

Real-time image sharing system: Urban farm stand management facilitated by information resources and market orientation

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Abstract

Direct sales of agricultural products account for a significant portion of sales in urban areas; therefore, efficient management contributes to the sustainability of urban farming. Recent innovations in real-time image sharing (RTIS) have emerged as tools for urban farmers to improve their direct sales efforts, allowing both farmers and customers


to view real-time images of their farm stands. However, how farmers manage information for direct sales within their business models remains poorly understood. In particular, little is known about how RTIS implementation improves farm stand management and how farmers' information resources and market orientation influence this process. To investigate this, we conducted qualitative longitudinal data collection using a case study approach, interviewing nine farmers in Tokyo who used RTIS for direct-sales marketing. We assessed their information resources, market orientation, and firm performance before and after adopting RTIS. Our findings indicate that RTIS usage helps farmers gather information resources

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and subsequently adopt a market-oriented approach. Farmers can improve their shipping efficiency after accumulating information resources and enhancing market orientation, especially if they initially have limited information resources but a certain degree of market orientation at the time of RTIS implementation. Farmers also develop process innovation as a strategy integrated with their information resources and market-oriented approach. Additionally, farmers who optimize their shipping systems can improve their farm stand sales, particularly if they adopt process innovation after RTIS implementation. We conclude by discussing the academic and practical implications of our study, along with agricultural policies that support effective RTIS use, considering regional characteristics.

Keywords

real-time image sharing, direct marketing, farm stands, information resource, market orientation, shipping optimization, process innovation

Introduction and Literature Review

Recently, various information technology (IT) innovations have been developed for farm management, with information management technology playing a crucial role in sales of agricultural products. These include point-of-sale (POS) systems that help gather and utilize sales data (Steckel et al., 2004), e-commerce sites for online sales (Lin et al., 2020; Zheng et al., 2019), and social network services (SNS) for communication with customers (Lin et al., 2020; Zheng et al., 2019). These technologies function as real-time information-sharing systems (Ghouri & Mani, 2019), facilitating the flow of information among shipping organizations, farmers, and customers.

Farmers are increasingly using these technologies to sell directly to customers and reduce transaction and logistics costs by shortening distribution channels. This approach enhances the freshness of farm products (Letelier Araya et al., 2025), fosters community connections, and promotes customer health (Sonnino & Marsden, 2006). Additionally, addressing information asymmetries between farmers and customers (Chae et al., 2018) helps improve sales of products that meet customer needs

(Kurnia et al., 2015). However, effective marketing and distribution of agricultural products through direct sales requires comprehensive management of the value chain to meet customer demand and ensure quality and safety (Lee et al., 2012).

In this context, a new direct-sales management system called “Mie-Vege” was developed in 2021 by the Tokyo Metropolitan Government and coordinating manufacturers. This system automatically posts images captured by webcams installed in stores onto a website, allowing sellers and buyers to monitor the current status of the sales floor while guaranteeing customer privacy (Wolfert et al., 2017). What sets it apart is the use of images for information sharing between buyers and sellers, referred to as a type of real-time image sharing (RTIS; Wu et al., 2009).

Farm stands are an important channel for the direct sale of agricultural products in urban areas (Yoshida, 2020). For example, 33% of farmers in Tokyo and 18% of farmers in Kanagawa sell their products to neighbors in farm stands where they operate individually (Ministry of Agriculture, Forestry and Fisheries, 2020). This is because Japanese urban areas, where urban sprawl surrounds farmlands with residential and commercial development (Sorensen, 2001), have a substantial customer base for agricultural products. As shown in Figure 1, many urban farmers establish farm stands in their own work sheds or huts to sell horticultural products directly to customers, reducing distribution costs. This approach also lessens the impact of market price fluctuations for agricultural products (Aguiar et al., 2018) and allows the distribution of affordable food and the acquisition of social capital (Colson-Fearon & Versey, 2022). Some farm stands are staffed by farmers, whereas others are unattended. In unattended stands, farmers see their customers only when visiting to set up displays and clean them, and customers purchase items from displays or vending machines.

Two key factors enable farmers to maintain a competitive advantage through farm stand management: the acquisition of information resources and the implementation of market orientation.

First, as farmers accumulate marketing-related management resources, they succeed in business diversification, including sales from farm stands

Figure 1. Farm Stands and Their Sales Floors in a Japanese Urban Area (left is attended, and right is unattended)

The areas enclosed by white lines in the figures represent the sales floors where the products are displayed.



(Ilbery, 1991). Both the tangible and intangible resources held by diversified farmers significantly influence their financial performance (Walley et al., 2011). Accumulating information resources also supports vertical integration in farm management (Yagi & Howitt, 2013) by utilizing insights from customer service experiences and relationships (Holloway et al., 2007). Farmers operating farm stands can also gain, integrate, and utilize information resources to establish a competitive advantage quickly.

Second, market orientation is a vital factor for sustaining competitive advantage among firms that engage in direct sales (Abbu & Gopalakrishna, 2021). Narver and Slater (1990) defined market orientation as “an organizational culture that most effectively and efficiently creates the necessary behaviors for the creation of superior value for buyers and, thus, continuously superior performance for the business.” To enhance farm stand sales in urban farming, farmers must understand customer demands and clearly communicate their products’ value. Market orientation is especially important in farm stands, where farmers must proactively engage with customers and share information. Previous studies have indicated that profitability and customer service improves in direct marketing firms when market orientation is paired with a foundation of information sharing (Abbu & Gopalakrishna, 2021).

However, until now, farmers’ process of im-

proving direct sales management using information systems has remained unclear. Farm stands are primary direct-sales channels for urban agriculture, where each farmer’s resources and management orientation directly influence consumer satisfaction and customer relationship management, and therefore RTIS usage is likely to have a significant impact. Nevertheless, the process by which RTIS contributes to firm performance is not well understood, nor is the role of information resources and market orientation. Understanding this process is important for proposing policies that support RTIS use.

Therefore, this research aims to clarify how farmers improve firm performance through direct-sales information management using RTIS and to identify the characteristics of those who do so effectively. To achieve these objectives, we interviewed urban farmers engaged in farmstand management and assessed the effectiveness of information management in direct-sales marketing and related support systems.

Literature Review

This literature review explores significant research on IT utilization toward accumulation of information resources in agricultural product sales, improvement of market orientation, and the subsequent sales performance in order to construct hypotheses regarding the process of farm stand management improvement through RTIS.

RTIS relies on image data, providing a real-time visual representation of the sales floor on a smartphone screen, and enables viewers to understand the situation of the sales floor more easily than the text data used by most existing systems. Smartphones are more convenient than PCs for retrieving real-time information resources (Hearn & Bange, 2002; Kitchen, 2008), especially for farmers who spend much of their time in the field. Farmers can use the Internet via smartphones to improve firms' access to information on market prices and production and consumption trends, facilitate information sharing among employees in a cloud environment, and help maintain customer relationships (Anderson & Rainie, 2010; Mishra et al., 2009; Pitichat, 2013). However, because IT is adopted more by younger farmers (Giua et al., 2021), older farmers may find it difficult to share images of farm stands.

Information resources are defined as "information collection requests containing a data profile for each request" (Trauth, 1989). They are crucial for firms seeking competitive advantage, fostering a flexible culture, and developing strategic plans (Powell & Dent-Micallef, 1997), and are built through effective information management. In retail industry, inventory management by POS or monitoring camera systems can provide insights into customer behavior and inventory changes in real time (Andarwati et al., 2020; Frontoni et al., 2014; Steckel et al., 2004), while also facilitating internal information sharing (Andarwati et al., 2020). However, data on customer behavior and inventory changes are only useful in agricultural marketing if users can trace their continuous changes (Steckel et al., 2004). In this regard, the RTIS can support decision-making more effectively than POS information.

Market orientation has been established as a key antecedent to sustained competitive advantage and organizational performance (Kirca et al., 2005; Kumar et al., 2011). Narver and Slater (1990) described market orientation as composed of three

behavioral components: customer orientation, competitor orientation, and interfunctional coordination.¹

The introduction of IT, especially an interfunctional information coordination system, improves market orientation (Borges et al. 2009). Furthermore, the continuous accumulation of information resources through IT facilitates the implementation of market orientation (Narver et al., 1998). Market orientation within firms is also considered to facilitate the adoption of IT and enhance information management by accelerating information acquisition. Micheels and Gow (2015) found that organizational learning with IT mediates the relationship between market orientation and organizational performance in farm management. This suggests that when a market-oriented business becomes aware of new IT innovations, it deepens its information management and accumulates information resources, which in turn enhances its market orientation.

A strong relationship between market orientation and firm performance is particularly evident in the manufacturing sector, which typically features a low concentration of authority and a risk-averse culture (Kirca et al., 2005). Market orientation has also been measured in farm management and has been shown to improve financial performance (Ho et al., 2018; Micheels & Gow, 2008, 2015; Mirzaei et al., 2016), contributing to the success of direct marketing. This study proposes that farmers implement their market orientation through the use of RTIS, measuring it using the three behavioral components defined by Narver and Slater (1990).

Direct sales performance in farm management is evaluated from three viewpoints: shipping optimization, process innovation, and sales improvement. Previous studies have shown that the real-time inventory status and customer behavior data obtained through POS systems are vital for optimizing shipping systems (Steckel et al., 2004). Additionally, firms operating E-commerce services gain a better understanding of supply and demand

¹ According to Narver and Slater (1990), customer orientation is the sufficient understanding of one's target buyers to be able to create superior value for them continuously. Competitor orientation means that a seller understands the short-term strengths and weaknesses and long-term capabilities and strategies of both the current and potential key competitor. Interfunctional coordination is the coordinated utilization of company resources in creating superior value for target customers.

dynamics (Kurnia et al., 2015) and reduce information asymmetries with their customers (Chae et al., 2018), outcomes we also anticipate from the use of RTIS in this study. Therefore, we consider shipping optimization in farmstand management as the first performance indicator.

Innovation is a key success factor in IT-based businesses and is driven by market orientation (Borges et al., 2009). Implementing a market orientation is the first step toward improving organizational performance (Slater & Narver, 1995), and its impact is often mediated by innovation (Baker & Sinkula, 2002; Han et al., 1998). Innovation is defined as “the adoption of an idea or behavior pertaining to a product, service, device, system, policy, or program that is new to the adopting organization” (Damanpour & Gopalakrishnan, 2001). It can be broadly categorized into product innovation and process innovation, the latter of which is defined as the implementation of a new or significantly improved production or delivery method (Damanpour & Gopalakrishnan, 2001; OECD & Eurostat, 2018), which may include the introduction of new business management practices enabled by IT. Process innovation is viewed as a vital resource for achieving long-term competitive advantage (Frishammar et al., 2012). Firms with strong IT capabilities are more likely to create product innovations, while process innovation development is often supported by external IT partnerships (Yu et al., 2016). In agricultural enterprises, IT adoption frequently involves collaboration with suppliers, enabling not only the use of external products but also access to technical and managerial support through data sharing and product improvement recommendations. Disseminating farmstand information is assumed to encourage farmers to adapt their product promotion, pricing, and business practices, thereby developing process innovation. In this study, we propose process innovation as the second performance indicator, clarifying how farmers’ initial levels of information resource accumulation and market orientation affect this process.

Furthermore, the accumulation of information resources enhances organizational performance. For example, the use of POS systems has been shown to increase sales by encouraging customer

purchasing behavior (Steckel et al., 2004). E-commerce implementation promotes purchasing behavior (Wang & Herrando, 2019), leads to higher sales (Cosgun & Dogerlioglu, 2012), reduces transaction costs (Damanpour & Damanpour, 2001; Kurnia et al., 2015), and expands trade areas (Damanpour & Damanpour, 2001). The use of SNS by small- and medium-sized businesses also promotes purchasing behavior (Guha et al., 2018), and family farmers have reported increased sales through internet use (Khanal & Mishra, 2016). Therefore, we consider the increase in sales at farm stands as the third performance factor, resulting from shipping optimization and process innovation in farm stand management.

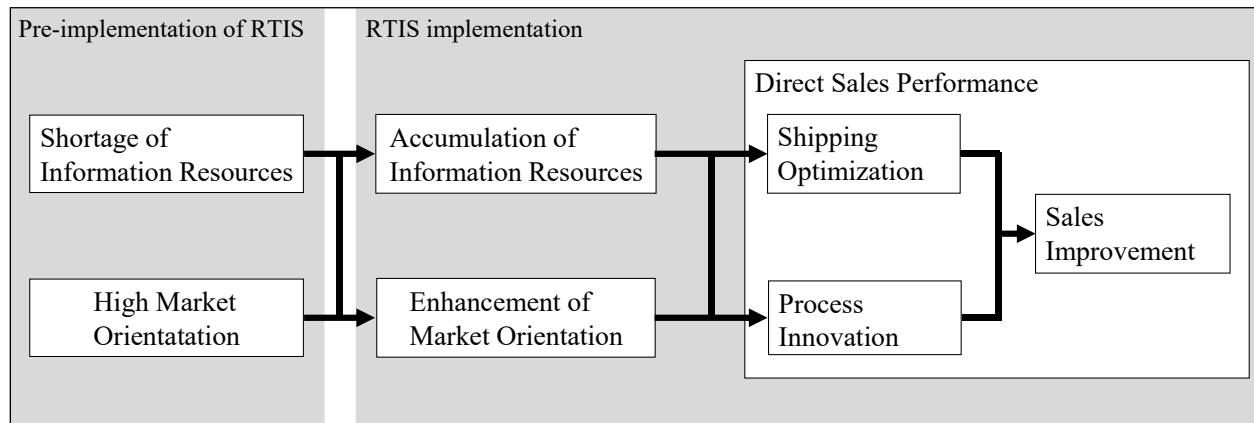
Materials and Methods

Based on the above literature review, this qualitative study assessed the impact of urban farmers’ use of RTIS on their farm stands’ operation. We hypothesized that farmers with limited information resources but high market orientation before using RTIS use it to accumulate information resources and further enhance their market orientation, as shown in Figure 2. Another hypothesis was that RTIS supports the accumulation of information resources, while high market orientation motivates farmers to improve their direct-sales performance by optimizing the product replenishment shipping system, implementing process innovation, and thereby increasing farm stand sales.

This study employed a case study methodology with longitudinal approaches used for data collection. We categorized farms based on their information resources and market orientation and compared the direct sales performance across these groups. Data were gathered via semi-structured interviews over three periods with nine farmers: at the time of RTIS implementation, three months later, and one year later.

Study Site

This study focused on urban farmers who sell their products at farm stands in Tokyo Prefecture, one of the most densely populated and sprawling cities in the world. In Tokyo, farmlands are often surrounded by urban residential and commercial developments (Sorensen, 2001). Tokyo has the

Figure 2. Hypothesized Process of Farm Stand Management Improvement Through RTIS Implementation

highest proportion of farmers in Japan selling products at farm stands (Ministry of Agriculture, Forestry and Fisheries, 2020). Many cities feature farm stands located within them on their official maps or websites, making it easy for residents to purchase agricultural products. Furthermore, it also has the second highest proportion of farmers implementing data-driven agriculture (Ministry of Agriculture, Forestry and Fisheries, 2020). Farmers in Tokyo tend to adopt new IT to improve farm management, making it an appropriate site for conducting this study.

RTIS in Farm Stand Management

This study focuses on the particular system “Mie-Vege” (see Figure 3) to clarify the impact of using RTIS for a certain period on farmers’ operation of their farm stands. Mie-Vege includes a webcam that captures images of the farmstand sales area and a website that displays these images. Once the webcam is installed, it automatically takes photos and uploads them to a cloud server via a built-in SIM communication module or a Wi-Fi connection. The website then displays real-time images, allowing farmers operating the farm stands to view not only their own stand but also real-time images of other farm stands. Addition, farmers share the

corresponding URLs with their customers, allowing them to view the images remotely. Mie-Vege is appropriate for this study because it guarantees the privacy of visitors² and is the only packaged system with image delivery functionality for farm stands,³ enabling farmers to continue using the RTIS throughout the research period.

Semi-Structured Interviews

We conducted three interviews with farmers to clarify the process and antecedents of improving firm performance through the use of RTIS.

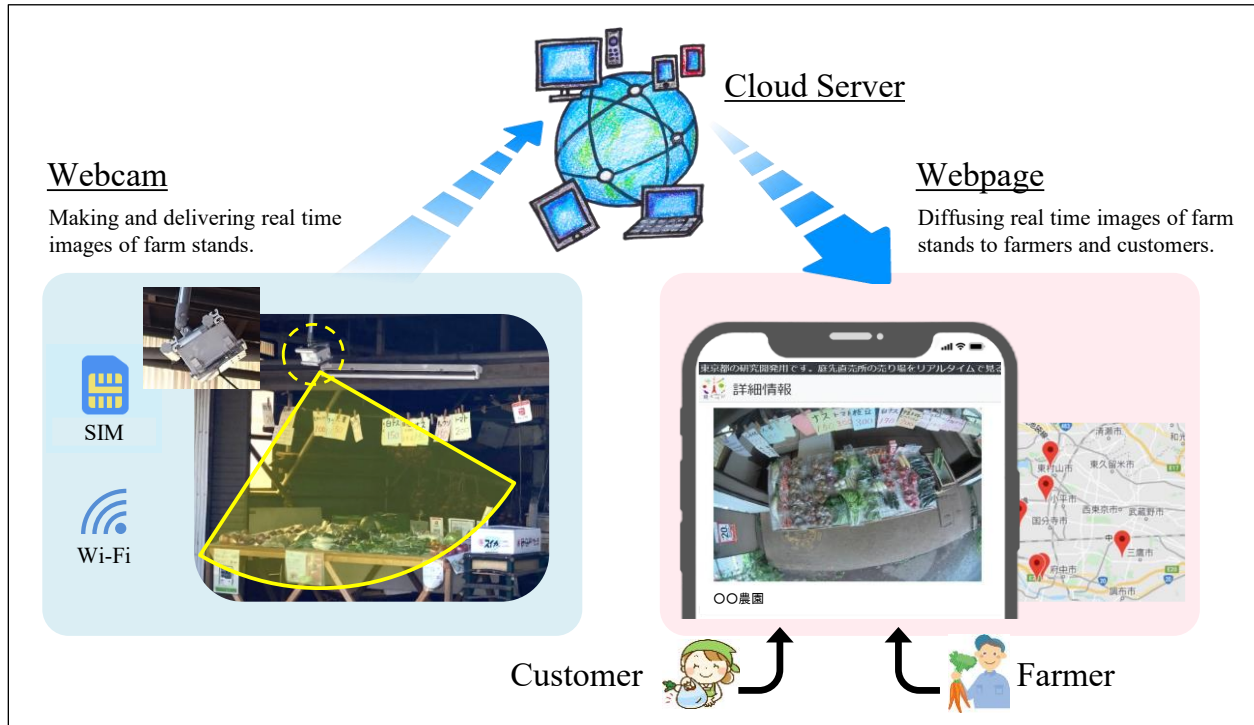
This study was exploratory in nature, conducted prior to RTIS diffusion, and targeted farmers who could utilize RTIS to disseminate information about farm stands. Therefore, the case study involved nine farm households in Tokyo engaged in farm stand management. We established two criteria for selecting participants: 1) They must operate a farm stand for at least two-thirds of the year, and 2) the manager or successor should be under 50 years old at the start of the research and show a strong intention to continue managing the farm stand. Participants were selected based on information from the Tokyo

² The webcam features motion detection and only captures images after confirming no movement for ten seconds. Because it focuses only on the sales floor of the farm stand, stationary cars or people on the nearby street do not appear in the images. Image data are constantly updated, and past versions are not displayed online. The farm stand visitors are informed via signage that RTIS is implemented there.

³ When comparing the impacts across multiple farms, differing system functionalities could introduce bias. Furthermore, packaged systems enable faster recovery from issues, minimizing disruption to the study period.

Figure 3. Real-Time Image Sharing Infrastructure at Farm Stands in this Study

The webcam automatically captures still images of the sales area and uploads them to a cloud server via a built-in SIM module or a nearby Wi-Fi connection. Both customers and farmers can view real-time images of farmstands through webpages.



Metropolitan Agricultural and Forestry Research Center, supporting successors of urban family farming.⁴

This study was conducted over one year, from 2021 to 2022, to investigate information management and its effects on farm stand operations. We interviewed each farmer for 60 to 90 minutes on the three occasions: at the time of RTIS implementation, three months later, and one year later. To enhance the reliability of our findings, we also collected image data uploaded to the system and statements made by each farmer on SNS.

Interview at RTIS Implementation

The first interview was conducted to assess farmers' farm stand management practices, information

resources, and market orientation. The information resources examined in this study included internal information from farmers, such as information about customer relationships (Anderson & Rainie, 2010; Pitichat, 2013; Tan et al., 2002; Wajcman et al., 2008). The information also included real-time inventory status of their farm stands and customer perspective⁵ (Andarwati et al., 2020; Frontoni et al., 2014; Steckel et al., 2004; Zhang et al., 2020) and market information on prices, products, and displays (Mishra et al., 2009). Regarding market orientation, we assessed each of the three behavioral components identified by Narver and Slater (1990)—customer orientation, competitor orientation, and interfunctional coordination—by counting the number of specific actions each farmer

⁴ This method was selected as obtaining information on farmers and farm stand management from published sources is difficult. Despite difficulty in obtaining a sufficient size for statistical analysis, this method helps illustrate the dynamic changes in farm stand management resulting from system usage.

⁵ In this study, customer perspective indicates the information customers can obtain when viewing the RTIS: whether they can identify the types and prices of products, where they are displayed, and which products they want to buy. Farmers are able to gain this insight through continuously monitoring the RTIS and conversations with customers using it.

undertook. In line with their behavioral perspective, market orientation was operationalized as a set of observable organizational behaviors, rather than attitudinal orientations.⁶

Interviews After RTIS Implementation

We examined changes in farmers' information resources, market orientation, and firm performance related to farm stand management at three months and one year after implementing the system. In addition to the information resources identified at RTIS implementation, farmers' recognition of customer evaluations of the RTIS system (Tsekouropoulos et al., 2013) as an information resource was assessed. We focused on three aspects of firm performance. First, we measured each farmer's shipping optimization by counting the individuals who replenished products after recognizing the inventory at their farm stands and meet any of the following criteria: checking the

inventory by viewing the RTIS, receiving replenishment instructions via phone from another member who views the RTIS, or directly observing the inventory at the farm stand. Second, to examine farmers' behavior regarding process innovation development, we confirmed whether they undertook any of the following activities after RTIS usage: implementation of new market strategies, employee awareness initiatives, or improved sales floor displays. Third, as organizational performance, we compared farm stand sales before RTIS implementation with the average sales over the two years following implementation.

Overview and Classification of Case Study Farmers

This study categorized farmers based on their information resources and market orientation to compare the impacts of RTIS usage. Table 1 presents the information resources and market orien-

Table 1. Farmers' Information Resources and Market Orientation Related to Farm Stands at RTIS Implementation

ID	Information resource ^a			Market orientation ^b			Total
	Customer relationship	Real-time product inventory in own stand	Total	Customer orientation ^c	Competitive orientation ^d	Interfunctional coordination ^e	
A1	2	0	2	8	3	5	16
A2	1	0	1	10	5	2	17
A3	2	0	2	9	3	5	17
B1	3	1	4	5	3	1	9
B2	3	1	4	3	3	1	7
C1	0	0	0	2	2	2	6
C2	1	0	1	2	2	1	5
D1	0	0	0	0	0	0	0
D2	0	0	0	0	2	0	2

^a A codebook of information resources is provided in Supplementary Table A.1. This notation is consistent in the following tables.

^b The number of specific behaviors that represent market orientation is based on the index developed by Narver and Slater (1990). Further details on market orientation are provided in Supplementary Table A.2. This notation is consistent in the following tables.

^c Count of specific actions regarding customer satisfaction objectives, customer commitment, creating customer value, measuring customer satisfaction, after-sales services, understanding customer needs.

^d Count of specific actions regarding salespeople sharing competitor information, responding rapidly to competitors' actions, top management discussing competitors' strategies, target opportunities for competitive advantages.

^e Count of specific actions for interfunctional customer calls, information sharing among functions, all functions contributing to customer value, functional integration in strategy.

⁶ The specific actions used to construct each component are summarized in Table 1.

tation of each farmer at the time of RTIS implementation. Some farmers gain customer relationships through direct interactions at farmers markets or usage of social media. Regarding real-time inventory management, farmers B1 and B2 were consistently aware of their current stock levels before implementing RTIS because some family members were always present in the stands during opening hours and called others when necessary. Differences among farmers were apparent in market orientation, particularly customer orientation, which is stronger than competitor orientation and interfunctional coordination.

Based on these results, we classified farmers into four categories according to their level of information resources and market orientation. We then analyzed each group's firm performance relative to their characteristics. Group A has limited information resources but high market orientation, Group B has abundant information resources and moderate market orientation, Group C has limited information resources and medium market orienta-

tion, and Group D has limited information resources and low market orientation.

Table 2 provides an overview of the farmers involved in the case study. All farmers used multiple sales channels, with the proportion of farm-stand sales ranging from 10% to 85%, as shown in Figure 4. They sold products through diverse channels, such as farmers markets, supermarkets, and school lunch programs, in addition to farm stands, as pointed out in prior research (Yoshida, 2020). Farmers B1 and B2 had two family members working at their stands, while the others sold their products without staffing the stands. Each farm had at least one person responsible for product shipments. Some farmers also created websites or SNS accounts to share information.

Results

This section presents the key findings from the study, drawing on qualitative research data across nine farmers in Tokyo. The results are organized thematically to highlight the accumulation of infor-

Table 2. Overview of Case Study Farmers (at the Start of the Research)

ID	Organization (number of farm stand clerks; number of the shippers; attended or unattended stand) ^a	Annual farm stand sales (USD) ^b	Sales promotion channels	Average number of sales products ^c
A1	Manager, his spouse, successor couple (0; 4; unattended)	19,983	SNS (2 types), Homepage,	11
A2	Manager, his spouse, successor (0; 2; unattended)	19,983	SNS, Homepage	1
A3	Manager, 4 part-time (0; 2; unattended)	13,032	SNS, Homepage	1
B1	Manager, his spouse, successor, relatives (2; 3; attended)	24,327	SNS	14
B2	Manager, his spouse, successor, relatives (2; 3; attended)	38,228	SNS	17
C1	Manager, his successor (0; 2; unattended)	15,639		9
C2	Manager, his successor, 3 volunteers (0; 3; unattended)	6,950		6
D1	Management couple (0; 2; unattended)	8,688		5
D2	Management couple (0; 2; unattended)	6,082		5

^a If the clerk number is 0, the farm stand is unattended.

^b 1 USD = 115 JPY according to the exchange rate on January 1, 2022.

^c Annual average number of products sold at farm stands per day. All farmers produce and sell vegetables; A2 and A3 only sell tomatoes, while C1 handles kiwifruits in addition to vegetables. Their products are interchangeable and, in fact, are changed in response to weather and demand every year.

mation resources, market orientation improvement, and the process of how urban farmers achieve efficient farm stand management from a multifaceted perspective.

Accumulation of Information Resources Through RTIS Implementation

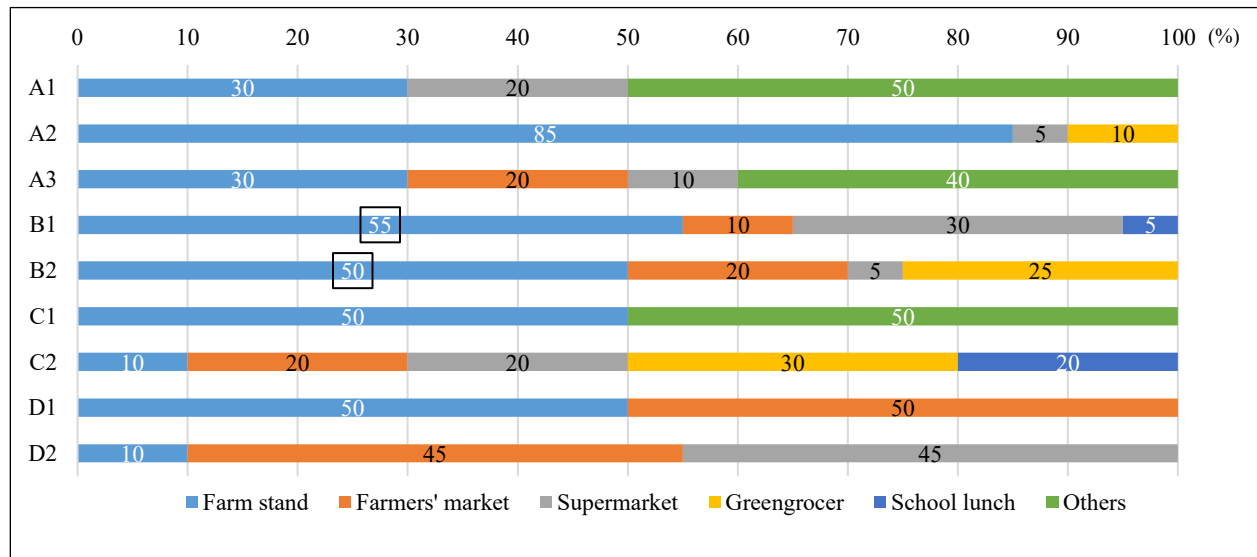
Table 3 presents changes in information resources related to the farm stands in the case study. Customer relationships remained unchanged for the farmers. However, some farmers gained awareness of real-time product inventory and a customer perspective of their farm stands. Farmers in Groups A and C accessed product inventory information through RTIS, even when away from their stands, such as when working in the field or at home. Farmers in Group B were already aware of their inventory levels before RTIS implementation, and this did not change. Group D farmers began using remote viewing three months after adopting RTIS but discontinued it one year later.

Prior to RTIS implementation, farmers managed their farm stands from the perspective of an

operator; none of them were able to view it from the customer's point of view. By repeatedly watching images of the RTIS and talking with their customers, Farmer A1 and all Group B farmers were able to gain a customer perspective on their own stands for the first time, enabling them to adjust product arrangements on the sales floor.

Regarding external information, some farmers accessed data on selling prices, product varieties, and displays at other farm stands as well as customer evaluations of the system. Notably, all farmers learned about other product varieties three months after RTIS implementation. Farmers B2, C1, and D1 also collected information on prices at other farm stands. Additionally, Group B farmers used the system to observe how other stands arranged their sales floors, set up pop-ups, and displayed price tags. Therefore, they learn about competitors' practices to explore practices they could implement in their own farm management. Furthermore, farmers in Groups A, B, and C gathered customer feedback to understand the benefits of using the system.⁷

Figure 4. Each Case Study Farmer's Sales Channel and Its Ratio



Note: B1 and B2 sold products with clerks at their farm stands, while the others sold unattended. Other sales channels included online shops, restaurants, department stores, wholesalers, and delivery sales.

⁷ Farmers in Groups A and B introduced RTIS to their customers through SNS and their websites three months after implementation. All farmers facilitated customer access to RTIS by posting multiple times and prominently placing its URL on their homepage. At attended stands, the system was communicated to customers during in-store interactions. At unattended stands, communication occurred through conversations with customers encountered during product replenishment or via SNS.

Implementing Market Orientation via RTIS

Table 4 illustrates the changes in market orientation among the case study farmers resulting from the use of RTIS, focusing on the three behavioral components. Most of these farmers completed accumulating information resources within three months after RTIS implementation, while many of them continued strengthening their market orientation for one year.

Customer orientation was already high for Group A farmers before RTIS implementation but

improved for all farmers afterward. Specifically, they incorporated customer feedback on pricing and product assortments. They also identified customers who frequently used RTIS, provided guidance on its use, gained deeper insights into customer satisfaction, and adjusted product displays based on the camera's coverage.

Competitor orientation improved through information gathered by viewing other farm stands via the system. Farmers who accessed data on product variety, pricing, and displays at other

Table 3. Accumulation of Information Resources Related to Farm Stands^{a b}

ID	Information inside the farm									Information outside the farm									Total					
	Customer relationship			Real-time product inventory in own stand			Customer perspective			Product prices at other stands			Other farm stand products			Displays of other stands			System evaluation from their customers					
	0m	3m	12m	0m	3m	12m	0m	3m	12m	0m	3m	12m	0m	3m	12m	0m	3m	12m	0m	3m	12m	0m	3m	12m
A1	2	2	2	0	1	1	0	1	1	0	0	0	0	1	1	0	0	0	0	1	1	2	6	6
A2	1	1	1	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	4	4
A3	2	2	2	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	2	4	5
B1	3	3	3	1	1	1	0	1	1	0	0	0	0	1	1	0	1	1	0	1	1	4	8	8
B2	3	3	3	1	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	4	9	9
C1	0	0	0	0	1	1	0	0	0	0	1	1	0	1	1	0	0	0	0	0	1	0	3	4
C2	1	1	1	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	4	4
D1	0	0	0	0	1	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	3	2
D2	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2	1

^a 0m denotes the data at RTIS implementation. 3m and 12m denote three months and one year after that, respectively. This notation is consistent in the following tables.

^b Gray cells indicate an increase in information resources compared to the time of RTIS implementation; darker gray cells indicate a greater increase than that observed 3 months after RTIS implementation.

Table 4. Increased Market Orientation Among Case Study Farmers^{a b}

ID	Customer orientation			Competitor orientation			Interfunctional coordination			Total		
	0m	3m	12m	0m	3m	12m	0m	3m	12m	0m	3m	12m
A1	8	12	15	3	4	4	5	6	7	16	22	26
A2	10	12	13	5	5	5	2	4	4	17	21	22
A3	9	9	12	3	3	3	5	5	6	17	17	21
B1	5	8	10	3	5	5	1	3	3	9	16	18
B2	3	5	7	3	5	6	1	2	4	7	12	17
C1	2	3	4	2	4	4	2	3	3	6	10	11
C2	2	6	6	2	2	2	1	2	3	5	10	11
D1	0	1	1	0	2	2	0	0	0	0	3	3
D2	0	1	1	2	2	3	0	0	0	2	3	4

^a Further details on market orientation are provided in Supplementary Table A.2.

^b Gray cells indicate an increase in market orientation compared to the time of RTIS implementation; darker gray cells indicate a greater increase than that observed 3 months after RTIS implementation.

stands began considering strategies for managing their own farm stands. These strategies included differentiation, motivation, and better understanding of market prices.

Regarding interfunctional coordination, some farmers enhanced functional integration over the course of the year by monitoring their farm stands via RTIS. They familiarized successors and family members with the system's functions and its applications for family management. Additional efforts included sharing posting techniques on SNS in the family, centralizing information by placing the URL on Google Maps and other advertising media, and consolidating information for pop-up events.

Impact on Farm Stand Management

Table 5 presents firm performance related to farm stand management before and after RTIS implementation, including shipping optimization, process innovations, and year-on-year sales comparisons. The following sections provide detailed explanations of these changes.

Shipping Optimization

Farmers in Groups A and C increased the number of family members capable of remotely monitoring

and replenishing product inventories. Before implementing RTIS, they risked losing sales opportunities at their unattended farm stands because they could not check product inventory. RTIS improved the shipping process by allowing replenishment decisions even when farmers are absent. Two scenarios emerged: In one, all members responsible for replenishment used RTIS (A2, C1); in the other, some members viewed the system and instructed others to replenish (A1, A3, C2).

In both cases, farmers could verify product levels before replenishing or instructing others, minimizing unnecessary work and maximizing sales opportunities. In contrast, Group B farmers experienced minimal changes to their shipping systems, as many were consistently present at their farm stands. For example, B1's production manager only used RTIS in July, the peak season, to assess replenishment needs. Meanwhile, Group D farmers began accumulating product inventory information three months after implementation but discontinued this after one year, resulting in no improvements to their shipping system.

Process Innovation

Group A farmers, who were already highly market

Table 5. Changes in Firm Performance Related to Farm Stand Management ^{a b}

ID	Shipping optimization ^c			Process innovation ^d			Year-on-year sales ratios (%) ^e		
	0m	3m	12m	0m	3m	12m	1 yr after	2 yrs after	Average
A1	0	2	2 (2)		x	x	147	113	130
A2	0	2	2			x	114	165	140
A3	0	1 (1)	1 (1)			x	110	151	131
B1	2 (1)	3	3		x	x	100	99	100
B2	2 (1)	2 (1)	2 (1)		x	x	73	69	71
C1	0	2	2				129	132	131
C2	0	1 (1)	1 (1)				121	113	117
D1	0	1	0				73	65	69
D2	0	1 (1)	0				75	48	62

^a Further details on shipping optimization changes and process innovation are provided in Supplementary Table A.3.

^b Gray cells indicate more efficient farm stand management compared to management at the time of RTIS implementation.

^c Number of members who replenish products based on the inventory at their farm stand (numbers in parentheses indicate members who replenish under the instruction of the information-holders).

^d Implementation of new market strategies, employee awareness initiatives, and improved sales floor displays.

^e The baseline was annual sales from May 2020 to April 2021, compared to the annual sales exactly one or two years later, on average. Weather and market impacts were consistent across all farms, because the distance between farmers' fields was no more than 12 km. The year-on-year variations in vegetable market prices are 100% in 2020 and 2021 and 103% in 2022, showing little significant fluctuation (Ministry of Agriculture, Forestry and Fisheries, 2025).

oriented before implementing RTIS, developed strategies to create new value by sharing information through the system. For instance, Farmer A1 displayed fresh but overstocked products within the camera's view to increase the likelihood of customer purchase. This practice illustrates anchor bias from nudge theory (Thaler & Sunstein, 2009), as it encourages customers to buy fresh items and thereby improves inventory turnover. Farmer A2 regularly monitored sales through RTIS and observed that sales improved when space was available on the sales floor. Based on this insight, they sometimes left the sales floor partially empty during product replenishment to give customers the impression that the farm stand was popular. Farmer A3 informed employees about the system and emphasized sales promotions and customer service. Even before RTIS implementation, Farmer A3 engaged in extensive interfunctional coordination to develop employee skills and revised work manuals based on employee feedback. This high level of market orientation supports process innovations. Group B farmers gained valuable insights by using RTIS to view real-time images of other farm stands and applied these to improve their own displays. The system facilitates product identification on the sales floor, simplifies customer inquiries, and enhances the efficiency of sales activities.

Increased Sales at Farm Stands

From the farm stand sales data, we found that farmers in Groups A and C, who implemented shipping optimization, experienced sales growth. In contrast, sales for farmers in Groups B and D either remained unchanged or decreased. Farmers who experienced sales growth optimized their shipping systems through timely product replenishment. These farmers likely accumulated sufficient information resources and a certain level of market orientation, enabling them to use RTIS effectively to enhance replenishment efficiency and boost sales.

Additionally, farmers who adopted process innovation increased their farm stand sales when they improved product replenishment. For instance, Farmer A1 innovated their sales process for three months after RTIS implementation and

recorded the highest sales increase after one year. Farmers A2 and A3 adopted process innovations in their sales after one year and experienced significant sales growth in the second year. On the other hand, although Group B farmers adopted process innovation, their sales did not improve. Shipping optimization is critical for increasing farmstand sales, with process innovation acting as a mediator in this relationship.

Discussion

Based on the results of this study, Figure 5 illustrates the process by which urban farmers use RTIS to improve farm stand management, as well as the relationship between farmers' information resources, market orientation, and performance achieved through RTIS implementation. In the following, we discuss the details of this process, the characteristics of farmers who used RTIS effectively, and policies that support RTIS use.

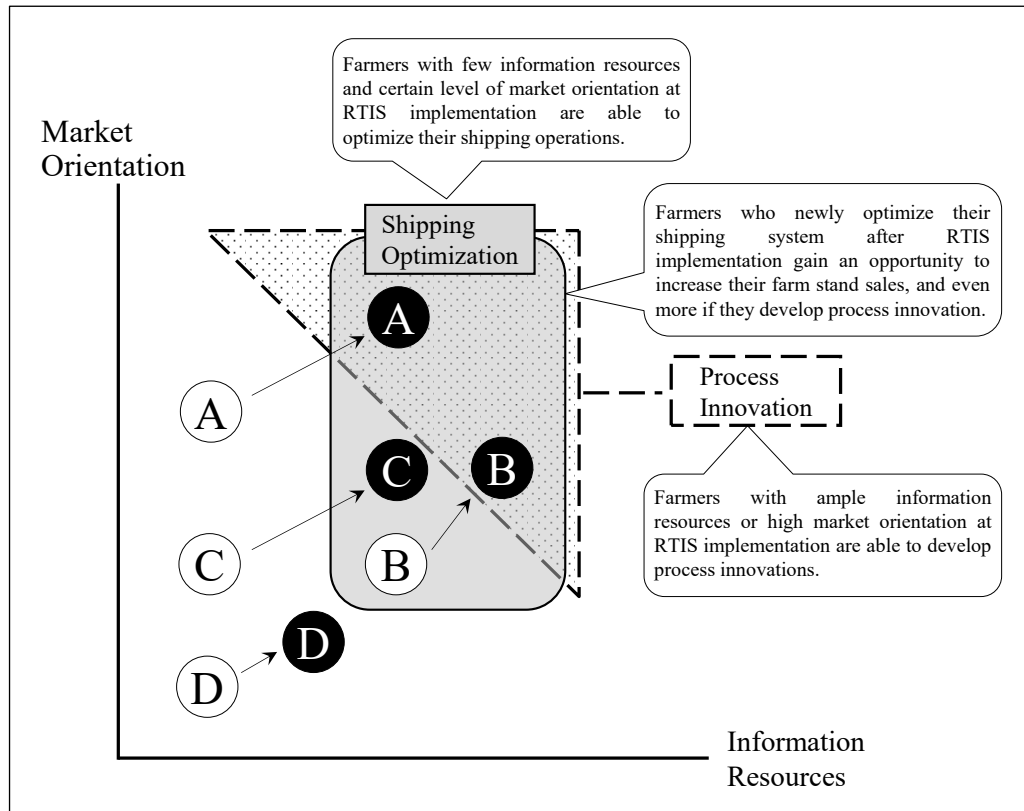
Process of Improving Farm Stand Management Through RTIS Use

First, farmers can accumulate information resources through RTIS. These resources include details about their farm stands, such as product displays, prices, and customer evaluations. Previous studies have shown that customer and inventory trends are communicated to shippers via POS data and information from farmers markets (Andarwati et al., 2020; Steckel et al., 2004; Takeno et al., 2008). This study confirms similar effects for RTIS. It also supports the idea that new production and marketing strategies can be developed by analyzing information on products and prices from other farm stands. The farmers in this study accumulated information resources through frequent interaction with customers, gathering customer opinions on SNS, and using RTIS.

Second, farmers using RTIS can enhance their market orientation. While IT applications in firms' market-oriented strategies for collecting customer information and sharing data across departments are limited, our findings show improvements in all three components of market orientation (Narver & Slater, 1990). Farmers can enhance their market orientation after accumulating information resources, as they need time to interpret the data

Figure 5. Farm Stand Management Performance Achieved by Farmers Using RTIS with Information Resources and Market Orientation

Capital letters indicate the groups of farmers in this study and white dots indicate before RTIS implementation, black dots after the implementation.



obtained through RTIS. In other words, market orientation can be more readily enhanced by linking RTIS data to information accumulated through face-to-face sales with customers or existing market-oriented strategies, as was the case with Group B farmers with sufficient information resources.

Third, the results indicate that farmers' accumulation of information resources and enhanced market orientation through RTIS lead to optimized shipping operations and process innovations. For example, farmers optimized the arrangement of the sales floor, adopted new marketing strategies, and increased employee awareness. Previous research has linked firm performance to information resource accumulation and the implementation of

market orientation (Ho et al., 2018; Micheels & Gow, 2008, 2015; Mirzaei et al., 2016), and this study aligns with those findings. Moreover, farmers with ample information resources or high market orientation were able to develop process innovations after implementing RTIS. This innovation results from sharing real-time images of the sales floor with customers, a capability not available through existing POS, SNS, or e-commerce systems. The process innovations identified here are consistent with earlier research on market-oriented outcomes: employee team spirit (Kohli & Jaworski, 1990), customer satisfaction (Kirca et al., 2005), and cost reductions in sales promotions (Han et al., 1998; Yu et al., 2016).⁸

⁸ These process innovations can be identified from the actions of groups A and B, described in Supplementary Table A3. Employee team spirit means explaining the importance of creating a customer-focused sales floor and service (A3). Customer satisfaction means recommending fresh products to customers (A1), adjusting placement to enhance visualization value (B1). Cost reductions in sales promotions means advertising that the farm stand is popular (A2) and reducing their inquiries to us (B2).

This study also shows that among farmers who optimized their shipping operations through RTIS implementation, those who developed process innovations gained further opportunities for sales growth. This finding indicates that farmers need time to gain a competitive advantage by integrating valuable information resources with innovative marketing strategies at their farm stands. In contrast, Group B farmers in this study did not immediately increase farm stand sales despite enhancing market orientation and developing process innovations because they had already accumulated information resources before implementing RTIS. While previous research has shown that improving market orientation increases profitability (Narver & Slater, 1990), in the context of farm stand RTIS usage, this effect occurs only when farmers accumulate information resources before enhancing market orientation.

Classification of Farmers' Information Resources and Market Orientation in RTIS Use

This study demonstrates that firm performance in farm stand management varies depending on the level of information resources and market orientation at the time of RTIS introduction. Assessing farmers' levels of information resources and market orientation approximates their performance with the system.

Both Groups A and B adopted process innovation based on information gained through RTIS use. However, Group A, which was more market-oriented, used RTIS to enhance shipping efficiency and sales, while little improvement in shipping or sales was observed in Group B, which had more information resources at the beginning. Comparing Groups A and C, Group A adopted process innovation owing to its higher market orientation, resulting in greater sales growth than Group C. To maximize organizational impact on farm stands and achieve long-term sales growth, Group C needs to adopt process innovation alongside shipping optimization. Group C had a higher market orientation than Group D and achieved shipping optimization and improved sales despite both groups implementing the same RTIS and lacking

accumulated sales data on farm stands. In contrast, Group D was less market-oriented and prioritized production management over farm stand management, which limited shipments and prevented accumulation of sales floor information. As a result, Group D did not experience improvements in shipping systems or sales. To use RTIS effectively to increase farm stand sales, Group D should first improve market orientation related to farm stand operations.

Indeed, farmers' use of RTIS could also be influenced by their business models, such as the sales ratio of farmstands. However, this ratio does not necessarily capture farmers' strategic intentions toward farm stand development. A low current ratio may reflect limited past opportunities rather than a lack of interest, whereas a high ratio may result from temporarily favorable local demand. In this context, market orientation provides a more appropriate lens for understanding farmers' engagement with RTIS. Farmers with strong market orientation tend to focus on understanding customer demand and improving responsiveness, leading them to adopt RTIS to optimize shipping operations at their farm stands, regardless of their current sales ratio (e.g., C2). Conversely, farmers with low market orientation may refrain from investing in such practices, even if they have a substantial portion of farm stand sales (e.g. D1). This suggests that RTIS adoption is shaped less by the current sales structure than by how farmers strategically position their farms within their overall business.

Practical Contributions

Mie-Vege was launched by the developer after the study period. As of October 2025, farmers must invest approximately 435 USD per year, while customers are free to browse. Considering the annual sales of urban farm stands, introducing this system is not necessarily beneficial for every farmer; for some, the expenses outweigh the benefits.⁹ The insights gained from this study regarding RTIS's impact and the differences between farmer groups are useful for the diffusion of technology and policy support. To support decisions on whether to

⁹ In fact, after the study period, farmers in Groups A, B, and C desired to use RTIS even if charged, but those in Group D did not.

accept this expenditure, in the following sections, we clarify the significance of information management using RTIS in farm stands and discuss the factors that enhance its effectiveness.

Shipping Optimization

All farmers who optimized their shipping systems improved interfunctional coordination, a key component of market orientation, and involved family members in restocking farm stands. The collaboration among family members observed in this study was a type of shared management resource that supports diversification strategies in urban farming (Rantamäki-Lahtinen, 2009; Yoshida et al., 2019). This enables flexible management decisions, thereby supporting information sharing in farm stands through the RTIS to achieve shipping optimization.

Process Innovation

The results of this study suggest that implementing market orientation through RTIS influences the development of process innovations, including the adoption of new marketing strategies, improvements in employee awareness, and enhancements in sales floor displays. The nature of these process innovations varies among farmers based on their prior market orientation.

Group A farmers, who were highly market-oriented before RTIS implementation, adopted new marketing strategies: recommending fresh products to customers (A1) and intentionally leaving some slots of their vending machines empty to suggest high demand (A2). Group B farmers, who had existing information resources before RTIS implementation, improved their sales floor displays and communicated to customers that their farm stands were more responsive to customer demand than competing stores. Additionally, they posted social media to convey product information that could not be fully captured by RTIS camera images alone. These process innovations create opportunities to make customers want to buy more products and eliminate overstock at farm stands. Furthermore, the visibility of farm stands is improved, leading to reduction in unnecessary inquiries and enhancement of customer service across the entire farm, as in the case of B2. Following this process,

farmers can effectively maintain their farm stands' competitive advantage over other retailers and build long-term social relationships with customers (Cassia et al., 2012).

Support for Effective RTIS Use

RTIS aligns with experimental continuous learning (Narver et al., 1998), influencing market orientation by building experience through experimentation. In terms of normative initial learning, another process to enhance market orientation, create learning opportunities, and select effective management strategies remains essential beyond using RTIS.

This periodic research revealed that some firm performance improvements appeared shortly after RTIS implementation, while others developed over time. For example, farmers received information about sales floor conditions and customer perspective at their farm stands immediately after implementation. However, some farmers understood customer evaluations of the system only after one year. This delay may have resulted from the time needed for farm stand members to communicate with customers about the system and encourage its use as well as limited opportunities for farmers without direct customer relationships to gather feedback. Additionally, the farmers showed enhanced market orientation one year after implementation compared to three months post-implementation. As they strengthened market orientation, they actively communicated their farm stand's advantages, recognized peak sales times, and integrated the system with their SNS, websites, and other promotional tools. Consequently, Group A farmers adopted process innovations, developed new customer services, and implemented marketing management strategies one year after RTIS implementation.

The Tokyo Metropolitan Government started to promote RTIS implementation in 2022 through its "Supportive Service for Challenging Farming in Tokyo." This initiative assists farmers not only with subsidies for RTIS implementation, but also with guidance on creating promotional tools, activating business models, adopting market-oriented practices, and building management resources, including human networks with customers and other farmers (Yoshida & Yagi, 2019). Further-

more, the government's farm extension service offers hardware and software support before RTIS implementation, provides setup guidance, and facilitates collaborative implementation by farmer groups. This approach enables farmers to become more market-oriented and accumulate management resources more quickly, thereby enhancing the system's impact. As of October 2025, RTIS had been implemented in 27 farm stands or farmers markets across the Tokyo Prefecture. Recent stagnation in urban population growth has made labor recruitment for farming and direct marketing more challenging. Given these urban dynamics, farmers are expected to increase implementation of this system in the future.


In addition, RTIS can be utilized not only in urban areas but also in suburban and rural regions. While RTIS implementation is important where the farm stand business model is viable with a certain population density, awareness of real-time product inventory on the sales floor is even necessary with labor shortages in agricultural product sales and retail operations. In fact, in July 2024, Mie-Vege was implemented at a farmers market on Miyakejima, a remote island in Tokyo with a small population and few farm stands, to improve agricultural product sales to tourists. For retailers seeking timely restocking or new customer acquisition, the findings of this study are beneficial regardless of whether they sell agricultural products.

Conclusion

This study demonstrates the process of RTIS utilization in managing farm stands, which represent one of the major sales channels for urban farmers. First, as part of the improvement process for farm stands using RTIS, farmers can accumulate information resources related to farm stand management, followed by an enhancement of market orientation. Subsequently, they can optimize their shipping systems, adopt process innovations, and

increase sales opportunities for agricultural products. Second, farmers with limited information resources prior to RTIS implementation can optimize their shipping systems, while highly market-oriented farmers can adopt process innovations. Farmers who adopt only process innovations cannot increase sales. However, those who optimize their shipping systems can improve sales with an opportunity for further growth if process innovation is also adopted. Based on these results, we propose supportive policies aimed at enhancing market orientation during RTIS implementation and accelerating the accumulation of information resources through RTIS use.

The findings suggest that farmers should first assess their existing information resources and market orientation before adopting RTIS and then strengthen market-oriented practices such as family cooperation and early communication with customers. In addition, the accumulation of diverse information resources, including customer feedback and images from other farm stands, can enhance the effectiveness of RTIS-based information management. When these requirements are widely recognized by farmers, extension agencies, and manufacturers, the RTIS can support the development of regional direct marketing business models.

One limitation of this study is that changes in information resources, market orientation, and firm performance may have been influenced by factors other than RTIS usage, such as the emergence of competing retailers or attractive sales channels for farmers. This research was conducted at the pre-dissemination stage of RTIS to quickly identify its impacts and differences among farmers, resulting in a limited sample size. As RTIS diffusion progresses, future studies could conduct quantitative analyses incorporating regional variables and other technology adoption factors. 

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Appendices

Table A1. Codebook of Variables of Information Resources

Categories	Variable	Description	Coding rule	Example evidence
Information inside the farm	Customer relationship	How many channels for maintaining customer relationships	Number of individuals	Clerks at their farm stands, local farmers markets or farm experience, usage of social media, such as Facebook, Instagram, LINE, or similar tools for customer contact (0 for unattended farm stand and non-usage of any social media)
	Real-time product inventory in own stand	Check real-time product inventory at their farm stand if necessary	1 = Present, 0 = Absent	Mention of direct observation by clerks or remotely using RTIS
	Customer perspective	Observe the stands from customer's point of view	1 = Present, 0 = Absent	Mention of gaining new perspectives through continuous viewing RTIS images or conversation with customers using RTIS for sales floor improvement
Information outside the farm	Product prices at other stands	Review the selling prices of other farm stands	1 = Present, 0 = Absent	Mention of checking prices of products there
	Other stand products	Examine the variety of products sold at other farm stands	1 = Present, 0 = Absent	Mention of checking products variety there
	Displays of other stands	Observe the displays at other farm stands	1 = Present, 0 = Absent	Mention of checking how to display products and price tags there
	System evaluation from their customers	Confirm system evaluations with farm stand customers	1 = Present, 0 = Absent	Mention of receiving positive feedback regarding its convenience for shopping or improvement requests such as changing the field of view

Table A2. Changes in Market Orientation Among Case Study Farmers

CUSTOMER ORIENTATION						
ID	Customer satisfaction objectives			Customer commitment		
	0m	3m	12m	0m	3m	12m
A1	<ul style="list-style-type: none"> ○ We started a layaway service based on visitor requests. 			<ul style="list-style-type: none"> ○ We placed an information sign for our farm stand in a position visible from the main street so that first-time customers can find it without getting lost. 	<ul style="list-style-type: none"> ● We considered the color scheme of the entire store to make customers feel comfortable at our farm stand. ● We placed popular items within the camera's coverage area and clearly indicated that additional items were available outside the area so that customers see value in coming in. 	<ul style="list-style-type: none"> ● We introduced RTIS to customers instead of SNS because it allows them to intuitively understand the sales condition. ● We particularly recommend the RTIS to customers who buy multiple items or travel from a distance.
A2	<ul style="list-style-type: none"> ○ In response to customer feedback, we began offering low-sugar tomatoes and tomatoes suitable for gift giving. 			<ul style="list-style-type: none"> ○ We announced the scheduled end of sales on SNS to ensure that interested customers had the opportunity to purchase before sales closed. ○ We used unique trade names for our products instead of common variety names to help customers better understand their characteristics. ○ We placed a sign with information about our farm stand on the main street so that first-time customers could find us easily. 	<ul style="list-style-type: none"> ● We not only check store conditions using the RTIS but also identify peak sales hours to prevent stock shortages. ● We assure our customers that they can shop with confidence because their images are not leaked through the RTIS. 	<ul style="list-style-type: none"> ● We have identified patterns in higher sales periods as well as peak sales hours. For example, customers tend to purchase more items when the sales floor is less crowded with products.
A3				<ul style="list-style-type: none"> ○ We track how many times customers scan the QR codes at our farm stands to measure the effectiveness of our advertising. ○ We sell our products in small, convenient bags to encourage customers to purchase them. 		<ul style="list-style-type: none"> ● We introduced the RTIS to customers who travel from far away or are strongly committed to attending our farm's event.

B1	<ul style="list-style-type: none"> ○ We cropped and sold herbs when we had extra land and labor available, responding to our customers' requests. 	<ul style="list-style-type: none"> ○ We introduced an electronic payment service at our farm stand to participate in discount promotions. 	<ul style="list-style-type: none"> ● We keep our farm stand looking attractive because customers see it regularly via the RTIS system. For example, we change the sheets on the sales floor once a year. 	<ul style="list-style-type: none"> ● We installed a vending machine and consistently sell products to increase opportunities for customers to make purchases. ● We also use a municipal information dissemination application to share recommendations for our farm stand.
B2	<p>We opened a LINE account to send information to customers who did not use Instagram, based on their requests.</p>	<ul style="list-style-type: none"> ● We posted the locations of our farm stands on Google Maps to guide customers who do not use SNS. 	<ul style="list-style-type: none"> ● We promote items aggressively on Instagram, which has a large audience, and share information about items with smaller quantities on our official LINE account, which is seen by frequent customers. 	<ul style="list-style-type: none"> ● We recognized the need to renew our price tags and recipe information and visited other farm stands with the RTIS system to study how to display effective pop-ups.
C1				
C2	<p>We listened to customers' recorded soliloquies from the camera and referred to them when setting prices.</p>	<ul style="list-style-type: none"> ○ We placed an information sign for our farm stand on the main street to help first-time customers find it without getting lost. 	<ul style="list-style-type: none"> ○ We placed take-home flyers at our farm stands so customers could view the RTIS information at home. 	
D1				
D2				<ul style="list-style-type: none"> ○ We replaced the "open" sign with a larger one to make it visible via the RTIS system.

Note: 0m denotes data collected at the time of RTIS system installation, while 3m and 12m represent three months and one year afterward, respectively.

○ indicates the market orientation identified before the system was used.

● indicates the market orientation identified after system use.

These notations are consistent throughout the following tables.

Table A2 continued

CUSTOMER ORIENTATION						
Create customer value			Measure customer satisfaction			
ID	0m	3m	12m	0m	3m	12m
A1	<ul style="list-style-type: none"> ○ We made a time-lapse video of the sales-floor remodeling process and showed it to our clients to build anticipation. ○ By using our own brand name, we communicate to customers that we produce and sell seasonal vegetables rich in flavor. 	<ul style="list-style-type: none"> ● We consistently replenish the sales floor with products and keep the store open on time, ensuring customers see our farm stand through the RTIS system. 	<ul style="list-style-type: none"> ● We plan to make the selling price less visible through the RTIS system, considering customers who buy our goods through other sales channels where quality and prices are higher. 	<ul style="list-style-type: none"> ○ We select the items we sell based on our customers' preferences and ask them to evaluate the quality after purchase. 	<ul style="list-style-type: none"> ● We use the RTIS system to understand what our customers see at our farm stand. 	
A2	<ul style="list-style-type: none"> ○ We publicize the expected start of sales through SNS and inserts to generate customer excitement. ○ We adhere to a pricing standard based on sugar content and inform customers that they can shop confidently at our farm stand by displaying sugar content clearly. ○ We use the same product stickers at our farm stand as in other sales channels, linking these prices under the same brand. 			<ul style="list-style-type: none"> ○ We assess customer satisfaction with each product through direct conversations at our farm stand. 		
A3	<ul style="list-style-type: none"> ○ We display posts at our farm stand highlighting the unique qualities of our products compared to other farmers' to support premium pricing. ○ We publicize the expected start of sales through SNS to build customer anticipation. ○ We use the same packaging and stickers for B-grade products as for A-grade ones to convey the farm's name and quality. 		<ul style="list-style-type: none"> ● We developed our production department to better meet the demand generated by the RTIS system and to encourage purchasing. 	<ul style="list-style-type: none"> ○ We interview supermarkets and markets to gather information on customer responses, shelf space, store conditions, and customer needs. 		

	<ul style="list-style-type: none"> ○ We continue to use the same tomato varieties to maintain consistent taste. 		
B1	<ul style="list-style-type: none"> ● We had willingness to expand our product variety because customers regularly used the RTIS system to browse the sales floor. 	<ul style="list-style-type: none"> ○ We request customers' opinions on new items and use their feedback to decide whether to continue selling them. 	<ul style="list-style-type: none"> ● We proposed to the system developer that an access counter be installed to measure the impact of RTIS on customer engagement.
B2		<ul style="list-style-type: none"> ○ We ask customers to compare our items with those from their neighborhood. 	
C1	<ul style="list-style-type: none"> ○ Because many customers look forward to the start of kiwifruit sales, we post the scheduled date at our farm stand. 		<ul style="list-style-type: none"> ● The RTIS system helped us to understand that our customers often bought unusual items and were satisfied with them.
C2			<ul style="list-style-type: none"> ● We monitor customer satisfaction by capturing their soliloquies through the camera's sound collection feature.
D1	<ul style="list-style-type: none"> ● We raise awareness to increase the number of items, ensuring the RTIS system effectively disseminates information about our farm stand. 		
D2			

Table A2 continued

CUSTOMER ORIENTATION						
ID	After-sales services			Understand customer needs		
	0m	3m	12m	0m	3m	12m
A1	<ul style="list-style-type: none"> ○ We sell salad sets that are easy to prepare for customers who live alone, making it easier for them to buy our products. ○ We promote unusual items with simple recipes through pop-ups and SNS. 			<ul style="list-style-type: none"> ○ We not only listen to our customers' requests but also encourage them to share their cooking success with us, which we then share with other customers through SNS and in person. 		
A2	<ul style="list-style-type: none"> ○ We demonstrate how to cook with our products via Instagram. 			<ul style="list-style-type: none"> ○ We identified demand for tomatos with low sugar content and tomatos suitable for gift-giving. 		
A3	<ul style="list-style-type: none"> ○ We plan to sell salad sets combined with other items to help customers prepare meals easily. 		<ul style="list-style-type: none"> ● We make and sell sweet potatoes at our farm stand in winter to encourage customers to visit and provide them with easy meal options. 	<ul style="list-style-type: none"> ○ We gathered customer requests through SNS and at our farm experience events. 		
B1				<ul style="list-style-type: none"> ○ We learned cooking methods for vegetables from our customers and recommended these to others. ○ We discovered customer requests during conversations at our farm stand; for example, many asked us to sell herbs. 		
B2	<ul style="list-style-type: none"> ○ We recognized that customers needed information about our farm stand beyond Instagram and saw the need for additional information tools. ○ We understand our customers' purchasing behavior before and after visiting the farm stand. 					

C1	○ We post simple cooking instructions for unusual products at the farm stand to inform customers.		● We recognized strong customer demand because we created the RTIS flyer ourselves, and more clients than expected took it home.
C2	○ We provide cooking tips for expensive items, such as peanuts.	● We identified items that customers were unsure how to cook from their camera-recorded soliloquies and provided instructions on how to prepare them.	
D1			
D2			

Table A2 continued

COMPETITOR ORIENTATION						
ID	Salespeople share competitor information			Respond rapidly to competitors' actions		
	0m	3m	12m	0m	3m	12m
A1				<ul style="list-style-type: none"> ○ We asked our extension advisors how to correctly use sensitive terms such as “pesticide-free” and “organic” used by other farmers, and we applied these terms appropriately on SNS. 		
A2	<ul style="list-style-type: none"> ○ We often buy and eat tomatoes produced by competing farmers. ○ We examine the fruit tomatoes sold by other farmers on e-commerce platforms to determine appropriate sizes and promotional strategies. 			<ul style="list-style-type: none"> ○ We decide the price difference between our products and those of other farmers by comparing sugar content and taste. 		
A3	<ul style="list-style-type: none"> ○ We evaluate the quality of our tomatoes by tasting those sold by other farms and comparing their prices. 			<ul style="list-style-type: none"> ○ We plan to reduce our sales volume at the cooperative farmers market if other farmers continue to sell at lower prices. 		
B1		<ul style="list-style-type: none"> ● We observed other farm stands through the RTIS system and felt motivated by their improvements to their sales floors. ● We considered which products we could and should produce on our own farm by studying other farm stands via the RTIS system. 		<ul style="list-style-type: none"> ○ We ship to supermarkets without competition from other farmers during periods when other farmers' products overlap with ours at the cooperative farmers market. ○ We determine our selling price by examining prices at supermarkets and the cooperative farmers market. 		
B2		<ul style="list-style-type: none"> ● We closely examine the sales methods of newly discovered farm stands through the RTIS 	<ul style="list-style-type: none"> ● We considered introducing a vending machine at our farm stand and used the RTIS system to 	<ul style="list-style-type: none"> ○ We mainly ship items that neighboring farmers do not sell at the cooperative farmers market. 	<ul style="list-style-type: none"> ● We use the RTIS system to monitor vegetable price quotations in other areas 	

	system.	examine unattended sales areas to identify effective sales practices.	of Tokyo because, although we often sell products to nearby customers, we recognize the need to develop future sales channels.
C1	<ul style="list-style-type: none"> ● We consider which products or varieties we could and should produce on our own farm by observing other farm stands through the RTIS system. 	<ul style="list-style-type: none"> ○ We set our selling price considering the prices at other stores frequented by our customers. ○ We choose to grow and sell varieties not produced by neighboring farmers. 	<ul style="list-style-type: none"> ● We used the RTIS system to track vegetable price quotations at other farm stands since we only sold our vegetables at our own stand and had limited price reference information.
C2		<ul style="list-style-type: none"> ○ We plant new varieties and crops introduced at workshops and adopt a strategy to differentiate ourselves from neighboring farmers. 	
D1	<ul style="list-style-type: none"> ● We browsed B2's farm stands via the RTIS system to check their prices and items for reference in our own cultivation and sales. ● We used the RTIS system to study the management of other farm stands, especially since COVID-19 reduced our opportunities to visit them in person. 		
D2	<ul style="list-style-type: none"> ○ We frequently examine vegetables from other producers at communal markets and supermarkets, checking their prices as well. 	<ul style="list-style-type: none"> ● We launched an Instagram account and studied how other farmers marketed their products. 	

Table A2 continued

COMPETITOR ORIENTATION		
Target opportunities for competitive advantages		
ID	0m	12m
A1	<ul style="list-style-type: none"> ○ We choose cultivated products based on our customers' preferences rather than social trends because following trends too closely might drive customers to other farm stands. ○ We do not easily lower the price of our products, as doing so could cause customers seeking high-quality produce to leave. 	<ul style="list-style-type: none"> ● We reassure customers during business hours by ensuring enough vegetables are available for purchase, since, according to the RTIS system, some other farm stands do not clearly indicate whether they are open.
A2	<ul style="list-style-type: none"> ○ We maintain the price of our produce by differentiating our quality from other farmers; for example, we sell tomatoes with higher sugar content than neighboring farmers and offer them at a lower price compared to other high-sugar tomatoes. ○ We implement differentiation strategies such as showcasing our farm's history and emphasizing product freshness—approaches not used by online tomato marketing companies. 	
A3	<ul style="list-style-type: none"> ○ We viewed neighboring farmers who grew tomatoes in greenhouses and sold them as competitors and therefore adopted different sales methods. 	
B1	<ul style="list-style-type: none"> ○ We were aware of farm stands running cashless payment redemption campaigns and recognized our farm stand's location as more advantageous than others. 	
B2	<ul style="list-style-type: none"> ○ We also sell produce purchased from three other farmers at our farm stand, believing that offering a wide variety helps us stand out. ○ We focus on growing and selling cut flowers because many customers want them and competition in the neighborhood is limited. 	
C1		
C2	<ul style="list-style-type: none"> ○ We ship much of our produce to school lunches and supermarkets because prices and quality at farmers markets are lower, preventing us from achieving high profits there. 	
D1		
D2	<ul style="list-style-type: none"> ○ We differentiate ourselves from other farmers through quality rather than branding strategies. 	

Table A2 continued

INTERFUNCTIONAL COORDINATION						
ID	All functions contribute to customer value			Functional integration in strategy		
	0m	3m	12m	0m	3m	12m
A1	<ul style="list-style-type: none"> ○ We use both Instagram and an official LINE account for social networking: Instagram targets consumers who have never visited our farm stand or who buy our products at other shops, while LINE is reserved for those who have visited the farm stand. ○ We share supportive customer comments received through SNS with the entire family to motivate everyone to work. 			<ul style="list-style-type: none"> ○ Our successor has experience in the child-care business and applies this experience to create pop-ups for our products. ○ We use the same pop-up at our farm stand that we have previously used at the market. ○ We display our family crest at the farm stand to convey to customers the significance of our farm's history. 	<ul style="list-style-type: none"> ● Our successor taught our manager the functions of the RTIS system and verified the product shipping system using it. 	<ul style="list-style-type: none"> ● We posted RTIS information on Instagram and on the price box at our farm stand so all customers can see it.
A2	<ul style="list-style-type: none"> ○ We maintain a clear decision-making process within our farm; for example, female employees decide the design of the product seal based on their opinions. 			<ul style="list-style-type: none"> ○ We divided cultivation responsibilities between the manager and his successor but cooperate in shipping to improve operational efficiency. 	<ul style="list-style-type: none"> ● Our successor taught our manager how to use the RTIS system for promotional purposes. ● We centralized information on our farm stand so customers can access the RTIS system through our farm's website. 	
A3	<ul style="list-style-type: none"> ○ We conduct annual staff surveys to understand their preferred tasks, aiming to enhance their skills and motivation. ○ We involve all staff members in customer experience events, allowing them to hear directly from customers to boost motivation and encourage creativity. 			<ul style="list-style-type: none"> ○ We pay allowances to staff members skilled in photography to manage SNS outside of their regular working hours. ○ We revised work manuals based on staff feedback. ○ We use common shipping bags for products across sales channels to accommodate sudden shipment changes. 		<ul style="list-style-type: none"> ● Our manager taught all staff the functions of the RTIS system and verified the product shipping system using it.

B1	<ul style="list-style-type: none"> ○ We discuss and decide within the family whether to share information about our farm stand through SNS. 	<ul style="list-style-type: none"> ● Our successor taught all family members how to use the RTIS system and shared ways to introduce it to customers at our farm stand. ● Our successor taught the manager's wife how to post on Instagram so she can share information about our farm stand with customers during slower work periods.
B2	<ul style="list-style-type: none"> ○ We discuss and decide within the family which information to disseminate to customers through SNS. 	<ul style="list-style-type: none"> ● Our successor taught all family members how to use the RTIS system and shared how to introduce it to customers at our farm stand. ● We enabled our customers to access the RTIS system through all our SNS channels and Google Maps. ● To create pop-ups for customers using the RTIS system, our successor proposed sharing information between a staff member skilled in cooking vegetables and another skilled in design.
C1	<ul style="list-style-type: none"> ○ Our successor, skilled in PC design, created all posters displayed at our farm stand. ○ We use Google Calendar to share work schedules. 	<ul style="list-style-type: none"> ● Our successor taught our manager how to use the RTIS system.
C2	<ul style="list-style-type: none"> ○ We use a farm management information system to share cultivation and marketing data between the principal and successor, enabling joint decisions on work plans and sales channels. 	<ul style="list-style-type: none"> ● Our successor taught our manager the functions of the RTIS system and verified the product shipping system using it. ● When our successor was away from the farm stand and detected an anomaly through the RTIS system, he informed the manager to resolve the issue promptly.
D1		
D2		

Table A3. Effects of Using the Real-Time Image Sharing System among the Case Study Farmers

ID	Shipping optimization			Process innovation		
	0m	3m	12m	0m	3m	12m
A1		<ul style="list-style-type: none"> When our successor couple work outside, they check our farm stand via the RTIS system and replenish products if needed. If one of them cannot replenish, he or she asks the other to do so. 	<ul style="list-style-type: none"> Our successor couple checks our farm stand using the RTIS system, and when neither of them can replenish, they ask our manager couple to do so. 			<ul style="list-style-type: none"> We guide our customers to check the RTIS system in advance when they ask us to reserve products. We display fresh and well-stocked items in the center of the camera's range, increasing the likelihood that customers will order them.
A2		<ul style="list-style-type: none"> Our successor and the proprietor check the farm stand via the RTIS system. Based on the results, they also determine the approximate replenishment time. 				<ul style="list-style-type: none"> We discovered that customers buy more products when they see that others are buying them. Therefore, we deliberately leave some blank space on the sales floor to signal that it is a popular farm stand rather than filling it completely.
A3		<ul style="list-style-type: none"> When our manager works outside, he checks our farm stand and sometimes asks our staff to replenish products. 	<ul style="list-style-type: none"> Based on changes in product volume seen via the RTIS system, we determine the approximate replenishment time. 			<ul style="list-style-type: none"> We trained our staff on how to use the RTIS system and emphasize the importance of creating a customer-focused sales floor and service.
B1	<ul style="list-style-type: none"> We have two clerks, and when we need to replenish, the clerks contact the successor in charge of cultivation. 	<ul style="list-style-type: none"> During the busy season, our successor monitors our farm stand with the RTIS system and replenishes products before the clerks contact him. 			<ul style="list-style-type: none"> Based on our experience talking with customers, we understood the visibility of each product via the RTIS system and adjusted product placement to enhance the value of visualization. 	
B2	<ul style="list-style-type: none"> We have two clerks. When we need to replenish, the clerks contact the staff in charge of cultivation. 				<ul style="list-style-type: none"> We encourage customers to identify products and prices by looking at pop-ups via the RTIS system, increasing its value and reducing their inquiries to us. 	

ID	Shipping optimization			Process innovation		
	0m	3m	12m	0m	3m	12m
C1		<ul style="list-style-type: none"> ● Our successor and manager check our farm stand with the RTIS when working on the farm, going out, or even at home to replenish products efficiently. 				
C2		<ul style="list-style-type: none"> ● Our successor checks our farm stand via the RTIS system when working in the field, going outside, or at home. When he is away and notices replenishment is needed, he asks our manager to do so. 	<ul style="list-style-type: none"> ● The successor determines the estimated replenishment time based on changes in product volume seen via the RTIS system. 			
D1		<ul style="list-style-type: none"> ● Our manager checks our farm stand with the RTIS system while working in the field and decides whether or not to replenish products. 	<ul style="list-style-type: none"> – We were unable to improve shipments owing to reduced labor and inconsistent or decreased production. 			
D2		<ul style="list-style-type: none"> ● Our manager checks our farm stand via the RTIS system when he goes outside and sometimes asks his wife to replenish products. 	<ul style="list-style-type: none"> – We had very few products to replenish our farm stand because steady demand existed through our other sales channels. 			

Note: ○ indicates effects observed before the system was used, ● indicates effects observed after the system was implemented, and – indicates a loss of effect.