

Comparative economic efficiency of organic and conventional rice production in Central Vietnam: Implications for sustainable development

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Abstract

Vietnam's rice sector faces growing sustainability challenges due to the heavy reliance on agrochemicals in intensive cultivation. The Vietnamese government has promoted organic rice production as a potential solution. However, its economic viability relative to conventional practices remains uncertain, particularly at the regional level. This study addresses this gap by comparing the economic efficiency of organic and conventional rice farming in Thua Thien Hue Province. Data were collected from 100 rice farming households (42 organic, 58 conventional) during the winter–spring 2023 crop. The analysis focused on production costs, revenues, and profits, employing descriptive statistics and independent-samples t-tests. The findings indicate that conventional rice farming generates higher revenues and profits, primarily due to a 29.97 kg/500 m² yield advantage over organic methods. Although organic rice had a slightly higher market price (USD 0.012/kg), this was insufficient to offset the productivity gap. Nevertheless, when family labour costs were excluded, organic farming incurred lower cash production costs, resulting in higher net income. Overall, conventional farming currently delivers greater economic returns in the study area. To enhance the profitability of organic rice cultivation, improving labour efficiency through farmer training and mechanisation is essential. The organic model remains highly dependent on external actors for technical support and market access. While this support has been crucial in enabling organic production, it also highlights the need to empower farmers to reduce such dependency. These insights contribute to the evidence base for designing integrated strategies that support Vietnam's transition toward more sustainable agricultural systems.

Introduction

The global intensification of agricultural practices, driven by the need to meet rising food demands, has resulted in widespread environmental degradation and socio-economic risks (Pingali and Roger 1995; Tilman et al. 2002; Foley et al. 2011; FAO 2017). In Vietnam, the rice sector, a cornerstone of national food security and a major export commodity, has become increasingly reliant on input-intensive methods (Stuart et al. 2018; Maitah et al. 2020; Nguyen et al. 2022; OECD 2023). Over recent decades, efforts to maximise yields through the extensive use of chemical fertilisers and pesticides have led to soil degradation, water

contamination, biodiversity loss, and health risks for both farmers and consumers (Berg 2001; Phuong and Gopalakrishnan 2003; Dasgupta et al. 2007; Lamers et al. 2011; Cassou et al. 2017; Trinh et al. 2018; Cassou et al. 2018). These negative outcomes have raised growing concerns about the long-term sustainability of rice production in the country (World Bank 2016).

In response, the Vietnamese government has promoted sustainable agricultural development by advancing organic rice production as a viable alternative, with a focus on environmental protection, food safety, and rural livelihood enhancement. The Organic Agriculture Development Plan for 2020-2030 sets specific targets to expand organic rice cultivation to 50,000 - 70,000 ha by 2025 and

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100,000 - 150,000 ha by 2030 (Government of Vietnam 2020). These efforts are further reinforced by national standards that formalise organic agricultural practices and offer technical guidelines for production, processing, and labelling (Ministry of Science and Technology 2018, 2017a, 2017b).

Despite formal policy commitments, the adoption of organic rice farming remains limited. A key barrier is the uncertainty surrounding its economic viability. Although organic rice often secures a price premium, lower yields commonly observed in organic systems raise concerns about overall profitability. While research on the economic performance of organic rice in Vietnam is expanding, most studies have focused on the Mekong Delta region (Nguyen, Tran, and Duong 2019; Khong 2022). This has left a notable gap in empirical evidence from the Central region, particularly Thua Thien Hue province.

Thua Thien Hue, characterised by small-scale farming and frequent exposure to climatic stresses such as heavy rainfall, flooding, and tropical storms, presents a relevant context for examining organic rice production. In recent years, the province has piloted several organic rice initiatives, reflecting growing local policy interest in sustainable agricultural practices. While previous studies in the province (Nguyen et al. 2020a; Nguyen et al. 2020b) offer useful insights, they lack comprehensive analyses of production cost structures, revenues, and profitability. Moreover, many assessments overlook the role of family labour - a significant yet frequently unaccounted input.

This study addresses these gaps by comparing the economic efficiency of organic and conventional rice farming in Thuy Phu commune, Thua Thien Hue province. Drawing on primary data from a representative sample of farming households, it provides a detailed and statistically grounded evaluation of the viability of organic rice production in central Vietnam. The findings aim to inform targeted policy interventions, support evidence based

decision-making, and promote more sustainable and resilient rice production systems.

Methodology

Data collection

Secondary data were sourced from official reports issued by the Department of Agriculture and Rural Development (DARD) of Thua Thien Hue Province, focusing on the status and development of organic agricultural production in the region. In addition, in-depth interviews were conducted with key stakeholders involved in the implementation and support of organic rice production at the provincial level. These included representatives from relevant agricultural agencies (Sub-Department of Rural Development and Provincial Agricultural Extension Centre), agricultural cooperatives, and companies participating in organic rice value chains. The interviews provided valuable qualitative insights into the policy context, technical support, and institutional arrangements surrounding the development of the organic rice model in the province.

Primary data were collected through face-to-face interviews with 100 rice farming households in Thuy Phu commune, Huong Thuy town, Thua Thien Hue province. Thuy Phu was selected because of its early and sustained adoption of the organic rice model (since 2016), implemented in collaboration with the Phu Bai Agricultural Cooperative and Que Lam Organic Agriculture Co., Ltd. The commune is located in Huong Thuy, one of the province's key rice-producing areas in terms of acreage and productivity. Data for both organic and conventional models were collected within the same commune, ensuring consistent climatic conditions such as rainfall and temperature across the study area.

A stratified random sampling method was used to ensure proportional representation of the two farming models, resulting in a sample of 42 organic and 58 conventional households.

The survey was conducted from June to August 2023, targeting the winter–spring 2023 crop (January – May), which lasted approximately 125 days. While the organic model exclusively used the J02 rice variety, the conventional model employed a mix of six varieties. Because the unit of analysis in this study was the household rather than individual plots, isolating economic data by specific variety was not feasible. Consequently, the analysis incorporated all rice plots cultivated by each conventional household. To ensure the validity of the economic comparison between the two systems, it is important to note that the J02 variety remained the dominant cultivar in the conventional group, accounting for 56.6% of the total cultivated area. This significant presence serves as a strong reference point, enhancing the comparability with the organic model.

A structured questionnaire was developed based on literature review, expert discussion, and field observations. It was pilot-tested with seven households to ensure clarity and consistency. The final questionnaire collected detailed quantitative data on cultivated area, number of plots, family labour, seed and fertiliser use (quantity and price), productivity, selling price, and production costs.

Data analysis

Descriptive statistics and independent-samples t-tests were employed to examine key production characteristics, economic outcomes, and economic efficiency across the two farming systems. While t-tests assessed statistically significant differences between organic and conventional models, descriptive statistics offered insights into the central tendencies and variability of each indicator.

Economic outcomes were evaluated using standard financial metrics, including revenue, income, and profit per 500 m². Cost-efficiency

ratios, revenue-to-cost, income-to-cost, and profit-to-cost, were computed using both total and cash costs. Labour productivity was analysed through income and profit per family labour day. These indicators together provide a comprehensive basis for comparing economic efficiency across farming systems. All statistical analyses were conducted using Stata version 16.1.

Results

Situation of linkage in organic rice production in Thuy Phu commune

The development of organic agriculture in Thua Thien Hue province has been strongly supported by provincial initiatives, foreign projects, and company involvement, with additional reinforcement from the active participation of agricultural cooperatives. Companies have played a central role in linking production with markets, providing technical support, and ensuring stable purchase prices, while cooperatives coordinate farmer engagement and organise production at the local level. These forms of support have been instrumental in establishing and scaling up the organic rice model in the region.

Que Lam Organic Agriculture Co., Ltd. (referred to as Que Lam Company), a subsidiary of the Que Lam Group Joint Stock Company, collaborates with farmers in Thuy Phu commune to develop organic rice production. This partnership established a tripartite linkage involving organic rice farmers, Phu Bai Agricultural Cooperative, and Que Lam Company. Representing the farmers, the Phu Bai Agricultural Cooperative signed a formal contract with Que Lam Company, witnessed by local authorities (Figure 1).

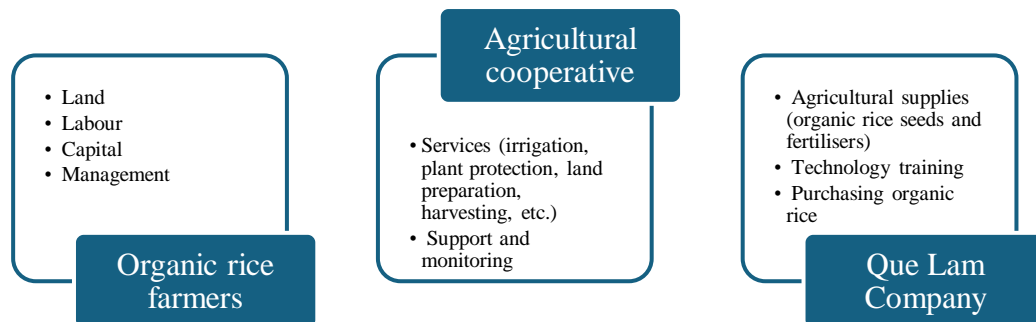


Figure 1: Roles of key actors in the organic rice value chain in Thuy Phu commune.

The partnership between Que Lam Company and farmers in Thuy Phu commune was initiated in 2016 with 24 ha of organic rice cultivation. The area expanded to 37 ha in 2018 and reached a peak of 49.3 ha in 2019. However, during the subsequent period (2020–2022), the cultivated area declined to approximately 30 ha. This reduction was partly attributed to the impact of the COVID-19 pandemic, which led to a contraction in market demand for premium products such as organic rice, thereby prompting the company to reduce its procurement volumes. Furthermore, local

survey findings indicated that some farming households reverted from organic production to conventional practices, driven by limited profitability. These supply-side factors may have further contributed to the contraction of organic cultivation. A more comprehensive analysis of farmers’ production choices and the underlying decision-making dynamics will be presented in a forthcoming publication by the research team. As of the winter-spring 2023 crop, the total area allocated for organic rice production stood at 27 ha, involving 155 participating households (Figure 2).

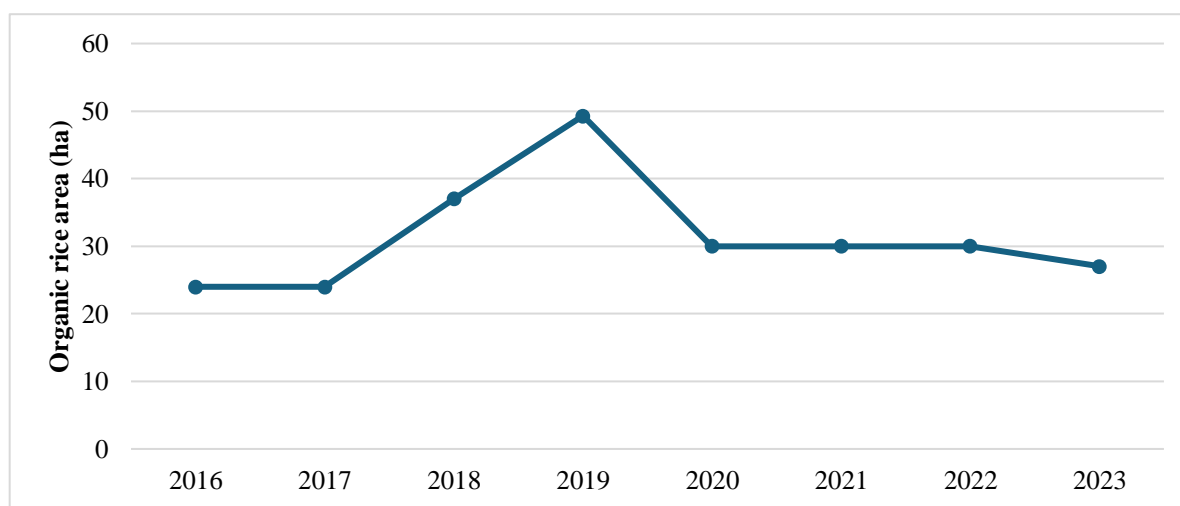


Figure 2: Organic rice cultivation area in Thuy Phu commune, 2016-2023 (hectares).

Source: Phu Bai Agricultural Cooperative, based on contracts co-signed with Organic Que Lam Agriculture Co., Ltd., 2016-2023

Farmers receive training in organic rice cultivation techniques through training courses organised by Que Lam Company. The company also supplies key agricultural inputs, including certified rice seeds and two types of organic fertilisers manufactured by the Que Lam Group Joint Stock Company: (1) Microbial organic fertiliser, containing 45% organic matter, 8% humic acid, and 2% total nitrogen: it also includes beneficial microbial strains (1×10^6 CFU/g), nitrogen-fixing, phosphate-solubilising, and cellulolytic microorganisms, which enhance soil biological activity and nutrient availability; and (2) Bio-organic mineral fertiliser, consisting of 45% organic matter and 7% humic acid, supplemented with mineral nutrients including total nitrogen at 2%, available phosphorus at 4%, and available potassium at 2%. This bio-organic mineral formulation provides immediate nutrient uptake while contributing

to long-term soil fertility improvement.

For holistic assistance to the farming community, technical officers from the Phu Bai Agricultural Cooperative guide and oversee farmers throughout the organic rice cultivation process. Concurrently, technical experts from Que Lam Company monitor operations to ensure farmers adhere to the production technical process. Que Lam Company pledges to purchase all organic rice from farmers at pre-determined fixed prices as stipulated in the contract for each crop season. The structure of product and service flows among stakeholders in the organic rice value chain is illustrated in Figure 3. The organic rice cultivated through Que Lam Company's partnership with local farmers will be accessible to consumers via Que Lam Organic Products Co., Ltd. (Que Lam Supermarket), promoting healthier and more sustainable dietary options within the community.

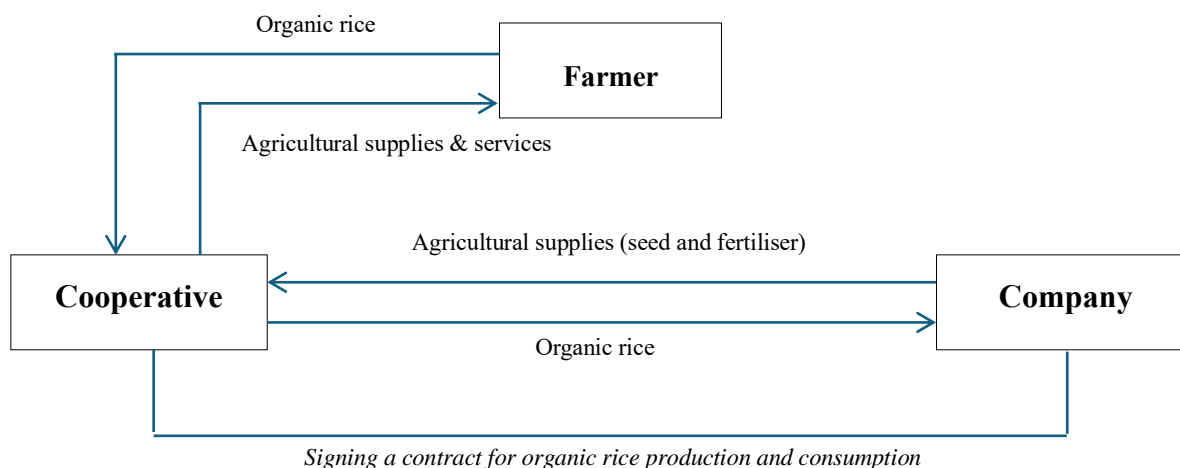


Figure 3: Goods and services flow in organic rice production

Comparative procedures and standardisation of agricultural supplies in organic and conventional rice production

Table 1 outlines the main differences in field management practices between organic and conventional rice production in terms of land

regulations, seed selection, fertiliser use, pest control, and weed management. Compared to conventional rice cultivation, organic farming practices demonstrate a more stringent and regulated approach. Organic systems impose specific restrictions on land selection and seed sources, strictly prohibit the use of chemical fertilisers and herbicides, and instead promote the use of organic inputs and manual labour.

Pest and disease control in organic farming also relies heavily on physical and biological methods, requiring more intensive field management compared to the chemical-based approaches in conventional farming. These contrasts highlight the higher labour demand and technical oversight required in organic production.

Table 1: Comparison of production procedures in organic and conventional rice cultivation

Conditions and requirements	Conventional rice cultivation	Organic rice cultivation
<i>Land preparation</i>	There are no specific regulations	- Organic rice cultivation land must comply with current regulations regarding heavy metal limits and pesticide residues - Keeping distance from cemeteries and industrial zones
<i>Seed selection</i>	There are no specific regulations	- Do not use genetically modified rice varieties - Indigenous rice varieties should be used
<i>Soil fertility management</i>	Chemical fertiliser application	Organic fertiliser application - Physical controls: Regular field sanitation to eliminate disease pathogens; using nets, adhesive traps, or light traps to catch harmful insects.
<i>Pest and disease management</i>	Plant protection products application	- Biological controls: Employing biological traps, fostering and protecting natural enemies, planting lure or repellent crops against harmful insects, using plant-based, mineral, or biological products free from synthetic compounds
<i>Weed management</i>	Herbicide application	Hand weeding

Tables 2 and 3 illustrate the differences in technical standards between organic and conventional rice production. These tables provide detailed information on the quantities of rice seeds, fertilisers, and pesticides associated with each respective production method.

Table 2: Standardisation of agricultural supplies in conventional rice production on 500 m²

Type of supply	Units	Quantity	Notes
<i>Rice seeds</i>	kg	4 - 5	From the confirmation level upwards, according to actual farm household surveys
<i>Pure nitrogen</i>	kg	25	Basic standard mixed fertilisers can be used with corresponding conversion rates of N, P ₂ O ₅ , K ₂ O).
<i>Pure phosphorus</i>	Kg	4	
<i>Pure potassium</i>	kg	5	
<i>Microbial organic fertiliser</i>	kg	40	
<i>Pesticide</i>	USD	2.06	

Source: Provincial People's Committee of Thua Thien Hue Province, 2023

Table 3: Standardisation of agricultural materials in organic rice production on 500 m²

Type of supply	Units	Rice crop	Quantity	Notes
<i>Rice seeds</i>	kg	Winter-spring	4	J02*
		Summer-autumn	4	DT39*
<i>Mineral organic fertilisers</i>	kg	Winter-spring	55	Que Lam Fertiliser
		Summer-autumn	60	
<i>Microbial organic fertiliser</i>	kg	Winter-spring	25	
		Summer-autumn	25	
<i>Pesticide</i>	USD	Winter-spring	1.24	Biological products, herbs
		Summer-autumn	1.24	

* Rice variety planted

Source: Phu Bai Agricultural Cooperative, based on contracts co-signed with Organic Que Lam Agriculture Co. Ltd. 2022–2023

Conventional rice production in Thua Thien Hue province is governed by the technical standards outlined in Decision No. 509/QD-UBND (Provincial People's Committee of Thua Thien Hue Province 2023). In Thuy Phu commune, farmers primarily cultivate varieties such as J02, HG12, HP3, Thai Bac, VNR20, and HT1 during the winter-spring crop. According to local agricultural extension officers and the cooperative director, while farmers can adjust agronomic practices (e.g. seeding density, fertiliser dosage) to suit specific soil fertility and environmental conditions, these adjustments should remain within the maximum allowable limits specified in the provincial guidelines (Table 2) to ensure both agronomic effectiveness and environmental protection.

Table 3 describes the standards for seeds and materials of the organic rice production model according to the technical process of Que Lam Company. High-quality pure rice varieties, J02 and DT39, were used for the crops in 2023. Farmers utilise mineral organic fertilisers and organic microbial fertilisers produced by Que Lam Group JSC for organic rice, following the dosage, timing, and methods outlined in the contract signed with Que Lam Company. Pest management for organic rice entails proper seed planting density and regular field sanitation to eliminate pathogens and weeds. Farmers may employ biological pesticides or herbal remedies for

spraying depending on the severity of pests and diseases. These technical differences are critical to interpreting variations in production costs and efficiency between the two farming models.

Economic efficiency evaluation of organic and conventional rice farming in Thuy Phu commune

Household production characteristics

The survey results indicated that the average area of rice cultivation is approximately 3,393 m² and 1,930 m² for the conventional and organic groups, respectively (Table 4). This disparity arises from the fact that the organic rice area accounts for only 10.4% of the total rice cultivation area in the winter-spring crop of 2023 in Thuy Phu commune. Due to fragmented and small-scale production, the average number of plots per household is 2.28 for conventional rice and 1.14 for organic rice. The average land area per plot is around 1,568 m² for conventional households and 1,729 m² for organic households. These differences are statistically significant at $P \leq 0.01$. The relatively small scale of organic rice farms may constrain scalability, as it hinders coordinated planning and mechanisation, complicates the consistent application of organic standards, and limits the ability to achieve economies of scale.

Table 4: Size of conventional and organic rice cultivation models

	Model	Mean	Standard deviation	Min	Max	Difference
<i>Area (m²)</i>	Conventional	3,393	1,641	1,176	8,292	1,463***
	Organic	1,930	785	692	3,869	
<i>No of plots</i>	Conventional	2.28	1.07	1	5	1.13***
	Organic	1.14	0.35	1	2	
<i>Average area/plot</i>	Conventional	1,568	516	848	3,040	-161 ^{ns}
	Organic	1,729	656	692	3303	

*** P ≤ 0.01; ns P > 0.05

Measurement of production costs for organic and conventional rice farming

Fertilisers accounted for the highest portion (30.35%) of production costs in conventional rice farming (Table 5). Conversely, in organic rice farming, family labour costs represent the highest proportion at 40.44% of the total production costs. Notably, the labour cost of the organic rice cultivation model surpasses that of the conventional rice cultivation model. For seeds, fertilisers, and pesticides, all three costs in organic rice farming are lower than in

conventional rice farming.

Family labour is the most significant difference in production costs between the two models. Specifically, the cost of family labour in organic rice production is higher than that of conventional rice production by USD 10.29/500 m² (P ≤ 0.01). Table 6 indicates that the organic rice cultivation model requires more labour in rice paddy management, with an observed difference of 1.67 labour days/500 m² between organic and conventional rice production, which is statistically significant at 1% level.

Table 5: Cost structure of conventional and organic methods in rice cultivation on 500 m²
Unit: USD/500 m²

	Model	Mean	Standard deviation	Min	Max	Proportion (%)	Difference
1 Seed	Conventional	5.55	0.56	3.51	6.38	8.17	0.73***
	Organic	4.82	0.26	4.43	5.33	6.8	
2 Fertiliser	Conventional	20.6	1.19	18.22	22.85	30.35	4.7***
	Organic	15.9	0.71	14.69	16.87	22.45	
3 Pesticide	Conventional	4.04	0.52	2.56	5.07	5.95	1.78***
	Organic	2.26	0.3	1.78	2.85	3.19	
4 Family labour	Conventional	18.35	0.88	15.48	19.81	27.03	-10.29***
	Organic	28.64	3.32	24.76	34.05	40.44	
5 Cooperative services	Conventional	15.12	0.24	14.79	16.03	22.28	0.09**
	Organic	15.03	0.04	15.02	15.23	21.23	
6 Other costs	Conventional	4.22	0.49	2.48	5.16	6.22	0.06 ^{ns}
	Organic	4.17	0.74	2.48	5.78	5.89	
7 Production costs in cash = (1) + (2) + (3) + (5) + (6)	Conventional	49.53	1.43	46.1	53.09	72.97	7.36***
	Organic	42.17	1.16	40.04	45.37	59.56	
8 Total costs = (7) + (4)	Conventional	67.88	1.54	64.07	71.66	100	-2.94***
	Organic	70.81	3.69	64.8	77.33	100	

*** P ≤ 0.01; ** P ≤ 0.05; ns P > 0.05

Table 6: Family labourers in conventional and organic methods of rice cultivation on 500 m²

	Model	Mean	Standard deviation	Min	Max	Difference
<i>Working day</i>	Conventional	2.96	0.14	2.5	3.2	-1.67***
	Organic	4.63	0.54	4	5.5	

*** P ≤ 0.01

Organic rice production entails strict requirements for managing soil, water, fertiliser, and harmful organisms to control weeds, insects, and diseases. This challenge mandates organic rice farmers to invest significant care and regular field visits to address factors harmful to the rice fields promptly. Furthermore, organic rice cultivation necessitates a larger amount of organic fertiliser compared to traditional rice production. The labour costs for transportation, loading, and fertilisation are considerable for transporting organic fertiliser to supply fields, especially for fields with unfavourable transportation systems.

Regarding seed costs, the difference of USD 0.73/500 m² (Table 5) reflects a

divergence in operational compliance. Conventional farmers used 22% more seed than the organic model ($P \leq 0.01$) (Table 7), often exceeding the recommended upper limit of 4–5 kg/500 m² (Table 2). This over application, likely driven by a reliance on experience rather than formal guidelines, may be one reason for reduced efficiency. In contrast, organic farmers adhered closely to the prescribed rate (4.32 vs. 4.00 kg/500 m²), demonstrating better compliance. However, the economic impact of over-use in conventional farming is partially mitigated by the lower market price of conventional seeds (USD 0.06/kg cheaper than organic seeds).

Table 7: Seed quantity and price in conventional and organic methods of rice cultivation on 500 m²

	Model	Mean	Standard deviation	Min	Max	Difference
Quantity (kg/500 m²)	Conventional	5.27	0.24	4.82	5.78	0.95***
	Organic	4.32	0.23	3.97	4.78	
Price (USD/kg)	Conventional	1.05	0.10	0.68	1.11	-0.06***
	Organic	1.11	0	1.11	1.11	

*** $P \leq 0.01$

For fertilisers, it seems that economic efficiency is driven by input characteristics rather than deviation from standards. Organic farming achieves a cost reduction of USD 4.7/500 m² compared to the conventional model ($P \leq 0.01$), despite requiring a significantly higher application volume (47.23 kg/500 m², or 169% more) (Table 8). This high

application rate is a technical necessity to compensate for the low nutrient concentration and slow release rates of organic inputs (Panday et al. 2024), rather than an inefficiency. Ultimately, the extremely low unit price of organic fertilisers (about USD 0.53/kg) ensures that this model remains more cost-effective despite the high physical volume required.

Table 8: Fertiliser quantity and price in conventional and organic methods of rice cultivation on 500 m²

	Model	Mean	Standard deviation	Min	Max	Difference
Quantity (kg/500 m²)	Conventional	27.97	0.99	25.85	29.9	-47.23***
	Organic	75.2	2.34	70.39	79.03	
Price (USD/kg)	Conventional	0.74	0.05	0.64	0.82	0.53***
	Organic	0.21	0.01	0.19	0.24	

*** $P \leq 0.01$

Another notable finding from the research is that the cost of plant protection products in the organic rice farming model is nearly 44% lower than in the conventional rice farming

model, with a difference of USD 1.78/500 m² ($P \leq 0.01$), indicating a significant pesticide cost reduction in organic rice production. This difference primarily stems from the non-use of

synthetic herbicides and insecticides in organic farming, which often constitute a considerable portion of input costs in conventional systems. Instead of chemical inputs, organic farmers employ preventive and manual practices such as hand weeding and biological pest control. Although these approaches are labour intensive, they help reduce reliance on costly agrochemicals. Prior studies have also identified reduced pesticide use as one of the main contributors to lower input costs in organic systems (Nguyen et al. 2020a; Khong 2022, 2020).

There is a small but statistically significant difference in the average cost of services provided by the Agricultural Cooperative between the two production models, with organic cultivation costing USD 0.09/500 m² less than conventional farming ($P \leq 0.05$). Both conventional and organic rice farmers receive the same range of services, including irrigation, internal transportation, plant protection, field protection, agricultural promotion, water regulation, land preparation, and harvesting. Although official service prices are identical across models, actual costs may vary due to field-specific conditions. Organic rice production areas benefit from more convenient transportation and favourable field conditions, which help minimise additional surcharge costs. For other expenses such as fuel, packaging, and communication, the difference between the two models is negligible and statistically insignificant.

Excluding family labour costs, the cash production costs for conventional rice farming are higher by USD 7.36/500 m² compared to organic rice cultivation, a statistically

significant difference at the 1% level. However, despite the higher cash production costs, the total rice production cost of the conventional model remains lower than that of the organic model by USD 2.94/500 m² ($P \leq 0.01$).

Profit of the conventional and organic rice cultivation models

Table 9 shows that in the winter-spring crop, organic rice achieved an average productivity of 326 kg/500 m², which was 30 kg/500 m² lower than conventional rice ($P \leq 0.01$). This finding aligns with previous research that also reported lower organic rice yields. Nguyen, et al. (2019) reported that in Tra Vinh and Soc Trang, organic rice yielded 237.2 kg/500 m², compared to 266.0 kg/500 m² for conventional rice. Khong (2022) reported a productivity gap of 99.9 kg/500 m² in Vinh Long province during the 2019 winter–spring crop, with the difference significant at $P \leq 0.01$. In Thua Thien Hue province, Nguyen et al. (2020a) found that organic rice yield was about 46.5 kg/500 m² lower than conventional yields. Previous studies have attributed this yield gap to several constraints, including nitrogen stress at critical growth stages, the limited immediate effect of organic fertilisers, weed and pest pressure, and farmer limited technical experience in the early years of conversion (Panday et al. 2024). In addition, local agricultural experts emphasised that lower seeding density, as required by organic farming standards (Tables 2 and 3), also contributes to reduced yields.

Table 9: Productivity and selling price of conventional and organic methods in rice cultivation on 500 m²

	Model	Mean	Standard deviation	Min	Max	Difference
Productivity (kg/500 m²)	Conventional	355.83	12.55	330	400	29.97***
	Organic	325.86	6.69	310	340	
Price (USD/kg)	Conventional	0.318	0.01	0.30	0.34	-0.012***
	Organic	0.330	0	0.33	0.33	

*** $P \leq 0.01$

Que Lam Company purchased organic rice at a rate of USD 0.33/kg during the winter-spring crop of 2023, in accordance with the pre-season contract with the Phu Bai Agricultural Cooperative. In contrast, the market average for conventional rice stood at USD 0.318/kg, representing a difference of USD 0.012/kg. Although not substantial, this variation is significant ($P \leq 0.01$). The difference in pricing between organic and conventional rice, while consistent with prior research, is gradually narrowing. In Tra Vinh province, Nguyen, Tran, and Duong (2019) indicated a price difference of USD 0.137/kg based on 2017 survey data, while Nguyen et al. (2020a) in Thua Thien Hue province reported a smaller difference of USD 0.082/kg in 2018. Elucidating the slight price differential between organic and conventional rice during the winter-spring crop of 2023, it becomes apparent that the purchasing price of organic rice in Thuy Phu commune by Que Lam Company has exhibited almost no change since 2016. Nonetheless, domestic rice prices in Vietnam have shown an upward trend in recent years, aligning with global market trends. This surge can be attributed primarily to the decline in rice output globally, exacerbated by adverse conditions such as floods in Pakistan and unfavourable weather in China and the Philippines (Redfern et al. 2012; FAO 2023; Shehzad 2023).

Table 10 shows that conventional rice production has higher revenue and lower production costs, resulting in greater profits compared to organic cultivation. Revenue from conventional rice and organic rice production amounted to USD 113.18/500 m² and USD 107.58/500 m², respectively, showing a difference of USD 5.60/500 m² ($P \leq 0.01$). The primary factor contributing to this difference is the lower productivity of organic rice. Despite the average selling price of organic rice being higher than that of conventional rice, the difference of USD

0.012/kg fails to elevate organic rice revenue above conventional rice. The price of organic rice purchased by Que Lam Company under the contract farming arrangement has remained virtually unchanged from 2016 to 2023. Specifically, the fixed purchase price for the J02 variety stood at USD 0.3095/kg of dried rice in 2018 and was only slightly adjusted to USD 0.33/kg from 2021 onward.

In the winter-spring crop of 2023, conventional farming yielded a higher average profit than organic farming (USD 45.30 vs USD 36.77 per 500 m²; $P \leq 0.01$). This difference of USD 8.53/500 m² highlights the superior profitability of the conventional model when all costs are considered. However, when family labour is excluded from cost calculations - shifting the focus from net profit to household income - organic farmers earn USD 1.76 per 500 m² more than their conventional counterparts. This disparity underscores the heavy reliance of organic farming on family labour, which inflates total production costs and reduces net profit despite higher gross income. These findings suggest that enhancing labour efficiency is critical to improving the economic viability of organic rice production.

Economic efficiency of conventional and organic rice cultivation models

Calculating key financial metrics, revenue-to-production cost ratio, income-to-production cost ratio, and the profit-to-production cost ratio, is essential for evaluating the economic efficiency of rice farming. These indicators provide crucial insights into the efficiency of resource allocation and the potential profitability for rice farmers. Table 11 presents a comparative analysis of these indicators between conventional and organic rice production methods. Notably, the values of all three indicators are higher for the conventional method compared to organic production.

Table 10: Comparison of economic results between conventional and organic rice cultivation models

		Unit: USD/500 m ²					
		Model	Mean	Standard deviation	Min	Max	Difference
1	Revenue	Conventional	113.18	4.74	101.03	122.16	5.6***
		Organic	107.58	2.21	102.35	112.25	
2	<i>Costs in cash</i>	Conventional	49.53	1.43	46.10	53.09	7.36***
		Organic	42.17	1.16	40.04	45.37	
3	<i>Total costs</i>	Conventional	67.88	1.54	64.07	71.66	-2.94***
		Organic	70.81	3.69	64.80	77.33	
4	<i>Income = (1) - (2)</i>	Conventional	63.65	4.69	53.05	72.47	-1.76**
		Organic	65.41	2.27	60.31	70.3	
5	<i>Profit = (1) - (3)</i>	Conventional	45.3	4.43	35.75	53.9	8.53***
		Organic	36.77	3.43	27.61	42.5	

*** P ≤ 0.01; ** P ≤ 0.05

Table 11: Comparison of economic efficiency between conventional and organic rice cultivation models

	Conventional	Organic	Difference
<i>Revenue/production costs</i>	1.67	1.52	0.15***
<i>Income/production costs</i>	0.94	0.93	0.01 ^{ns}
<i>Profit/production costs</i>	0.67	0.52	0.15***
<i>Revenue/cash costs</i>	2.29	2.55	-0.26***
<i>Income/cash costs</i>	1.29	1.55	-0.26***
<i>Profit/cash costs</i>	0.91	0.87	0.04**
<i>Income/family labour (USD/working day)</i>	21.5	14.31	7.19***
<i>Profit/family labour (USD/working day)</i>	15.31	8.11	7.19***

*** P ≤ 0.01; ** P ≤ 0.05; ns P > 0.05

Particularly striking is the revenue-to-production cost ratio, which surpasses 1 for both models, signaling potential profitability. A value less than 1 indicates an inability to cover investment costs, while a value of 1 suggests breaking even. In the 2023 winter-spring season, rice farmers employing the conventional method generated USD 1.67 of revenue for every USD 1.00 of production cost, whereas those using the organic method received USD 1.52 ($P \leq 0.01$). The profit-to-production cost ratio for the conventional method is 0.67, indicating a return of USD 0.67 for every dollar invested, compared to USD 0.52 for organic cultivation.

Contrary to the revenue-to-production cost and the income-to-production cost ratios, the revenue-to-cash cost and income-to-cash cost ratios of the organic rice cultivation model are

higher than those of the conventional rice cultivation model. These two indicators also have values greater than 1 for both cultivation models. The revenue-to-cash-cost ratio for organic farmers is 2.55, indicating that these farmers generate USD 2.55 of revenue for each dollar spent on cash costs, while conventional rice farmers earn only USD 2.29.

The income-to-family labour and profit-to-family labour ratios play a vital role in assessing the contributions of family labour. These indicators reveal the income or profit generated per working day of family labour in production. Table 11 shows the significant differences in these indicators between conventional and organic rice production methods. Despite the organic model's increased labour input, it may not yield commensurately higher outcomes.

Limitations of the study

While this study offers significant insights into the comparative economics of organic and conventional rice farming, several limitations should be acknowledged.

First, the absence of soil quality assessment limits the ability to conclusively attribute observed differences in outcomes to the production models, as unmeasured variations in soil characteristics may have contributed to performance differences. This is recognised as a methodological limitation.

Second, while the organic model exclusively used the J02 variety, the conventional model cultivated a mix of six varieties. Although J02 was the predominant variety in the conventional group, a strictly varietal-matched comparison would provide a clearer isolation of the farming system effect.

Third, the study relied on farmers' self-reported data, which may be subject to recall or response bias. Although commonly used in agricultural research, self-reported data can sometimes compromise accuracy due to memory limitations or social desirability.

Finally, the study was limited to a single commune and one crop season, which may restrict the generalisability of the findings to other regions and time periods. Future research should incorporate multi-year datasets and cover both major cropping seasons to better capture inter-annual variability and broader contextual differences.

Conclusion and recommendations

This study provides comparative evidence on the economic performance of organic and conventional rice farming. Organic rice farming is constrained by higher labour costs and lower yields compared to conventional farming. Nevertheless, the modest price premium and reduced reliance on chemical inputs create opportunities to improve household income and support the transition

towards sustainable rice cultivation in central Vietnam. When family labour is excluded, cash costs are lower under the organic model, resulting in slightly higher income than in conventional farming.

To scale up organic rice farming in the short term, policy and technical support should prioritise farmer training to improve labour efficiency and the gradual introduction of mechanisation, especially for fertilisation and weeding. In the long term, strengthening value chain linkages among farmers, cooperatives, and enterprises is essential to ensure market stability and quality assurance. Investments in infrastructure, improved access to organic inputs, and the promotion of marketing and branding will further enhance the competitiveness and sustainability of organic rice production.

However, the heavy reliance on external actors raises concerns regarding long-term sustainability. Should companies reduce their involvement, farmers may face challenges in maintaining certification standards, accessing quality inputs, and securing market outlets. Therefore, while company engagement currently serves as a foundation for organic rice development, it is imperative that farmers gradually strengthen their capacity and independence to ensure the resilience of the model in the absence of ongoing external support.

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Conflict of interest statement

The authors declare no conflict of interest.

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