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Title: Dr.

First Name: Eiji

Last Name: Morimoto

Position: Associate Professor

Organization: Graduate School of Agriculture and Science, Kobe University

Country: Japan



Brief career highlights (less than 250 words):

Dr. Morimoto serves as the Japan Representative for the International Society of Precision Agriculture (ISPA). After obtaining his Ph.D. in Agriculture from Kyoto University in 2003, he has passionately dedicated over 25 years to research and development in the field of precision agriculture, specifically focusing on rice paddy cultivation, a foundational crop for Japan. His long-term research has culminated in the successful commercialization of innovative technologies, such as rice transplanters equipped with real-time soil sensors and variable-rate fertilization systems that automatically adjust fertilizer application based on crop needs. These advanced technologies are seeing increased adoption not only within Japan but are also spreading to other Asian countries. Currently, leveraging his expertise, Dr. Morimoto is also actively engaged in developing smart agriculture technologies for upland field crops, horticulture, and fruit cultivation, contributing to the sustainable development of Japan's agricultural sector as a whole.

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ADOPTION OF PRECISION AGRICULTURE IN JAPAN

Eiji Morimoto^{1*}

¹ Graduate School of Agriculture Science, Kobe University, Japan.

*Corresponding Author: morimoto@gold.kobe-u.ac.jp

ABSTRACT

Japan is a country facing global challenges in terms of a declining and aging agricultural population, making the establishment of a sustainable production system a matter of urgency from the perspective of food security. While respecting Japan's traditional knowledge, the author believes that precision agriculture is an effective solution to resolve this situation. We argue that data-driven agriculture presents a higher degree of affinity with Japanese farmers, providing a more viable pathway toward widespread implementation. This study investigates the foundational principles of precision agriculture, evaluates various data-driven methodologies, and proposes strategies for fostering sustainable agricultural practices."

INTRODUCTION

Japanese agriculture faces severe structural challenges, including labor shortages and difficulties in skill transfer. In 2020, **70 %** of core agricultural workers were aged **65 or older**, while only **11 %** were **49 or younger**.⁽¹⁾ Furthermore, Japan's food self-sufficiency rate (calorie-based) was **38 %** in 2023, highlighting an urgent need for productivity improvement. Precision agriculture aims to enhance productivity and efficiency and ensure long-term sustainability through the utilization of data analysis and sensors. Precision agriculture aims to increase productivity and efficiency and ensure long-term sustainability through the use of data analysis and sensors. This paper argues that data-driven agriculture has a higher affinity with Japanese farmers and offers a more realistic path to widespread adoption. While the concept of precision agriculture was introduced in Japan in the early 2000s by Professor Shibusawa, various challenges emerged. One reason was the perception that meticulous management was already being carried out through Japan's experience-based farming methods. It took a long time to introduce the concept of community-based variability management. This historical context serves as the foundation for the high affinity of data-driven agriculture. This study aims to clarify the state of precision agriculture adoption in Japan and the underlying issues behind it.

MATERIAL AND METHOD

This research is based on a comprehensive review of statistical data, survey reports, policy documents, and related case studies published by the Ministry of Agriculture, Forestry and Fisheries (MAFF). Specifically, data were collected from MAFF's "Census of Agriculture and Forestry"⁽¹⁾, "Survey on Agricultural Structure Dynamics"⁽²⁾, "Food Self-Sufficiency Rate and Food Self-Sufficiency Capacity Indicators"⁽³⁾, "Current Status of Smart Agriculture"⁽⁴⁾, "Agricultural Business Conditions Survey"⁽⁵⁾, "Institutionalization of Public Road Travel for Agricultural Robots"⁽⁶⁾, and "Specific Initiatives for the Social Implementation of Smart Agriculture".⁽⁷⁾ This methodology integrated these statistical data to quantitatively analyze the challenges facing Japanese agriculture, the status of smart agriculture adoption, expected effects, and barriers to dissemination. Particular attention was paid to comparing data-driven agriculture and highly mechanized technologies from the perspectives of farmer acceptance and practicality.

RESULTS AND DISCUSSION

The adoption rate of precision agriculture in rice production was 49.2% as of 2022. The highest expectation for smart agriculture is "labor reduction" (83.1%), followed by "improved quality and yield" (43.6%) and "reduced pesticide and fertilizer use" (40.7%). Automatic Steering Systems: In fiscal year 2022, 4,980 units were shipped nationwide, with a cumulative total of 22,970 units shipped since 2008. On the other hand, a recent UK study by James et al. (2025) found that

robotic tractors were less efficient than human-operated farming⁽⁸⁾. This was due to factors such as the need for constant human supervision, GNSS reception issues, the need for manual intervention when natural objects are mistakenly identified as obstacles, and the complexities of moving between fields. The researchers warn that without addressing challenges like differing legal frameworks across countries—such as Japan's safety standards, which are scheduled for revision in 2024 with clarification on public road operation expected in 2025—these technologies may never move beyond the "showcase" stage. Agricultural Drones: A 2022 survey found that 80% of farmers within Japan Agricultural Cooperatives (JA) regions were using drones for pesticide spraying, on a national average. Additionally, drone-based pesticide spraying has been reported to reduce manual labor by approximately 93%⁽⁷⁾. However, a key challenge for drones is the limited operating time of their batteries due to age-related degradation, which is evidenced by the fact that only about 2% of farmers own drones and contracted work is the main form of usage. Sensor Technology: A 2023 survey by the MAFF showed that the overall adoption rate for smart agriculture, which includes sensor technology, was 26.1%. In Europe and North America, research in data-driven agriculture—which uses sensors, AI, and data analysis for "visualization" and "optimization"—has become a major trend, with most presentations at ECPA2025 falling into this category. This field management approach supports farmers' decision-making by supplementing their experience and intuition with objective data. It maintains farmer autonomy and allows for gradual adoption, which is considered highly compatible with farms of all sizes in Asia and Oceania⁽⁶⁾. A key challenge for the widespread adoption of data-driven agriculture is improving farmers' understanding of the collected data. For example, it's difficult to distinguish whether a pixel on an NDVI map generated from satellite imagery indicates poor crop growth or if it contains elements other than crops. This issue is more pronounced in Japan's small, fragmented fields, which is why there's growing anticipation for proximity remote sensing using small robots and other similar technologies.

CONCLUSION

This paper concludes that data-driven agriculture has a higher potential for widespread adoption in Japan than the automation of existing machinery. Unlike robotic machinery, which is expensive and struggles with Japan's complex terrain, data-driven methods can be implemented gradually and are suitable for farms of all sizes. This approach supports farmers' existing skills, making it easier to share knowledge and ultimately improving working conditions.

Challenges and Solutions

For data-driven precision farming to succeed in Japan, several challenges must be addressed:

- **High initial costs:** Expansion of subsidies is needed.
- **Low digital literacy:** Providing training opportunities is essential.
- **Lack of data standardization:** Promoting infrastructure and standardization for data sharing is crucial.

The paper emphasizes that success in Asian-Oceanian agriculture will depend on collaboration among all stakeholders to create practical solutions that improve productivity and the quality of life for farmers.

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