), are entering into the agricultural sector.

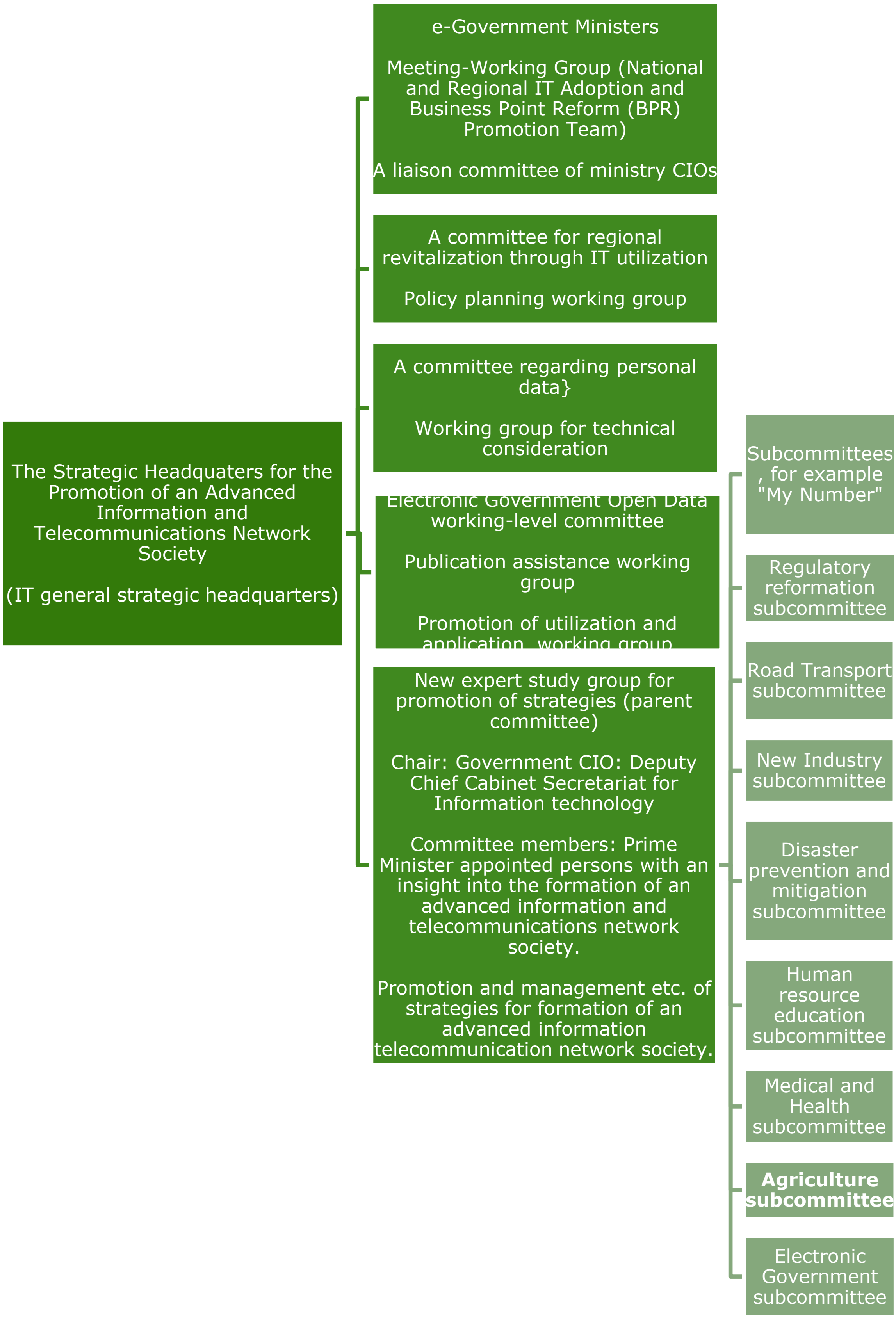
7.1 Positioning of agriculture policies

The "e-Japan" policy, which was adopted by the IT strategy headquarters in 2001, presented a national IT strategy. "Japanese government needs to act comprehensively and practically as soon as possible to achieve a knowledge-emergent society. In such a society, all Japanese people would be able to actively use Information and Telecocmmunications (IT) and receive its maximum benefit." Its goal is to become the world's most advanced IT Nation within five years by constructing an environment where private sectors can fully practice based on market principles. Also, "e-Japan II", which was adopted in 2003, had an additional policy, which said, "It is necessary to promote the usage and application of IT in key areas such as health, finance, education and administrative services".

In June of 2013, a new expert study group for strategy to promote management of the government strategies in order to construct an advanced information and telecommunications network society.

In this new expert study group for promotion of strategies, nine subcommittees (Agriculture Subcommittee) were established.

7.1.1.1 A system of Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society: July 2015



7.1.2 Status of Agriculture Subcommittee

The following is a schedule of the agriculture subcommittee under the IT Strategic Headquarters, in chronological order.

	Dates	The main items
No.1	October, 2013	Declaration to be the World's Most Advanced IT Nation, roadmaps, and corresponding measures Related agencies' main initiatives to utilize IT for agriculture (Ministry of Agriculture, Forestry and Fisheries, Ministry of Economy, Trade and Industry, Ministry of Public Management, Home Affairs, Posts and Telecommunications)
No.2	December, 2013	-Initiatives for the establishment of "Made by Japan", greater efficiency, advancement, and higher quality achieved by IT utilization, and human resources development.
No.3	February, 2014	-A budget proposal for measures corresponding to the roadmaps (agriculture), direction of the agriculture subcommittee, progress on the smart agricultural society, outlines of issues to be addressed, etc.
No.4	March, 2014	-Initiatives for FY 2014 and beyond, strategy for agriculture-related data management and distribution services etc.
No.5	May, 2014	The direction of the strategy to promote distribution of agricultural information, "Declaration to be the World's Most Advanced IT Nation", and proposed revision of "Roadmaps for the Declaration to be the World's Most Advanced IT Nation", etc.
No.6	May, 2014	Creation and distribution assistance strategy of agricultural information aiming to increase international competitiveness, Declaration to be the World's Most Advanced IT Nation, proposed revision of "Roadmaps for Declaration to be the World's Most Advanced IT Nation", etc.
No.7	July 2014	A progress status of "Declaration to be the World's Most Advanced IT Nation" and "roadmaps", review for individual guidelines in consideration of creation and distribution promotion strategy of agricultural information.
No.8	September 2014	Policies of "Declaration to be the World's Most Advanced IT Nation and the roadmaps", individual guidelines for standardization in consideration of creation and distribution promotion strategy of agricultural information.

No.9	December, 2014	Policies of "Declaration to be the World's Most Advanced IT Nation and the roadmaps", progress status of each ministry's measures in FY 2014, creation of guidelines for ensuring functional and portable agricultural information for mutual utilization.
No.10	February, 2015	Creation of guidelines for standardization of agricultural information, holding a committee for regional revitalization, IT utilization, and future reviews at subcommittees
No.11	March, 2015	Creation of standardization roadmaps and guidelines, issues in the agriculture field for regional revitalization etc. A trend survey on patented technology, projects related to the FY2014 roadmaps, and FY2015 roadmaps.
No.12	May 2015	"Proposed revision of Declaration to be the World's Advanced IT Nation and roadmaps"
No.13	March, 2016	A summary of FY 2015 and guidelines to be announced, and the direction of initiatives for FY2016 and beyond.

7.1.3 Declaration to be the World's Advanced IT Nation, agricultural field

Initiatives for realization of the society that Japan should seek to become. Decisions made by the cabinet, June 14th 2017.

In Japanese agriculture, which produces high-quality produce, and the peripheral industries that support agriculture, various types of data, such as advanced knowledge of farmers, will be highly utilized for the measures of "AI (agri-informatics) agriculture." Agriculture will become an intelligent industry by the creation of new business models through such measures, and "Made by Japan Agriculture" will be established through deployment of the business models abroad.

- Realize a society that promotes the creation of new types of innovative industries and services and development of all industries.
- With the use of IT, achieve advancements of Japanese agriculture and peripheral industries, convert them into intelligent industries, and deploy them internationally.

→ Achievement of Made by Japan Agriculture <targets>

- Before FY 2015, develop an environment that will encourage entrants of companies to agriculture and incorporation of agricultural operations, in order to promote new entry into agricultural management, ensure smooth acquisition of successors, and large scale farming.
- Before FY 2016, establish "agri-informatics", a new production system utilizing farming data.
- After 2017, deploy agricultural products, produced using "agri-informatics" etc., and technologies internationally.
- Before 2018, create combined services that include data and know-how, which were acquired through "agri-informatics" etc., with the products to deploy and grow to one of the main sources of the industry’s revenue.
- In FY 2020, Amount of agricultural and marine products exports to exceed 1 trillion yen.

7.1.3.1 Milestones

1 Short term: FY2013 to FY2015

- Establish business models, which utilize farming data (e,g, "agri-informatics"), and transform agriculture into an intelligent industry.
    - Through practical experiments of specific agricultural products and the establishment of new production systems and business models, organize information sharing platforms and measures to utilize intellectual properties. In addition, implement standardization and unified specifications. (Ministry of Agriculture, Forestry and Fisheries, Ministry of Public Management, Home Affairs, Posts and Telecommunications, Ministry of Economy, Trade and Industry)

  - Deploy multi-functional services, such as sales of products accompanied by data and know-how acquired through agri-informatics.（Ministry of Agriculture, Forestry and Fisheries、Ministry of Public Management, Home Affairs, Posts and Telecommunications、Ministry of Economy, Trade and Industry）
  - Develop an environment to encourage companies to enter into agriculture and promote incorporation of agricultural operations (Ministry of agriculture, forestry and fisheries)
- Develop a traceability system, linking farmers to the table.
  - Establish a reviewing organization, which includes public and private sectors, in order to study the current conditions of the traceability system and form a grand design of the system. (Ministry of Agriculture, Forestry and Fisheries, Ministry of Public Management, Home Affairs, Posts and Telecommunications, Ministry of Economy, Trade and Industry)
  - Organize issues found through practical experiments and start standardization and unification of specifications processes (Ministry of agriculture, forestry and fisheries, Ministry of Internal Affairs and communications, Ministry of Economy, Trade and Industry)

2 Mid-term: FY2016 to FY2018

- Establish business models, which utilize farming data, e.g. "agri-informatics", and transform agriculture into an intelligent industry.
  - Organize information sharing platforms and measures to utilize intellectual property through practical experiments of various agricultural products and establishment of new production systems and business models. In addition, implement standardization and unified specifications. (Ministry of Agriculture, Forestry and Fisheries, Ministry of Public Management, Home Affairs, Posts and Telecommunications, Ministry of Economy, Trade and Industry)
  - Develop established business models for general purpose and practical use, and start deployment nationally and internationally. (Ministry of Agriculture, Forestry and Fisheries,

Ministry of Public Management, Home Affairs, Posts and Telecommunications, Ministry of Economy, Trade and Industry)

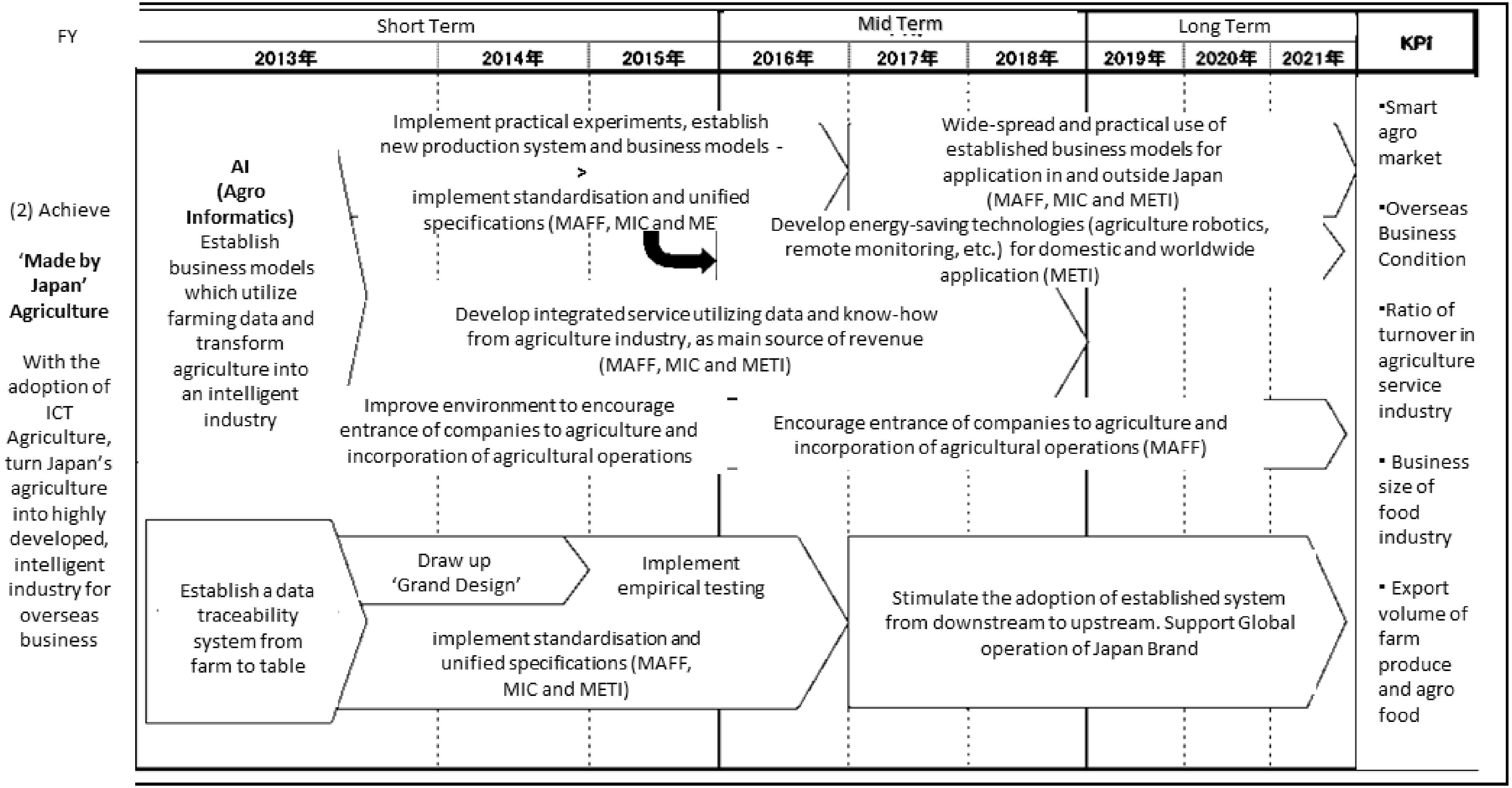
- In the peripheral industries of agriculture, for example agricultural machineries and materials, deploy multi-functional services, such as sales of products accompanied by data and know-how acquired through agri-informatic etc..（Ministry of Agriculture, Forestry and Fisheries、Ministry of Public Management, Home Affairs, Posts and Telecommunications、Ministry of Economy, Trade and Industry ）
- Develop energy-saving technologies for automation of farming and remote-monitoring etc. and deploy such technologies both nationally and internationally. (Ministry of Agriculture, Forestry and Fisheries)
- Encourage entrance of companies to agriculture and the incorporation of agricultural operations, and promote IT utilization in agriculture. (Ministry of Agriculture, Forestry and Fisheries)

- Development of a traceability system, that links farmers to the table.
  - Organize issues found through practical experiments and promote operations for unification of specifications, and implementation of processes and standardization. (Ministry of Agriculture, Forestry and Fisheries, Ministry of Internal Affairs and Communications, Ministry of Economy, Trade and Industry)
  - Promote introduction of a traceability system from farmers to consumers, and use such a system as a standard platform in order to support global development of Japanese-brand agricultural products and food. (Ministry of Agriculture, Forestry and Fisheries, Ministry of Internal Affairs and Communications, Ministry of Economy, Trade and Industry)

3 Long term: FY 2019 to FY2021

- Establish business models, which utilize farming data (e.g. . "agri-informatics"), and transform agriculture into an intelligent industry.
  - Develop established business models for general purpose and practical use, and promote deployment of such business models nationally and internationally. (Ministry of Agriculture, Forestry and Fisheries, Ministry of Public Management, Home Affairs, Posts and Telecommunications, Ministry of Economy, Trade and Industry)
  - Develop energy-saving technologies, such as automation of farming and remote-monitoring, and deploy them both nationally and internationally. (Ministry of Agriculture, Forestry and Fisheries)
  - Encourage entrance of companies to agriculture and the incorporation of agricultural operations, and promote IT utilization in agriculture. (Ministry of Agriculture, Forestry and Fisheries)
- Development of a traceability system, linking farmers to the table.
  - Promote adaptation of a traceability system linking farmers to consumers, and use such a system as a standard platform to support global development of Japanese-brand agricultural products and food. (Ministry of Agriculture, forestry and fisheries, Ministry of Internal Affairs and communications, Ministry of Economy, Trade and Industry)

7.1.3.2 Abstract from the agricultural sector's roadmaps of Declaration to be the World's Advanced IT Nation: a schedule of practices

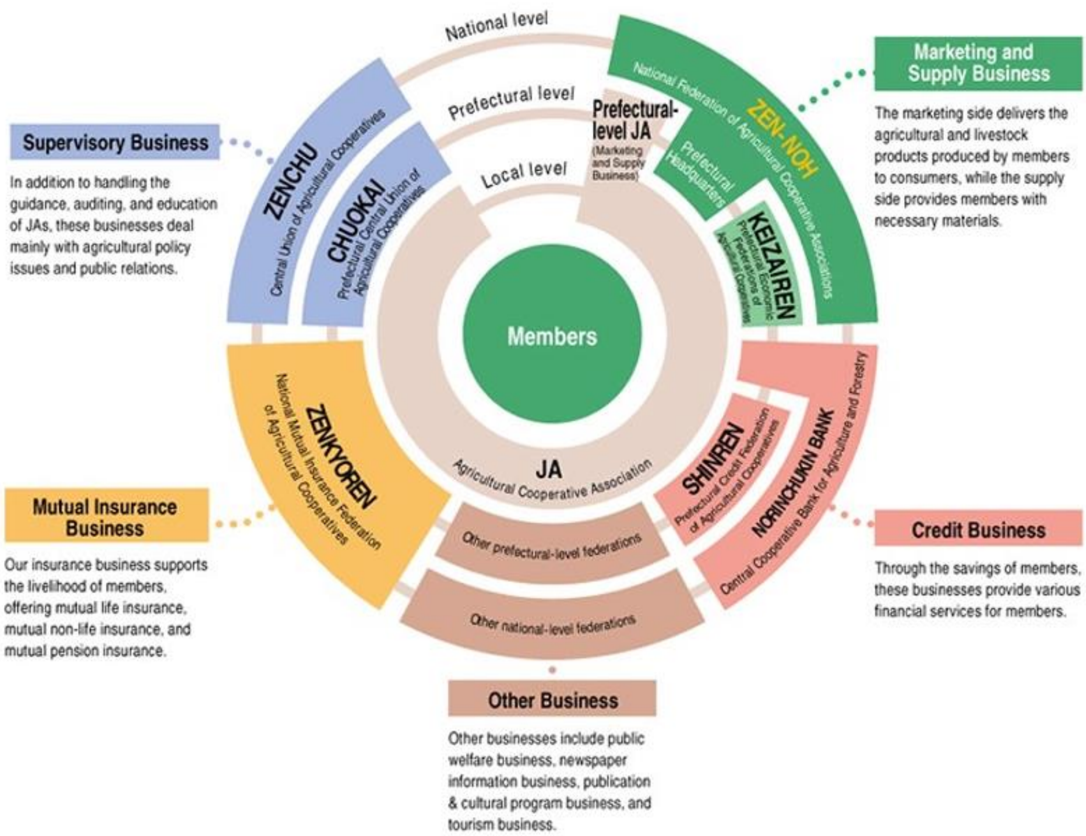


7.2 Position of JA (Japan Agricultural Cooperatives)

7.2.1.1 About JA

JA is a cooperative association, which was organized to protect and improve farming operation and the lives of farmers in the spirit of mutual help, and to build a better society. JA gives farming and life management instruction. It also organizes cooperative purchases of production and household materials and cooperative marketing of agricultural and livestock products. In addition, it offers financial services (accepting savings, loans for agricultural production, and living expenses), shared facilities for agricultural production and living, as well as mutual-aid programs and efforts to prepare for unexpected events. [5]

Organizational Structure of the JA Group



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[5] <JA Group> JA Homepage https://org.ja-group.jp/about/group

JA is organized around 47 municipalities (provinces) nationwide. Each municipal government has an agricultural cooperative association for each level (national, local, prefectural). (Current number of agricultural cooperative associations is 664 / March 2017.) There are 4,560,000 members.

Most farmers ship their products and purchase agricultural machinery and fertilizer through JA.

JA is a powerful organization, with a large mobilization capability. Although it is not as influential as it used to be, it functions as a lobby group against the government.

Therefore, IT companies (Fujitsu, Hitachi, NEC, and agricultural planners, etc.), who are considering offering agricultural cloud services, are including JA headquarters, JAs at the municipality level, and regional JAs in their customer list as their first customers to be introduced to the services.

Also, the agriculture promotion offices of 47 municipalities (such as Farmland Policy Planning Division) allocate budgets given by the government, and provide business assistance services (business consultation and guidance, etc.). Thus, IT corporations count such offices as customers as well.

7.3 Opportunities that foreign companies and knowledge/research institutes can offer

7.3.1.1 Situation of Japanese companies expanding overseas

Currently, there are a few cases found of Japanese companies expanding overseas in the agriculture field. Only a few cases exist, such as Kikkoman, that has ventured into the Food Valley in Netherlands.

7.3.1.2 Present situation of Japan

A concept of "Japanese version of Food Valley" has been developing. It is an R&D foundation created in collaboration of public and private sectors, and using Food Valley in the Netherlands as a reference.

It is in progress along with commercialization research by the private sector and collaboration of research among different fields.

7.3.1.3 Relationship between Japan and the Netherlands

The Netherlands had been a country with a close relationship to Japan for more than 400 years, but, today, the relationship of both countries is not as close as it used to be.

Trends in trade shows that the Netherlands' exports to Japan is 0.8% of the total. As a trading partner of the Netherlands, Japan is almost non-existent. Also as an importing destination, Japan is second to China among Asian countries, but it is still only 2.2% of the total imports.

According to the Ministry of Foreign Affairs of Japan website, Japan and the Netherlands have developed cooperation in the fields of atomic physics, metal materials, agriculture, construction, pharmaceuticals, electronics, etc. And, in 1997, in order to promote cooperation of the two countries, the Japan-Netherlands science and technology cooperation agreement was signed and took effect.

Under this agreement, the first Japan-Netherlands Joint Committee on Cooperation in Science and Technology was held in 1998 in Den Haag, on the day the agreement took effect. By December of 2016, a total of 6 meetings had been held.

The latest meeting was held in November 2015. Both countries exchanged opinions on important news of their science and technology policies, gave reports on themes of: ICT/smart industry (focused on quantum technology and cyber security), agriculture, renewable energy/nuclear fusion, funding and research exchange.

7.3.1.4 Comparison of two cultures

The Netherlands believes that because it is a small country it will "sink without mutual cooperation." On the other hand, Japanese society doesn't have smooth lateral communications. That is a significance difference between the 2 countries.[6]

In particular, the Japanese agricultural sector has a conservative attitude. It’s rare that they require interaction or collaboration with others. For example, there were some incidents where Japanese varieties (Fuji apples and Akihime strawberries etc.) with excellent quality were stolen and cultivated without permission. In response to such incidents, the sector became exclusive in management of the varieties. In comparison, the Netherlands tries to share results where they can, so that risk may be reduced as much as possible. This creates a win-win relationship for both sides.

Also, there are big differences in university systems and management practices. Universities in the Netherlands can benefit from auxiliary income, such as patent income. But, universities in Japan are penalized from profit they make through reduction of operational subsidies from the government. As a result, instead of taking away some funding, universities maintain themselves at the break-even point (a baseline) and academic-industrial collaborative incentives loose their appeal.

In 2016, Ministry of Agriculture, Forestry and Fisheries, being inspired by the Netherlands Food Valley, started a program called "A place for collection and utilization of 'knowledge.' " In December 2016, there are 47 platforms, such as agricultural machinery, plant breeding, and food. They are effective at sharing and exchanging information among the members. Strengths of the Agriculture the Netherlands are that it understands research, market, and consumers very well. But, because it also understands the market it can create a series of processes: what type of research is required, how to offer the research, who to offer the research, etc..

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[6] Source: Trends in science and technology and innovation, Netherlands https://www.jst.go.jp/crds/report/report10/NL20170411.html

This is significantly different from Japan's approach, which has been producer-oriented. However, "A place for collection and utilization of 'knowledge' " program has started, showing a desire to create a new agricultural model. It is a big step forward.

The Netherlands and Japan have a close relationship, however, both countries are very different in history, culture, and society. That means that something functioning well in the Netherlands can't be applied in Japan without any modification. Despite that, when Japan seeks the way to build a sustainable society, the Netherlands may be the country which Japan can model to find its way.

Looking at the previous chapter, it seems the situation is pessimistic. However, there are some entrants and introductions from overseas.

For greenhouse cultivation, an environmental control system, Maximizer (Seiwa Ltd.), by Priva has been introduced.

Although it is an excellent system, it is not suitable for the environment in Japan.

By making this system/device as a benchmark, companies such as Nepon Inc. and Denso Corporation are starting to enter the market with affordable products suitable for the climate and produce in Japan.

More products from the Netherlands will make their way into the Japanese market by understanding the market characteristics and produce that grows in the climate of Japan. As a result, selecting good partners and deeply studying the Japanese climate is necessary.