

Smart Agriculture and Artificial Intelligence Applications: Cases of the Demonstration Project in Japan

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ABSTRACT

Artificial intelligence (AI) is increasingly being integrated into the agri-food sector, offering transformative potential for improving productivity, efficiency, and sustainability in Japan. However, it is unclear how demonstration subsidies for the introduction of AI smart agriculture in Japan are being used and how innovative AI farming technologies are being introduced by farming type. After the smart agriculture subsidies are reviewed, the results of the grant-funded demonstration projects are summarized. Based on the results of the National Agriculture and Food Research Organization (NARO) Smart Agriculture Demonstration Project, the status of AI technology adoption by farming type, as well as technology-specific considerations, is summarized.

Keywords: smart agriculture, Artificial Intelligence (AI), technology, demonstration project, Japan

INTRODUCTION

The integration of artificial intelligence (AI) is driving a major transformation in the agri-food sector, with the promise of enhanced productivity, efficiency, and sustainability. In Japan, AI applications in agriculture are being explored to address challenges, such as labor shortages and the need for sustainable practices. AI is used in precision agriculture to optimize farming operations from cultivation to harvest. This includes the use of data from agricultural machinery to perform optimal operations such as precision fertilization in paddy fields, which reduces fertilizer use and enhances productivity. Japan is advancing toward smart agriculture, which involves integrating digital technologies to improve production efficiency. This includes the development of systems such as the Farming Information Management System (FARMS) and Planning and Management Support software (PMS) to manage farmwork information across multiple fields (Nagasaki, 2019). Research in Japan has focused on intelligent systems for agriculture, including the use of neural networks and genetic algorithms, to optimize plant growth in controlled environments such as hydroponics. Developments in intelligent agricultural robots are being made to assist with various farming tasks, contributing to labor-saving and precise management (Hashimoto *et al.*, 2001).

Several studies discuss Japan's smart agriculture policies, often highlighting the government's efforts to address the country's aging farming population and decreasing labor force through technological innovation. Many of these papers focus on the policies' impact on specific sectors, such as rice farming, and the challenges of implementation. Li *et al.* (2023) provide a comprehensive review of smart agriculture in Japan, with a focus on its application in large-scale rice farming. It discusses government policies and their role in promoting labor-saving, precise management, and disaster reduction. Iba and Lilavanichakul (2023) examine how smart farming technologies are being adopted in Japan's hilly and mountainous regions. It analyzes the business models and government subsidies that support the use of these technologies to prevent farmland abandonment. Nanseki *et al.* (2023) explore the impacts and policy implications of smart farming on rice production in Japan, based on the "Noshonavi1000" research project. They argue that appropriate technologies, rather than just advanced ones, are crucial for agricultural innovation.

Ministry of Agriculture, Forestry and Fisheries (2024) is a government report that outlines Japan's official policy on promoting smart agriculture. It details various initiatives, demonstration projects, and the "Act on Promoting the Active Utilization of Smart Agricultural Technologies." A private research institution offers recommendations for improving the deployment of smart agriculture in Japan. It emphasizes the importance of scaling up farm sizes to make the adoption of smart technologies more economically viable (Mitsubishi Research Institute, Inc., 2025).

In these previous studies, it is unclear how demonstration subsidies for the introduction of AI smart agriculture in Japan are being used and how innovative AI farming technologies are being introduced by farming type. This study organizes smart agriculture-related subsidies and summarizes the status of AI smart agriculture technology adoption based on the results of demonstration projects.

METHODOLOGY

This study surveys the status of smart agriculture in Japan based on literature and data published on websites by ministries and agencies. First, an overview of the grants is provided, and the results of the grant-funded demonstration projects and future challenges are summarized. Based on the results of the *National Agriculture and Food Research Organization (NARO)* Smart Agriculture Demonstration Project, the status of AI technology adoption by farming time and technology-specific considerations is summarized.

SUBSIDIES FOR AI UTILIZATION IN AGRICULTURE IN JAPAN

Japan offers various government and municipal subsidy programs designed to encourage productivity improvement, labor saving, and the adoption of smart agriculture with artificial intelligence in the agricultural sector (Table 1).

Table 1. Subsidies related to smart agriculture

Classification	Smart Agriculture Acceleration Demonstration Project	Strong Agriculture Promotion Grant	"Monozukuri" Subsidy
Ministry	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Ministry of Economy, Trade and Industry (METI)
Aim	To conduct demonstrations of smart agriculture utilizing advanced technologies such as robots, AI, and IoT, to clarify the management effects of technology adoption, and to accelerate social implementation.	To support the establishment of advanced agricultural management and the development of regional agricultural leaders based on "Strong Agriculture Promotion Plans" created by prefectures.	To support capital investments, etc., by small and medium-sized enterprises (SMEs) and small-scale businesses for developing innovative services, prototypes, or improving production processes that contribute to productivity improvement.
Eligible Applicants	Farmers, agricultural corporations, etc.	Farmers, agricultural corporations, agricultural cooperatives, local governments, etc.	SMEs and small-scale businesses, etc.
Budget Size	Several billion yen.	Several hundred billion yen.	Several hundred billion yen.

Source: Created by the author based on information on the MAFF and METI website.

One significant national subsidy is the Smart Agriculture Acceleration Demonstration Project, promoted by

the Ministry of Agriculture, Forestry, and Fisheries. This project demonstrates smart agricultural practices that utilize advanced technologies, including robots, AI, and the Internet of Things (IoT). It aims to clarify the management benefits of adopting these technologies and accelerate their implementation in society. Within demonstration areas, subsidies may be available for the introduction of machinery and the construction of systems. Eligible applicants are farmers, agricultural corporations, and others who are willing to introduce smart agricultural machinery and construct systems. Budgets vary depending on the fiscal year. Based on the scale of previous related projects, the overall budget is likely to be several billion yen. The specific subsidy amounts for individual demonstration projects varied.

Another significant national subsidy is the Strong Agriculture Promotion Grant. This grant supports the establishment of advanced agricultural management practices and the development of regional farm leaders based on “Strong Agriculture Promotion Plans” formulated by the prefectures. The introduction of smart agricultural technologies is also eligible for support under this grant.

Furthermore, the “Monozukuri” Subsidy, officially known as the Small and Medium Enterprise Productivity Revolution Promotion Project Subsidy, supports the productivity improvement efforts of small and medium-sized enterprises and small-scale businesses, and agricultural corporations are also eligible to apply. This subsidy can include the introduction of AI-powered smart agricultural machinery and systems.

The objectives listed in the Table 1 indicate that the Smart Agriculture Acceleration Demonstration Project is the most direct and powerful subsidy for promoting smart agriculture in Japan. The next section summarizes the status of smart agriculture technology adoption in Japan, based on information from the Smart Agriculture Acceleration Demonstration Project’s results portal.

TECHNOLOGY IMPLEMENTATION IN DEMONSTRATION PROJECTS

Smart agriculture technology overview

The NARO Smart Agriculture Demonstration Project is a project to demonstrate “smart agriculture” using advanced technologies such as robots, AI, and IoT, and to accelerate the social implementation of smart agriculture. The objective of the project is to introduce smart farming technologies to production sites, conduct technological demonstrations, and clarify the effects of introducing these technologies on management. The project began in FY2020, and over the past five years, demonstrations have been conducted in 217 districts of Japan. The status of technology introduction is summarized based on data posted on NARO’s Smart Agriculture Results Portal website.

Table 2 provides an overview of the key Smart Agricultural Technologies adopted by farmers in the demonstration project, which are categorized into Machines and Systems. These technologies aim to enhance efficiency, reduce the labor burden, and improve farm management through automation and data analysis.

The “Machine” category includes several pieces of heavy machinery and assistive devices focused on automating physical farm tasks. Autonomous tractors and rice transplanters are designed to navigate fields and set routes automatically, whereas the combine harvester automates the entire harvesting process. Brush cutters can be controlled remotely for maintenance purposes. In terms of specialized tasks, drones are utilized for fertilizer and pesticide spraying. To address the physical demands of farming, power-assist suits are available as assistive devices to reduce the burden on workers. Furthermore, harvesting/transportation robots automate the complex processes of crop collection and movement. Automatic feeders and fully automated milking machines are used for livestock management. The price ranges for these machines vary significantly, with heavy equipment, such as the combine harvester, which is the most expensive (JPY11 to 18.5 million, US\$70,732-118,958), and power-assist suits being the most accessible¹.

The “System” category focuses on digital solutions and data-driven management. Water management systems utilize sensors for the automatic measurement of critical parameters such as water level and temperature, with prices ranging from free to JPY0.75 million (US\$0 - 4,822). Farm and crop management systems provide centralized platforms for managing farm data, production records, and environmental information. Predictive and operational control systems are crucial. The yield/shipment prediction system uses historical data to forecast harvests. For precision driving, the automatic steering system offers automatic control of the steering wheel and allows driving along a predetermined route. Variable-rate fertilization systems optimize resource use by adjusting

¹ Using the exchange rate of JPY 1 = US\$0.00643 for November 18, 2025.

the fertilizer application based on real-time growth data. Finally, the individual action monitoring system is an advanced tool for livestock farming designed to record and manage the behavior and health status of individual animals.

Table 2. Overview of smart agricultural technologies

Category	Feature	Price range
Machine		
Autonomous tractor	Tractors that travel automatically in the field.	JPY10-15 million (US\$ 64,297- 96,445)
Rice transplanter	Rice transplanters that automatically travel along a set route.	JPY3.0 - 5.5 million (US\$ 19,292-35,370)
Combine harvester	Combines that automatically perform harvesting operations.	JPY11.0 -18.5 million (US\$ 70,732-118,958)
Brush cutter	Brush cutters that can be remotely controlled.	-
Drone fertilizer/pesticide spraying	Drones carrying fertilizers and pesticides.	JPY0.8 to 3.0 million (US\$ 5,144 -19,291)
Power-assist suit	Assistive devices to reduce the burden on their backs.	JPY0.025 to 1.5 million (US\$160 - 9,645)
Harvesting/transportation robot	Robots automate the harvesting and the transportation.	-
Automatic feeder	Automatic feeding of livestock feed	-
Milking machine	Automation of the entire milking process	-
System		
Water management system	Automatic measurement of water level, temperature, etc. with sensors.	Free - JPY0.75 million (US\$ 0 - 4,822)
Farm management system	Centralized data management for farm management.	-
Crop management system	Records and manages production and environmental data,	-
Yield/shipment prediction system	System to predict harvest based on past data.	-
Automatic steering system	Automatic control of steering wheel and driving on a set route.	JPY0.4 to 2.5 million (US\$2,572 -16,075)
Variable-rate fertilization system	Adjust the amount of fertilizer applied based on growth data.	-
Individual action monitor system	Record and manage the behavior and health of individual animals	-

Source: Created by the author based on website on the Smart Agriculture Results Portal and Smart Agriculture Promotion Forum 2020.

Adopted technology for each crop sector

Table 3 presents a breakdown of the number of farms that have adopted various smart agricultural technologies, categorized by farming type. The data show distinct patterns of technology adoption across different sectors.

The most widely adopted technologies for rice farming included autonomous tractors (28 farms), drones for fertilizer/pesticide spraying (25 farms), and rice transplanters (22 farms). This suggests a strong focus on the mechanization and automation of key tasks in rice cultivation. Similar to rice farming, field crops utilize large tracts of farmland, confirming the trend toward the adoption of tractors, drones, and other technologies.

Autonomous tractors (22 farms) and drone spraying (18 farms) are widespread in the vegetable farming sector. However, technologies for data management and automation, such as yield/shipment prediction systems (7 farms) and harvesting/transportation robots (5 farms), also show significant adoption. This indicates interest in technologies that optimize production and logistics. Although there were only 6 demonstration farms in the floriculture sector, they showed great interest in farm management systems, crop management systems, and vegetable farming. Horticulture stands out, with a high number of farms using farm management systems (17 farms) and power-assist suits (5 farms), suggesting a need for detailed oversight and physical assistance in these labor-intensive operations. Similar trends are observed in fruit and tea cultivation, although the number of demonstration farms is small.

Technologies related to livestock farming are highly specialized, with the most common being individual action surveillance (10 farms), automatic feeders (4 farms), and milking machines (4 farms). These technologies focus on monitoring, feeding, and milking, thus reflecting the unique demands of this sector.

Overall, the table highlights that technology adoption is not uniform across farming types. Technologies such as autonomous tractors and drone spraying are broadly applicable, whereas others, such as milking machines and rice transplanters, are specific to farming systems.

Table 3. Introduced technologies by farming type

Farming System	Farming Type							
	Rice	Field crop	Vegetables	Floriculture	Horticulture	Fruit	Tea	Livestock
Autonomous tractor	28	11	22	0	0	0	0	0
Rice transplanter	22	2	0	0	0	0	0	0
Combine harvester	14	4	1	0	0	0	0	0
Brush cutter	10	2	9	0	2	4	0	0
Drone	25	18	18	0	0	9	2	1
fertilizer/pesticide spraying								
Power-assist suit	1	0	4	0	3	5	0	0
Harvesting/transportation robot	0	0	5	1	6	4	0	1
Automatic feeder	0	0	0	0	0	0	0	4
Milking machine	0	0	0	0	0	0	0	4
Water management system	20	2	5	1	3	6	0	0
Farm management system	5	14	9	3	17	11	1	3
Crop management system	0	1	4	3	6	4	1	2
Yield/shipment prediction system	0	1	7	1	7	4	1	1
Automatic steering system	6	0	0	0	0	0	0	0
Variable-rate fertilization system	15	2	5	0	0	0	0	0
Individual action monitor system	0	0	0	0	0	0	0	10
No. of farms	47	25	42	6	28	22	3	13

Source: Created by the author based on information on the NARO Smart Agriculture Results Portal.

Impacts and considerations of smart agricultural technologies

Table 4 outlines the impact of the introduction of smart agricultural technologies adopted by farmers in the demonstration project, along with notes and considerations pointed out by the farmers for their effective implementation. These technologies generally lead to reduced work time and improved efficiency, although each presents unique challenges.

The introduction of smart agricultural machinery primarily focuses on reducing work time. This is the stated impact for the autonomous tractor, rice transplanter, combine harvester, and brush cutter. For the autonomous tractor, the efficiency gains, specifically reduced plowing and furrowing times, are found to be more effective in large fields. The combine harvester is less effective in narrow plots. Specialized machines offer targeted benefits. Drone fertilizer/pesticide spraying enables spraying in areas that would otherwise be inaccessible. However, this requires permission and reporting for legal and safety compliance. The power-assist suit provides a direct physical benefit by reducing strain on the lower back; however, its use is restricted to limited applications. Harvesting/transportation robots reduce the associated work time but require farmers to improve their pathways in the field. Automatic feeders not only reduce work time but also enable the early detection of diseases in

livestock. Milking machines reduce the associated work time.

Smart agricultural systems focus on optimization, control, and data management. Water management systems reduce the need for constant human oversight, resulting in reduced patrol times and improved irrigation control. However, this requires attention to the monthly costs and signal conditions. Management systems drive operational efficiency. Farm management systems are designed to enhance the efficiency of production and operations, whereas crop management systems facilitate efficient record-keeping and information sharing. However, both systems require compatibility with the machinery to function optimally. The other systems address specific operational requirements. Data-driven systems offer sophisticated advantages. The yield/shipment prediction system allows for the optimization of harvesting staffing, but it requires frequent drone photography to gather the necessary data. The automatic steering system achieves a reduced working time, but its performance depends on the farmer checking the GNSS reception status. The variable-rate fertilization system delivers fertilizer uniformity and increases yield, although the fertilization costs require attention. Finally, the individual action monitoring system reduces the work time and provides the added benefit of less stress for cows.

Table 4. Impacts of smart agricultural technologies

Type and Results	Impacts of Introduction	Note
Autonomous tractor	Reduced plowing and furrowing time.	More effective in large fields.
Rice transplanter	Reduced work time.	Sufficient line length needed.
Combine harvester	Reduced work time.	Not effectively used in narrow plots
Brush cutter	Reduced work time.	Heavy and large, difficult to transport.
Drone fertilizer/pesticide spraying	Spraying in areas that are inaccessible.	Requires permission and reporting.
Power-assist suit	Reduced strain on the lower back.	Limited applicable work.
Harvesting/transportation robot	Reduced harvesting and transportation time.	Need to improve pathways in the field.
Automatic feeder	Early detection of disease, reduced work time.	-
Milking machine	Reduced work time.	-
Water management system	Reduced patrol time, fine irrigation control,	Need mostly costs, signal conditions.
Farm management system	Improve efficiency of production and operation.	Need compatibility with machineries.
Crop management system	Efficient bookkeeping and information sharing,	Need compatibility with machineries.
Yield/shipment prediction system	Optimization of harvesting staffing.	Requires frequent drone photography.
Automatic steering system	Reduced work time.	Need to check GNSS reception status.
Variable-rate fertilization system	Fertilizer uniformity and increased yields	Fertilization costs need attention.
Individual action monitor system	Reduced work time., less stress for cows.	-

Source: Created by the author based on information on the NARO Smart Agriculture Results Portal.

AI applications in the impact of smart agricultural technologies

AI plays a crucial role in achieving many of the effects described in the table, primarily by enabling prediction, optimized control, and automated decision-making. Although Table 4 lists the direct effects, AI is the underlying technology that drives the efficiency of several systems.

AI algorithms, particularly Machine Learning (ML), are central to the following systems: AI models are trained on historical yield data, weather patterns, soil conditions, and past growth data (often collected via drones) to forecast future harvest size and quality. Deep learning enables the optimization of harvesting staffing and logistics with greater accuracy than traditional methods. Variable-rate fertilization systems utilize AI to analyze large datasets, including drone imagery, soil sensor data, and crop growth models, to determine the precise amount

of fertilizer required for different zones within a field. Data-driven decision-making directly leads to fertilizer uniformity and increased yield. For example, producers in the JA Nishimikawa Cucumber Division in Aichi Prefecture who participated in the demonstration project introduced the environmental monitoring system "AgriLog," enabling all division members to share facility environmental data and visualize parameters such as temperature, humidity, and carbon dioxide concentration. As a result, the acquisition of environmental data and plant physiological data (e.g., from photosynthesis chambers), the creation and utilization of a user interface, and improvements to the integrated environmental controller program optimized for cucumber cultivation led to the adoption of hydroponic cultivation. This increased yield per unit area by approximately 44%. In hydroponic soil cultivation, utilizing hydroponic data and environmental/plant physiological information data increased yields by approximately 14%. Furthermore, introducing hydroponics reduced labor time for tasks like soil preparation. Program improvements to the integrated environmental control unit enabled automation, and analyzing labor data allowed for appropriate staffing, resulting in a reduction of approximately 11.2% in labor hours per ton of yield.

AI excels at processing continuous streams of sensor data for anomaly detection. With automatic feeders for livestock, AI-powered computer vision and motion sensors monitor animal behavior and feeding patterns. AI can detect changes in consumption or activity to provide early detection of the disease before visible symptoms appear, far surpassing what the human eye can detect. An individual action monitoring system uses AI (often computer vision or sophisticated sensor fusion) to analyze the movement and posture of individual animals. AI identifies behaviors indicative of health, fertility, and stress, enabling proactive management that leads to reduced work time and less stress for cows. For example, at Toyonishi Farm in Hokkaido, a demonstration of low-cost individual monitoring using IoT technologies, such as animal sensing, was conducted. After introducing Farmnote Color to some of the fattening cattle at the demonstration farm, the difficulty standing detection function rescued three cows, and the number of deaths due to difficulty standing decreased compared to before the introduction. Furthermore, using a handheld RFID reader/app reduced the time required for headcount verification within the farm by 36% compared to conventional methods.

Regarding precision control and navigation, AI algorithms are key to the autonomous operation of machinery. While basic automated steering uses GPS, advanced autonomous systems employ AI for path planning, obstacle avoidance, and real-time navigation adjustment. This AI processing of sensor input allows for the precise execution of tasks, leading to reduced plowing and furrowing times and overall reduced work time. AI can integrate meteorological forecasts with sensor data to make real-time decisions regarding the timing and volume of irrigation. This optimizes water use beyond a simple threshold, leading to fine irrigation control and conservation. For example, regarding autonomous tractors, table 5 presents results from a Smart Agriculture Demonstration Project, comparing operational efficiency between conventional practices and smart agricultural machinery across diverse location conditions. The data compares the required operational input (time or cost per unit area) for specific tasks, primarily tillage and puddling. Efficiency gains were observed across all trials, ranging from 20% to 49%. The 32% reduction in mean rate demonstrates the substantial potential of smart farming technologies to optimize agricultural operations.

Table 5. Efficiency in autonomous tractors

Location Condition	Region	Conventional Practice	Smart Ag Machinery	Reduction Rate	Remarks
Flatland	Hokuriku	0.37	0.23	38%	Tillage (2-machine cooperation)
Flatland	Tōkai	0.60	0.48	20%	Tillage (2-machine cooperation)
Hilly/Mountainous	Kantō	0.46	0.28	39%	Tillage (2-machine cooperation)
Hilly/Mountainous	Chūgoku	0.46	0.34	28%	Tillage (2-machine cooperation)
Hilly/Mountainous	Kantō	2.85	2.29	20%	Puddling/Harrowing (2-machine cooperation)
Hilly/Mountainous	Shikoku	2.69	1.38	49%	Puddling (Rough/First: 2-machine cooperation, Main/Final: Straight-line assist)
Average				32%	

Source: Compiled by the author based on the table from the Smart Agriculture Results Portal.

CONCLUSION

This study provides an overview of subsidies and the results of demonstration projects to organize the status of smart agriculture and the adoption of AI technology in Japan. It was confirmed that AI-based technologies have been introduced on a trial basis through smart farming subsidies in a manner appropriate to the characteristics of the crop; however, there are issues such as the cost of introduction and improvement of operator capacity in operating the system.

In summary, AI applications in Japan's agri-industry focus on enhancing precision agriculture, developing intelligent systems and robotics, and addressing the challenges related to data integration. These efforts are supported by government policies aimed at achieving sustainable agricultural practices.

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