A Comparison of Cost and Benefit in Rice Production between Farmer Economies in Japan and China

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Abstract

This study examines the cost-benefit dynamics of rice production in Japan and China, with a particular focus on farm size, cost structure, and productivity. Utilizing data from both countries, we classify farmers into two categories based on landholdings: those cultivating less than 6.67 hectares and those with 6.67 hectares or more. This distinction allows us to assess the impact of farm size on agricultural performance. Our analysis reveals that large-scale farmers in both Japan and China achieve higher yields per hectare. However, while large-scale farmers in Japan demonstrate superior cost control and profitability, their counterparts in China face higher per-unit area costs, particularly in labor and land, which often result in financial losses. Similarly, small-scale farmers in both countries tend to operate at a loss. A comparative analysis of cost structures indicates that labor and capital costs constitute a significant share of rice production expenses in Japan, whereas land costs are more prominent in China. These findings highlight the critical role of mechanization, labor expenses, and land costs in shaping the economic landscape of rice farming in both nations. The study suggest that policy interventions focusing on technological innovation, cost reduction, and farm-scale efficiency could improve the profitability and sustainability of rice farming in Japan and China. This research contributes to understanding the economic and structural challenges in rice production and offers insights for improving agricultural policies in both nations.

Keywords: Farmer economy; Economies of scale; Cost-benefit analysis
JEL Classification: O12; Q12; Q18

1. Introduction

Rice production plays a crucial role in ensuring food security and supporting rural development in both Japan and China, where rice serves as a staple food. Japan maintains a nearly 100% self-sufficiency rate for rice, despite an overall food self-sufficiency rate of only 38% in terms of caloric intake. China accounts for approximately one-third of Asia's total rice production and consumption, and rice contributes to 40% of calorie intake. The demand for high-quality and nutritious rice has been rising rapidly. While rice consumption in China is expected to decline due to an increasingly diverse food supply, its overall volume remains critical for such a populous nation. Meanwhile, Japan has experienced a shrinking domestic rice market over the past decade.

Rice production in both Japan and China is primarily carried out by farmers, the majority of whom operate on a small scale. Given this context, a comparative analysis of rice cultivation between the two countries is both necessary and insightful. This study examines the costs and revenues associated with rice farming in Japan and China, exploring differences in input-output dynamics and identifying key factors limiting income growth.

Studying this issue is of great significance for several reasons. First, the analysis helps us understand the cost and revenue structure of rice cultivation in both countries, thereby identifying the constraints on improving rice profitability and efficiency. Second, this provides valuable policy references for the formulation and implementation of agricultural development strategies in both countries. Japan's shift from the Gentan policy to promoting agricultural exports, with China as a key market, makes it essential to compare rice production costs and efficiency in both countries. This comparison can enhance productivity and support a more integrated agricultural market. For China, studying Japan's agricultural strategies and technologies offers useful lessons for improving rice farming efficiency and sustainability.

Finally, a common global challenge in agriculture is how to mitigate the impacts of climate change while ensuring sustainable agricultural production. Balancing sufficient food

security with environmental concerns has become increasingly urgent. Agriculture must maintain adequate output to meet market demand, increase farmer incomes, and stabilize agricultural prices. As major rice-producing countries, both Japan and China are directly affected by these global challenges. A deeper understanding of their rice cultivation approaches and the constraints they face will provide valuable insights into how both nations can adapt to climate change while maintaining agricultural productivity and farmer livelihoods. In conclusion, comparing rice cultivation in Japan and China is not only crucial for ensuring stable rice production and improving farmers' income but also for understanding the differences in their agricultural systems and contributing to the broader dialogue on sustainable agricultural development and global challenges including climate change.

2. Stylized Facts of Rice Production in Japan and China

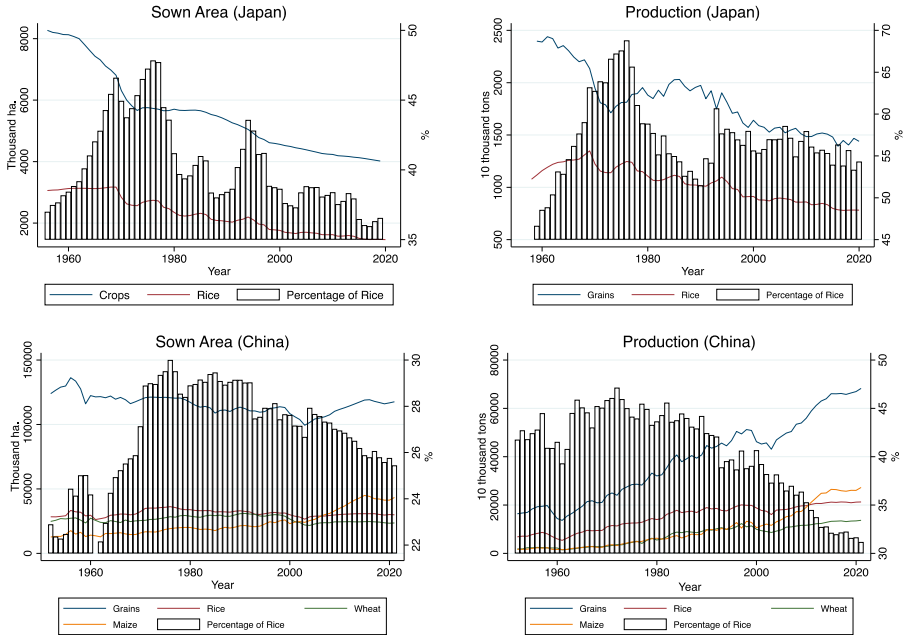
2.1 Domestic Rice Production and Trade

Japan's rice production is facing unprecedented challenges due to shifts in domestic food consumption patterns, an aging population, and a declining birthrate (Kusakari, 2011). The continuous decline in rice consumption poses a significant challenge to maintaining the domestic agricultural production base. As illustrated in Figure 1, Japan's rice cultivation area has steadily decreased since the 1980s. While the overall grain cultivation area has declined, rice's share of total grain sown area has dropped from a peak of 45% to the current 35%. Despite this reduction, rice remains Japan's dominant staple crop, accounting for more than 50% of total grain production.

In contrast, China has experienced a slow but steady increase in rice cultivation area and production since the 1980s. However, structural adjustments in cropping patterns and the loss of arable land due to urbanization have significantly impacted agricultural transformation (Hou et al., 2021). Rapid urbanization and the expansion of non-agricultural sectors have led to notable shifts in rice farming, particularly the transition from double cropping to single cropping. Due to labor shortages, approximately 37% of farmers have adopted single cropping, contributing to a decline in the total rice sown area and yield levels since the early 1980s (Chen et al., 2013). As a result, rice's share of total grain sown area has fallen below 26%, while its share of total grain production has declined to approximately 30%. In summary, Japan and China have experienced divergent trends in rice production and cultivation area since the 1980s. Japan has seen a continuous decline in rice cultivation area, with rice's share of total grain sown area decreasing, though it still maintains a dominant position in total grain production. Meanwhile, China's rice cultivation area and production have grown slowly, but the increasing demand for corn has led to a gradual reduction in rice's share of both the total grain sown area and total grain production. These trends reflect the differing challenges and shifts in food production priorities in both countries.

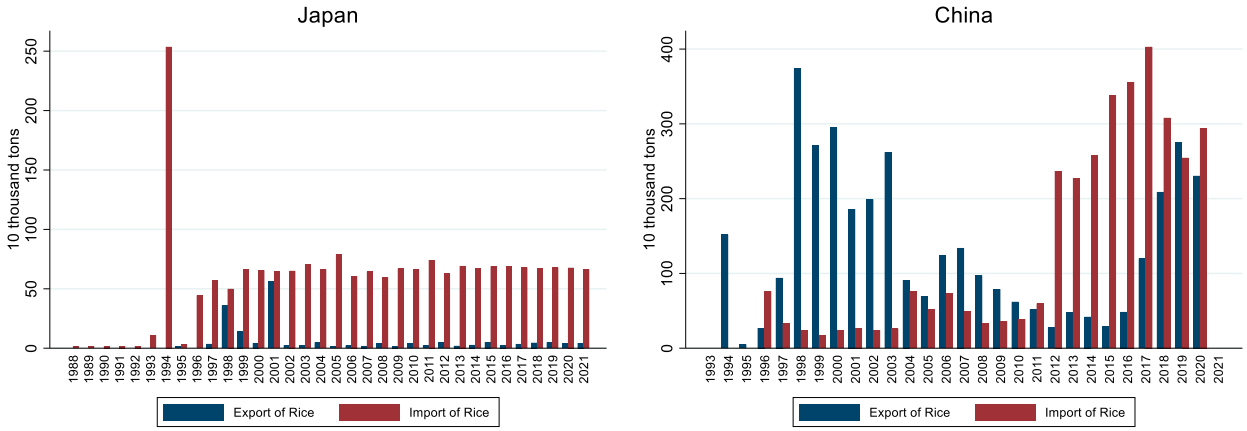
Japan, abolished the rice acreage reduction program (known as the Gentan Policy: 1970-2018) and attempts reduce agricultural production costs, in order to enhance the international competitiveness of agricultural products and promote the export of Japanese agricultural products, including rice. However, as shown in Figure 2, while Japan's rice export volume has been

Figure 1: Rice Production in Japan and China



Source: The data are from the database of the Ministry of Agriculture, Forestry, and Fisheries of Japan and the annual database of the National Bureau of Statistics of China.

Figure 2: Rice Export and Import in Japan and China



Source: The data are from the database of the Ministry of Agriculture, Forestry, and Fisheries of Japan and the annual database of the National Bureau of Statistics of China.

gradually increasing in recent years, its import volume remains substantial. A significant portion of rice imports is used for variety exchange and feed purposes.

In contrast, in China, due to the technical barriers in rice production and the continuous rise in production costs, stabilizing rice production to ensure food security and increasing the income of rice farmers have become the country's primary policy objectives. In the past decade, China's rice export volume has been increasing, but the import volume has grown even faster, resulting in a rice trade deficit.

2.2 Structure of Agricultural Entities in Rice Production

In both Japan and China, the primary producers of rice are farmers. According to Japan's 2020 Agricultural Census, there were 1.07 million farming households in the country, with 70% engaged in rice cultivation. In terms of farm size distribution, small-scale farmers (those operating on less than 3 hectares) accounted for 84% of all farming entities (see Figure 3). However, large-scale farmers managing over 20 hectares, though comprising only 3% of all rice producers, cultivated as much as 38% of Japan's total rice-growing area.

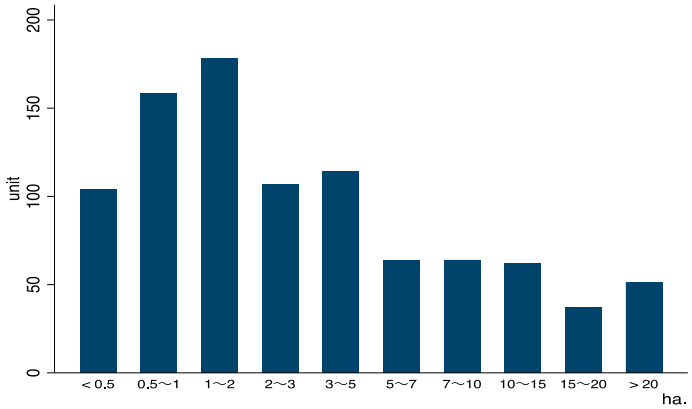
In China, the scale of rice farming is even smaller. As shown in Figure 4, 74% of Chinese farmers operate on less than 0.46 hectares of land, reflecting the highly fragmented nature of rice cultivation in the country.

2.3 Rice Processing and Distribution

Rice processing in Japan is characterized by a high degree of standardization and mechanization, with stringent quality controls imposed by the government to ensure both the safety and quality of rice. The sector is predominantly dominated by agricultural cooperatives and large enterprises, which oversee various stages of processing. In contrast, China's rice processing industry is highly diverse, encompassing both large state-owned enterprises and a vast number of small and medium-sized local businesses. While rice processing technology continues to advance, significant regional disparities persist, with some areas still relying on relatively basic equipment.

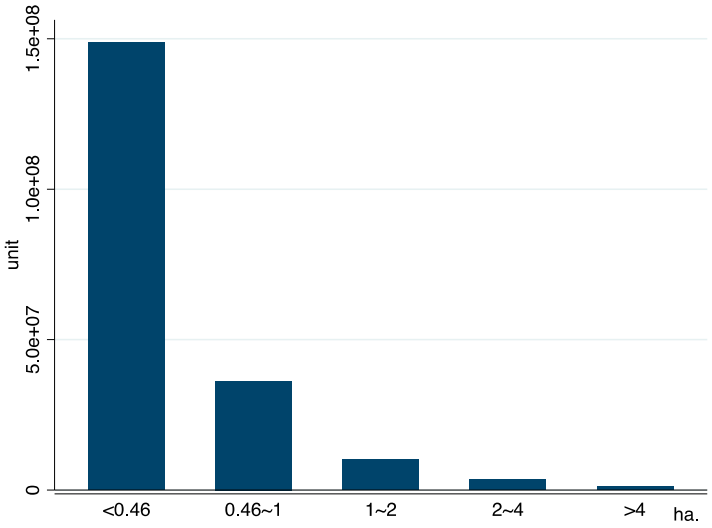
Regarding distribution, Japan's rice market is primarily managed through agricultural cooperatives (JA), which play a central role in procurement, storage, processing, and sales.

Figure 3. Distribution of Rice Farming Land Size in Japan



Source: The data are from Statistical Survey on Farm Management and Economy (Statistics Code: 00500201), Ministry of Agriculture, Forestry, and Fisheries of Japan.

Figure 4. The distribution of land size for farmers' operations in China



Source: The data are from China's Second National Agricultural Census (2006).

The distribution system is relatively closed, with rice mainly sold through traditional markets and supermarkets, and limited external demand. In contrast, China's rice distribution channels are more extensive, including wholesale markets, retail supermarkets, processors and millers, local shops and an expanding presence in e-commerce platforms. In recent years, online sales have played an increasingly significant role in the domestic rice market. Grain Minimum Purchase Price Policy was released in 2004. This policy ensures that the government purchases key grains (e.g., wheat, rice) from farmers at a pre-announced minimum price when market prices fall below the threshold. It aims to protect farmers' income stability and strengthen national food security.

Overall, Japan's rice supply system follows a model in which small-scale farmers are closely linked to agricultural cooperatives (JA), while in China, rice supply chain involves production by traditional small-holder farmers, new agricultural operators (such as specialized cooperatives and agribusiness enterprises), and family farms. It is characterized by decentralized small-holder farming, diverse participation and combination of scale and intensive farming, which is under transitioning toward market-oriented efficiency and greater scale while balancing food security with fiscal and competitive challenges.

3. Cost and Benefit Analysis in the Rice Sector

Given the critical role of land size in assessing and explaining agricultural production activities (Chayanov, 1991; Cornia, 1985; Hall & LeVeen, 1978; Helfand & Levine, 2004; Henneberry et al., 1991; Khataza et al., 2019; Lowder et al., 2016; Mottaleb & Mohanty, 2015; Weersink & Tauer, 1991; Wolf & Sumner, 2001), this study categorizes farmers into two groups: those operating on less than 6.67 hectares and those with 6.67 hectares or more. This classification aims to minimize the influence of land size on the analysis of rice production.

Table 1 presents operational data from farmers with landholdings below 6.67 hectares compared to those with larger holdings in Japan. The findings indicate that large-scale farmers achieve higher yields per unit area than small-scale farmers. Additionally, large-scale farmers demonstrate greater efficiency in fertilizer usage, applying a lower quantity of fertilizer per unit area. In terms of costs and revenues per unit area, large-scale farmers generate higher revenues and incur lower costs than their small-scale counterparts. As a result, the net profit for large-scale farmers is significantly higher. Notably, farmers with landholdings below 6.67 hectares report negative net profits, while those with larger holdings achieve positive net profits.

According to the data in Table 2, a similar pattern can be observed in rice production in China. Large-scale farmers attain higher yields per unit area than small-scale farmers. However, unlike in Japan, fertilizer usage per unit area is higher among large-scale farmers. Regarding per-unit area costs and revenues, large-scale farmers generate higher revenues but also incur higher costs compared to small-scale farmers. Although both groups operate at a loss, the financial performance of large-scale farmers is relatively better.

When comparing per-unit area rice yields between China and Japan, it is evident that Japan's yields are lower than those in China within the same farm size category. For instance, in the group with landholdings smaller than 6.67 hectares, the per-hectare yield in Japan is 4,707.17 kg, while in China, it is 7,627.50 kg. This suggests that, at the same scale, land productivity in China is superior. One possible explanation for this discrepancy is Japan's long-term policy of reducing

Table 1. Significance Test of Production Differences Among Rice Farmers of Various Scales (Japan, 2020–2021)

Variables	Rice Farmers (<6.67ha.)		Rice Farmers (>=6.67ha.)		Diff.
	Obs.	Means	Obs.	Means	
Yield (kg/ha.)	1242	4707.17	366	5507.90	-800.73***
Area (ha.)	1242	1.54	366	19.46	-17.92***
Fertilizer (kg/ ha.)	146	4807.62	52	2230.98	2576.64**
Nitrogen (kg/ha.)	128	129.73	91	82.51	47.23***
Phosphorus (kg/ha.)	150	263.15	44	113.25	149.90***
Potassium (kg/ha.)	66	126.21	15	34.33	91.88***
Others (kg/ha.)	20	1256.35	21	1021.00	235.35**
Organic fertilizer (kg/ha.)	146	4712.62	52	2133.21	2579.41**
Total income (JPY/ha.)	1242	981866.96	366	1130605.57	-148738.61***
Total cost (JPY/ha.)	1242	1629687.78	366	1045075.60	584612.20***
Fertilizer cost (JPY/ha.)	1239	95240.00	366	87115.00	8125.00***
Pesticide cost (JPY/ha.)	1239	82367.96	364	72966.43	9401.53***
Seed cost (JPY/ha.)	1237	54867.90	360	21022.36	33845.54***
Labor cost (JPY/ha.)	1242	464070.63	366	237142.19	226928.4***
Other cost (JPY/ha.)	1232	739794.79	358	449378.55	290416.2***
Farming profit (JPY/ha.)	1242	-647820.81	366	85529.97	-733350.8***

Source: Calculated by the authors. The data are collected as part of the Statistical Survey on Farm Management and Economy (Statistics code: 00500201) conducted by the Ministry of Agricultural, Forestry, and Fisheries of Japan.

Note: (1) Standard errors are reported in parentheses. (2) Significant levels are * 0.10, ** 0.05, *** 0.01.

Table 2. Significance Test of Production Differences Among Rice Farmers of Various Scales (China, 2016)

Variables	Rice Farmers (<6.67ha.)		Rice Farmers (>=6.67ha.)		Diff.
	Obs.	Means	Obs.	Means	
Yield (kg/ha.)	968	7627.50	250	8409.75	-782.25***
Area (ha.)	968	1.01	250	16.58	-3499.65***
Fertilizer (kg/ ha.)	968	550.35	250	614.55	-64.20***
Nitrogen (kg/ha.)	968	106.65	250	122.25	-15.60**
Phosphorus (kg/ha.)	968	13.35	250	14.7	-1.35
Potassium (kg/ha.)	968	24.75	250	30.6	-5.85***
Others (kg/ha.)	968	163.65	250	167.4	-3.75
Organic fertilizer (kg/ha.)	968	246.75	250	4.8	241.95*
Total income (RMB/ha.)	968	21107.70	250	25433.4	-4325.70***
Total cost (RMB/ha.)	968	25340.25	250	29530.65	-4190.40***
Fertilizer cost (RMB/ha.)	968	2016.75	250	1828.2	188.55***
Pesticide cost (RMB/ha.)	956	1250.34	249	1146.6	103.74*
Seed cost (RMB/ha.)	954	1062.45	250	892.5	169.95***
Labor cost (RMB/ha.)	968	7587.60	250	8340.3	-752.70***
Other cost (RMB/ha.)	952	13586.55	249	17375.55	-3789.00***
Farming profit (RMB/ha.)	968	-4232.55	250	-4097.19	-135.36

Source: Calculated by the authors. The data are collected by the project of "Differentiation on the output and efficiency of grain production and its mechanisms of improvement in China" led by the Institute of Crop Sciences, Chinese Academy of Agricultural Science which was implemented in 2016 including 1218 rice farmers covering 615 inbred rice farmers and 603 hybrid rice farmers, respectively.

Note: (1) Standard errors are reported in parentheses. (2) Significant levels are * 0.10, ** 0.05, *** 0.01.

Table 3. Comparison of Cost Structure between Japan and China

	Japan		China	
	(<6.67ha.)	(>=6.67ha.)	(<6.67ha.)	(>=6.67ha.)
Fertilizer cost (%)	6.63	10.04	7.91	6.18
Pesticide cost (%)	5.73	8.41	4.90	3.88
Seed cost (%)	3.82	2.42	4.17	3.02
Labor cost (%)	32.31	27.33	29.75	28.19
Other cost(%)	51.51	51.79	53.27	58.73
Benefit-cost ratio	0.60	1.08	0.83	0.86

Source: Calculated by the authors.

rice production, which has dampened farmers' motivation to enhance per-unit area yields. Additionally, compared to China, the shadow price of labor in Japan's rice sector is relatively high, reducing the incentive for productivity improvements.

To identify the profit constraints in the rice production sectors of Japan and China, let us examine the cost structure. In both countries, labor accounts for approximately one-third of the total cost. However, the proportion of labor costs is lower for large-scale farmers compared to small-scale farmers, indicating that smaller farms bear a higher share of labor costs.

Differences in fertilizer and pesticide usage also exist between the two countries. In Japan, the share of these inputs in total costs is generally higher across all farm size categories, except for the share of fertilizer costs among small-scale farmers. Furthermore, large-scale farmers in Japan allocate a higher proportion of their costs to fertilizers and pesticides compared to small-scale farmers. In contrast, in China, these costs constitute a larger share for small-scale farmers.

Since the current dataset does not provide specific values for land and capital, we utilize calculations from Dong (2024) to compare the share of land and capital in the total cost of the rice production sectors in both countries. Capital investment accounts for over 40% of the total cost in Japan's rice production, while in China, it is only 34%. Conversely, land costs constitute only 10% in Japan but 21% in China. This suggests a higher level of mechanization in Japan's rice production. The extensive use of machinery relies more on standardization and uniformity, facilitating the adoption of capital-intensive practices and contributing to cost reductions.

4. Conclusion

This study has provided an comprehensive analysis of the differences and similarities in rice production in Japan and China, focusing on farm size, cost structure, yield, and capital utilization. The key findings reveal distinct patterns in production efficiency, cost allocation, and economic outcomes across various farm sizes in both countries.

Firstly, both Japan and China exhibit a clear trend where large-scale farmers outperform small-scale farmers in terms of per-hectare yield, cost efficiency, and profitability. However, the cost structure between the two countries differs significantly. In Japan, labor and capital costs dominate, with labor accounting for approximately one-third of the total cost. The high share of capital costs in Japan suggests that the rice sector is more mechanized and relies on capital-intensive machinery to drive efficiency. On the other hand, land costs are a higher proportion of the total costs in China, indicating that land acquisition and utilization are more critical factors in China's rice production.

Moreover, the per-hectare yield comparison between the two countries reveals that China's land productivity is generally higher than Japan's, particularly in small-scale farming. This disparity can be attributed to various factors, including Japan's long-term policy of reducing rice production and the

Table 4 Land and Capital Cost in Rice Production between Japan and China

Per ha.	Japan	*China*
% of Raw Materials	18.53	15.03
% of Labor Cost	29.82	28.97
% of Land Cost	10.68	21.04
% of Capital	40.98	34.96
Cost Revenue Ratio	1.29	0.79

Source: Dong's study, 2024.

relatively high shadow price of labor in Japan, which dampens the incentive for higher productivity. In terms of fertilizer and pesticide usage, Japan's large-scale farmers tend to use higher quantities of these inputs, which contribute to higher production costs. In contrast, small-scale farmers in China exhibit a higher reliance on fertilizers and pesticides, impacting their overall cost structure. Despite these differences, both countries face challenges in controlling costs and achieving positive net profits, with small-scale farmers in both countries generally operating at a loss. The cost-revenue ratio and land and capital cost structure also highlight the underlying economic constraints in both countries' rice sectors. Japan's high capital investment and lower land costs suggest a higher degree of mechanization and standardized practices, whereas China's higher land costs reflect the continued reliance on labor-intensive methods for rice production.

Overall, while both countries encounter challenges related to rising costs, small-scale farming, and ensuring profitability, the solutions and strategies for improving rice production and farmer incomes may differ due to their unique agricultural structures. Policymakers in both Japan and China must focus on enhancing farm-scale efficiency, reducing labor costs, and increasing technological innovation to ensure sustainable rice production and secure farmer livelihoods amid changing economic and demographic conditions. This comparative analysis offers valuable insights into the efficiencies and constraints of rice production systems in both Japan and China, informing future policy decisions and further research on improving agricultural sustainability and food security in both nations.

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