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Contribution of food certifications to sustainable development: a mixed-method study in Vietnam

RESEARCH ARTICLE

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Abstract

Food certification (FC) is crucial for a sustainable food value chain, encompassing standards for safe and sustainable agricultural practices that contribute to achieving the Sustainable Development Goals (SDGs). This study uses a mixed-method approach to examine whether and under what contextual conditions FCs generate economic and sustainability outcomes in Vietnam. Empirical results indicate that farmers with FCs earn approximately 44% higher income than those without them, equivalent to about 125 000 VND. However, FCs do not help solve farming difficulties. Factors such as selling to processors, higher education, advantageous market positions, loans, and support programs significantly impact farmers' income. Qualitative analysis reveals that the effectiveness of FCs depends on various factors, including the types and levels of FCs; consumer awareness, trust, and willingness to pay; output markets and market segments; farmer capacity and farm environments; crop types; and stages of certification implementation. FCs can contribute to achieving multiple SDGs, including SDGs 1-6, 8, 10, 12, 13, 15 and 16.

Keywords: food certification, mixed-method, SDGs, sustainability, VietGAP, Vietnam
JEL codes: C83, Q01, Q13, Q18, Q56

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1. Introduction

In recent decades, significant transformations have reshaped global food systems, characterized by modern retail systems, private voluntary standards and certification, sustainable governance models, and shorter and vertically integrated value chains (Chiputwa *et al.*, 2015; Dornelles *et al.*, 2022; Hoang, 2021a). This rapid evolution is driven by shifting consumer preferences, increasing living standards and incomes, escalating concerns regarding food safety and social matters, improving awareness of sustainable issues, growing environmental impact of agricultural practices, and continuous advancements in science and technology (Chiputwa *et al.*, 2015; Hilal *et al.*, 2021; Hoang *et al.*, 2023). The concept of food certification (FC) has garnered substantial attention from consumers, producers, policymakers, and scholars due to its strong association with consumer and market facets: food safety and quality, consumer health and well-being, transactional expenses, and market access and uncertainties; producer and social issues: labor conditions, gender equality, producer income and welfare, and poverty and hunger mitigation; and environmental problems: carbon footprints, deforestation, land and water pollution, and agricultural waste (Ab Talib *et al.*, 2015; Bellassen *et al.*, 2022; Muller *et al.*, 2021; Ssebunya *et al.*, 2019).

Adherence to stringent standards of food certifications (FCs) often entails setup costs, production expenses, and certification fees, which can significantly increase the overall costs. These compliance costs represent the incremental expenses farmers, enterprises, or governments incurred in meeting specified standards compared to the traditional production methods (Maskus *et al.*, 2005). Initial certification costs include machinery, equipment, consultancy and training investments, and other setup costs (Kleemann *et al.*, 2014). In the production phase, certified food production necessitates higher expenditures on hired labor and inputs due to restrictions on chemical fertilizers and pesticides and the greater adoption of organic alternatives (Ibanez and Blackman, 2016; Tran and Goto, 2019). Moreover, reducing in chemical inputs may lead to decreasing yields and output. If the price premium of certified food products cannot offset the higher input costs and yield losses, FC producers can get a negative return on investment. For example, Froehlich *et al.* (2018) observed lower profits among certified food producers in Brazil due to increased labor, conversion, and financial expenses.

On the other hand, certified food production can assure food safety and often raise the quality of food products and their market prices (Liu *et al.*, 2020; Monier-Dilhan *et al.*, 2021). Therefore, certified food producers can achieve higher turnover, gross profit, net farm income, and economic benefits (measured by farm income) compared to conventional food producers when higher food prices and values can compensate for yield losses and increased input costs (Bellassen *et al.*, 2021; Bolwig *et al.*, 2009; Liu *et al.*, 2020). In general, small FC producers can obtain prices 20–30% higher than non-certified counterparts, potentially achieving increased profits and household incomes by 16–22% despite varying effects of standards on production costs and yields (Meemken, 2020). In addition, certified food production can bring various positive social and environmental outcomes by adhering to stringent standards of certified food production, such as restrictions on chemical fertilizer and pesticides, increased adoption of organic input and labor protection; increasing the supply of food and food security; improving certified food producers' bargaining power and equality, reducing negative environmental footprints and prohibiting the use of child labor and deforestation (Malak-Rawlikowska *et al.*, 2019; Muller *et al.*, 2021; Schleifer and Sun, 2020). These socioeconomic and environmental benefits of FCs indicate their contribution to the Sustainable Development Goals (SDGs) (United Nations, 2024).

However, empirical studies have still indicated divergent or contradictory evidence of the influence of FCs on economic benefits and sustainable development (Bonisoli *et al.*, 2019; Froehlich *et al.*, 2018; Ibanez and Blackman, 2016; Liu *et al.*, 2020; Oya *et al.*, 2018). These differences in FC impacts suggest that food certifications should not be assumed to generate uniform sustainability outcomes, as certification schemes differ in objectives, standards, and implementation requirements. Their effects may vary across economic, social, and environmental dimensions depending on production and farm conditions, market contexts, crop types, farmers' capacity and skills, governance systems, and stages of implementation (Bonisoli *et al.*, 2019;

d'Albertas *et al.*, 2023). There are also trade-offs between socioeconomic benefits and environmental outcomes (Van Derhaegen *et al.*, 2018). Moreover, different types and levels of FCs (e.g., Fairtrade, Organic, Global Good Agricultural Practice (GlobalGAP), local GAPs (VietGAP, ThaiGAP), Hazard Analysis and Critical Control Points (HACCP), ISO 22000 and Rainforest Alliance Certification (RFA)) can generate different sustainability and economic outcomes because they pursue distinct objectives and standards (Chiputwa *et al.*, 2015; Tran and Goto, 2019).

The benefits of FCs for small farmers in developing countries can be even more unclear and insignificant. These food producers often face difficulties of limited capacities, poor skills, small-scale and dispersed farms, weak bargaining power and market linkage, and disadvantageous farming conditions (Dong and Liang, 2023; Hoang and Tran, 2019). Additionally, consumers' awareness, understanding, and visibility of many FCs remain low, especially in developing countries. This lack of consumer awareness can restrict the market premium for certified food products, consequently reducing economic benefits for food producers (Annunziata *et al.*, 2019; Nguyen *et al.*, 2017). Moreover, domestic FCs in developing countries tend to be less stringent than international standards in developed countries for exported food products (Tran and Goto, 2019; Xu *et al.*, 2020). This disparity might obscure and diminish the clear sustainability benefits associated with FCs. There is also a scarcity of research investigating the impact of FCs on achieving SDGs.

This study addresses these gaps in the literature by additionally examining the effects of local FCs (VietGAP) on farmers' economic benefits and sustainable development across various crops in Vietnam by using both quantitative and qualitative methods. Vietnam, characterized as a developing country, relies on its agricultural sectors, which contribute significantly to its economy through export value, gross domestic production, employment, income generation, and the rural living environment (Hoang, 2021b). However, Vietnam's agricultural sectors confront challenges, such as fragmented and small-scale production, information and power asymmetry, low productivity, price instability, soil degradation, and climate change (Hoang and Nguyen, 2023; Hoang and Tran, 2019). Notably, Vietnamese consumers' awareness has changed, and they increasingly prioritize food quality, safety, and health attributes due to rising incomes, educational advancements, social connectivity, government regulations, and modern retail channels (Hoang *et al.*, 2023; Tran and Goto, 2019).

Despite the growing promotion of food certifications, agribusiness managers, cooperatives, food firms, and policymakers face a critical management challenge: determining whether and under what conditions certification adoption generates sufficient economic and sustainability returns to justify compliance costs and organizational changes. This challenge is particularly important for farmers and agrifood firms in developing countries, where certification implementation requires managerial decisions related to investment, market linkage, production practices, training, governance, and risk management. Existing studies report heterogeneous and contradictory findings, making managerial decision-making regarding FC adoption difficult.

This study uses econometric models to investigate the impact of FCs on farmers' income and farming difficulties (perceived production constraints). Next, the paper analyzes the impact mechanism and influence of FCs on sustainable development using expert interviews. These empirical findings and exploratory results are used to discuss the contribution of FCs to SDG. This study also provides practical managerial implications for farmers, cooperatives, agribusiness firms, certification bodies, and policymakers regarding the adoption and effectiveness of food certifications in developing-country food systems. The subsequent sections are organized as follows: Section 2 provides an overview of the existing literature, Section 3 explains the methodology and data, Section 4 presents the findings and discussion, and Section 5 summarizes the outcomes and conclusion.

2. Literature review

Food certifications (FCs) are increasingly associated with sustainable food systems because they establish standards for production practices, product quality, environmental protection, labor conditions, and governance mechanisms. Certification labels have become pivotal in global food markets, particularly in developed

countries, as certified products often attract higher consumer trust and price premiums than non-certified products (Carter and Cachelin, 2018; Monier-Dilhan *et al.*, 2021). Food consumers perceive FCs as signaling mechanisms indicating adherence to specific standards, while food producers use FCs to differentiate products and communicate food quality, safety, sustainability and social values (Brach *et al.*, 2018; Fernqvist and Ekelund, 2014; Grunert and Aachmann, 2016). In this study, sustainability is broadly understood through economic, social, and environmental dimensions aligned with relevant SDGs.

The purposes and functions of FCs vary according to certification types, levels, and providers. Beyond enhancing food safety, trust, and product quality, FCs promote sustainable practices, corporate responsibility, and compliance with regulatory, environmental, and social standards (Ibrahim, 2016; Latino *et al.*, 2022). Certification requirements may extend across food production, processing, transportation, and retailing and involve broader value-chain concerns such as occupational safety, environmental protection, human rights, community engagement, and resource use (UNFSS, 2013). From a management perspective, FC adoption is not merely a technical production decision but a strategic and operational issue involving resource allocation, market positioning, compliance management, farmer capability development and supply chain coordination.

Existing evidence further suggests that the effects of food certifications differ substantially across developed and developing countries and between small- and large-scale farming contexts. In developed countries, stronger institutions, higher consumer awareness, better market access, and premium market segments often facilitate the effectiveness of certification schemes and consumers' willingness to pay for certified products (Brach *et al.*, 2018; Carter and Cachelin, 2018; Monier-Dilhan *et al.*, 2021). In contrast, farmers in developing countries, particularly smallholders, frequently face constraints related to limited capital, fragmented land, lower technical capacity, weak market linkages, and certification costs, resulting in more heterogeneous economic and sustainability outcomes (Chiputwa *et al.*, 2015; Mitiku *et al.*, 2017; Qiao *et al.*, 2016; Tran and Goto, 2019; Hoang, 2021b). Moreover, certification impacts vary depending on farm size, market access, certification type, crop characteristics, governance systems, and institutional support, resulting in heterogeneous certification outcomes across contexts (Bonisoli *et al.*, 2019; d'Albertas *et al.*, 2023; Jena and Grote, 2022; Liu *et al.*, 2020).

Empirical studies have assessed the effects of FCs on farmers' economic benefits, farming difficulties, and sustainability outcomes, though findings remain mixed across certification types, crops, production areas, and measurement indicators. Many studies report positive impacts of FCs on farmers' income and welfare (Akoyi and Maertens, 2018; Barham and Weber, 2012; Brako *et al.*, 2021; Handschuch *et al.*, 2013; Jena and Grote, 2022; Qiao *et al.*, 2016), while others reveal insignificant or even negative effects (Dong and Liang, 2023; Ibanez and Blackman, 2016; Jena *et al.*, 2017; Mitiku *et al.*, 2017). Existing evidence further suggests that FCs can contribute to economic sustainability through improved prices, market access, income, and livelihood stability; social sustainability through safer working conditions, health protection, gender participation, and farmer training; and environmental sustainability through reduced chemical use, biodiversity conservation, efficient water management, and climate-smart agricultural practices. However, these outcomes are highly context-dependent and influenced by certification type, farm size, farmer capability, crop characteristics, market access, governance systems and institutional support, particularly in developing countries and among small farmers. Such heterogeneity makes it difficult to determine when and under what conditions FCs effectively contribute to sustainable development. OLS, 2SLS, SEM, and PSM are the main methods used to estimate the impact of FCs on farmers' economic benefits and farming difficulties in these empirical studies.

3. Methodology

3.1 Econometric methods

This study empirically investigates the influence of FCs on farmers' economic benefits and farming difficulties (perceived production constraints). Economic benefits are measured through total farming net income and

the logarithm of total farming net income per hectare. Farming difficulties are assessed through farmers' perceived constraints related to capital (DC), technology (DT), input quality (DI), and land degradation (DLD) when producing food products. Higher values of farming difficulty variables indicate higher perceived levels of constraints.

Given the continuous nature of income variables, Ordinary Least Squares (OLS) regression is employed to estimate the impact of FCs on farmers' income (Hoang, 2021b; Mitiku *et al.*, 2017). Potential endogeneity of certification adoption was examined using Hausman's test, which indicated the exogeneity of the certification dummy variable. To further address potential observable selection bias, the study additionally employs propensity score matching (PSM) to compare certified and non-certified farmers with similar characteristics. Nevertheless, because certification decisions may still be influenced by unobserved farmer characteristics, findings should be interpreted as robust associations rather than definitive causal effects.

The income equation is specified as follows:

$$Y_i = \alpha + \delta C_i + \beta X_i + \varepsilon_i$$

where Y_i is the on-farm income per hectare of farmer i; C_i is dummy variable that takes the value 1 if farmer i applies a FC and takes the value 0 otherwise; X_i is the vector of control variables; α, δ, and β are parameters to be estimated; and ε_i is error term.

Furthermore, this investigation utilized propensity score matching (PSM) (Liu *et al.*, 2020; Mitiku *et al.*, 2017; Rosenbaum and Rubin, 1983) to assess the impact of FCs, aiming to alleviate potential selection biases and ensure the reliability of findings. By distinguishing certified farmers as the treatment group and non-certified farmers as the control group, the study proceeded to ascertain the average treatment effect (ATE).

Initially, the study employed a Probit model to estimate the likelihood of farmers attaining certification. This predictive measure represents a weighted aggregation of characteristics within Z, where the weights correspond to the significance of each characteristic in delineating treatment acquisition. In essence, this research estimated:

$$\text{Prob}(D_i=1)=F(Z_i),$$

where $F(Z_i)$ is the predicted conditional propensity score of a household obtaining certification. The study aims to assess the impact of FC compared to non-certification.

The PSM estimator is the mean difference in outcomes over the common support, which is appropriately weighted by the propensity score. Following Li (2013) and Rosenbaum and Rubin (1983) the estimation of ATE can be represented as follows:

$$\text{ATE}=E(Y_i(1)|D_i=1,0)-E(Y_i(0)|D_i=1,0),$$

where ATE is the difference between the average effect that would be observed if all households in the treated and the control groups received treatment, compared with a matched sample of uncertified households selected using propensity scores.

The study utilized a kernel matching method, explicitly employing the default Gaussian kernel to match households. This technique calculates a weighted average across all units within the untreated group to establish a counterfactual outcome, thereby reducing variability by leveraging information from the entire untreated cohort (Caliendo and Kopeinig, 2008). This technique minimizes variance by employing a weighting function to generate the counterfactual outcome from all non-certified or control households. Following matching,

the study estimated the ATE as the weighted difference between treated and matched control households, incorporating bootstrapped standard errors.

The validity of PSM relies on two fundamental assumptions. First, the common support principle necessitates comparable control observations adjacent to treatment observations in the propensity score distribution, visually assessed by examining the overlap between certified and non-certified observations. Additionally, balancing properties are evaluated by comparing covariate means between treated and matched controls via two-sided *t*-tests (Mitiku *et al.*, 2017). The overall balance is further tested by re-estimating the propensity score on the matched sample, examining the Pseudo R^2 — which should be low, and conducting a likelihood ratio test on the joint significance of all regressors, which ideally should be rejected. Second, the conditional independence assumption stipulates that given observable variables and potential outcomes are independent of treatment assignment. The study assesses the robustness of findings against potential violations using Rosenbaum bounds (Rosenbaum, 2002). The results indicate that unobserved variables insignificantly influence subject selection and do not diminish the impact's significance on the outcome variable of interest.

Next, the study evaluates the impact of FC on farming difficulties by farmers' perceptions of their difficulties in capital, technology, input, and land degradation. Employing a Likert scale for these variables, an ordered probit model investigates food certification's influence on evaluating difficulties (Hoang, 2021b). Within the ordered probit model, the functions are defined as follows:

$$D_i^* = \delta C_i + \beta X_i + \varepsilon_i$$

where D_i^* is the exact but unobserved dependent variable of assessments of farming difficulties. Thus, the study can only observe the categories of response:

$$D = \begin{cases} 0 \text{ if } D_i^* < \mu_1 \\ 1 \text{ if } \mu_1 < D_i^* < \mu_2 \\ 2 \text{ if } \mu_2 < D_i^* < \mu_3 \\ 3 \text{ if } \mu_3 < D_i^* < \mu_4 \\ 4 \text{ if } \mu_4 < D_i^* < \mu_5 \\ 5 \text{ if } D_i^* > \mu_5 \end{cases}$$

The parameters μ_j, j = 1, …, 5, are known as cut points. Let $P_i(D)$ be the probability that the farmer i's response is D. This probability is as follows:

$$P_i(D) = P(\mu_{j-1} < D_i^* < \mu_j) = \Phi(\mu_j - \delta C_i - \beta X_i) - \Phi(\mu_{j-1} - \delta C_i - \beta X_i)$$

where Φ is the standard normal cumulative distribution function.

The estimated thresholds (μ1–μ5) represent cut-points between ordered response categories and support the ordered probit specification. As these thresholds do not have direct substantive interpretation, the discussion focuses on coefficient estimates and their statistical significance.

Data for quantitative analysis: The primary farm household data for the econometric model was obtained through fieldwork surveys conducted in the Mekong River Delta of Vietnam in 2019. The authors employed purposive and snowball sampling methods. The farmers in the sample were contacted through local government officers and cooperatives, i.e., agricultural extension officers, ward leaders, village heads, cooperative leaders,

and union leaders. The sample consisted of 449 farmers, after removing 11 outliers, comprising 161 rice farmers, 110 pomelo fruit farmers, 115 coconut farmers and 63 vegetable farmers. The farmers in the sample were interviewed through structured questionnaires one by one, and these farmer interviews took from 45–60 minutes. These structured questionnaires were developed and piloted before being officially utilized for this survey. They included four main sections, such as (i) farm household and production characteristics: encompassing education, age, gender, farming experience, FC, cooperative participation, family size, labor force, farm location, main crop and size, soil and water quality, turnovers, and input costs; (ii) contract and market factors: including contract form, payment method, sale place, contract terms, price information sources, buyer type, market estimation, and support preferences; (iii) supporting policy and programs: receiving supports from the government, organizations, and associations or not; and (iv) farmers' perceptions regarding farming difficulties and challenges. In the quantitative analysis, food certification refers specifically to Vietnamese Good Agricultural Practices — VietGAP certification among surveyed farmers, which is a set of agricultural production standards issued by Vietnam's Ministry of Agriculture and Rural Development.

3.2 Qualitative analysis

The study used a qualitative approach to support and deepen the interpretation of empirical findings by exploring heterogeneity in certification effectiveness across certification schemes, crop types, market conditions, and farm contexts and to better understand how FCs affect economic benefits and sustainable development. The authors conducted in-depth interviews and focus groups using semi-structured questionnaires to collect data. The data analysis involved four stages: coding, conceptualizing, categorizing and theorizing. The empirical findings and qualitative results were utilized to discuss the contribution of FC to the Sustainable Development Goals.

Data for qualitative analysis

The primary qualitative data were collected through in-depth interviews using semi-structured questionnaires conducted in the Mekong River Delta, the Central Highlands and Ho Chi Minh City, Vietnam (Fig. 1) during 2019–2020. The interviews focused on understanding how food certifications (FCs) affect economic benefits and sustainable development. A total of 35 participants were purposively selected, including agricultural cooperative leaders, farm owners, agribusiness firm leaders, local government officers, and agricultural economic experts.

To complement and contextualize the interview findings, the study additionally used a limited amount of qualitative and survey information from the authors' previous research projects (not published), including focus groups involving 40 food consumers with diverse demographic characteristics and a survey of 52 vegetable consumers in Ho Chi Minh City. These supplementary data were used exclusively to better understand consumer awareness, perceptions, trust, and willingness to pay a premium for certified food products and did not overlap with the primary interview dataset or the quantitative farmer sample. No conflicts of interest or duplication of empirical findings with prior publications exist.

4. Results and discussion

4.1 Empirical results

Descriptive statistics of certified and non-certified farmers

The descriptive statistical analysis of both the outcome and explanatory variables shows the mean differences between FC farmers and those without, utilizing *t*-tests (Table 1). Farmers mainly sell their food products to traders and processors, accounting for 77% and 25% of respondents. A smaller proportion of farmers provide their food products to cooperatives, exporters, retailers, and directly to consumers. On average, the

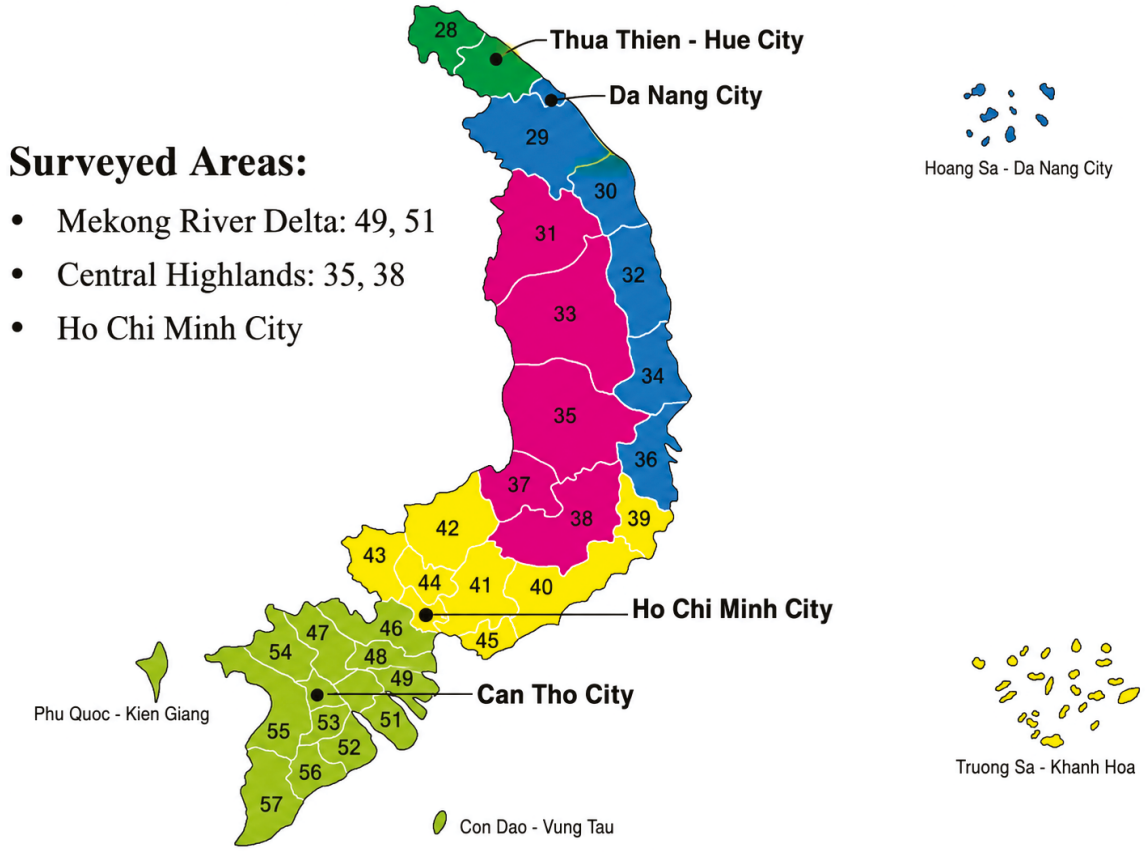

Figure 1. Study areas and locations of quantitative and qualitative data collection in Vietnam. Source: Authors.

household head has an education of 8 years, an age of 52 years, and 18.6 years of farming experience. Most participants are male, constituting 79% of the sample. On average, households maintain 2.78 individuals as part of their workforce. The average farm size remains relatively modest at 0.86 ha. The main soil types include alluvial (53%) and grey soils (22%). Most farms are near rivers (51%) and motorbike roads (35%), while a smaller proportion (23%) are near truck roads. Most farmers, 91%, have benefitted from agricultural support programs. Additionally, 73% of respondents reported having off-farming income. However, only 14% of food producers have access to credit facilities and the ability to secure loans.

The significant disparities between FC and non-FC farmers are notably evident in various aspects, including buyers, education levels, farming experience, farm size, loan accessibility, off-farm income, and participation in support programs. Certified food producers mainly provide their products to cooperatives and exporters, while non-certified farmers primarily sell to traders. Additionally, certified farmers tend to exhibit higher levels of education, operate larger farms, access larger loans, and benefit from support schemes. In contrast, non-certified food producers have more extended farming experience and higher off-farm income (Table 1). There is a significant difference in farmers' income per hectare between FC farmers (250 million VND) and non-FC farmers (88 million VND). However, the statistical results should not be used to conclude the impact of FCs on farmers' income, as the simple comparison of mean differences does not account for different factors and their relations in the models.

Table 1. Descriptive statistics of outcome and explanatory variables in the regression models.

Variable	Total	No certification	Certification	*p*-value
Buyers				
Trader (yes=1)	0.77 (0.42)	0.80 (0.40)	0.37 (0.49)	0.000***
Processor (yes=1)	0.25 (0.43)	0.25 (0.43)	0.23 (0.43)	0.853
Cooperative (yes=1)	0.03 (0.18)	0.03 (0.16)	0.13 (0.35)	0.002***
Exporter (yes=1)	0.03 (0.18)	0.01 (0.08)	0.37 (0.49)	0.000***
Retailer (yes=1)	0.008 (0.09)	0.01 (0.09)	0.00 (0)	0.609
End-user (yes=1)	0.06 (0.24)	0.06 (0.24)	0.07 (0.25)	0.896
Education (years)	8.36 (2.88)	8.21 (2.86)	10.13 (2.61)	0.000***
Age (years)	52.04 (10.38)	52.13 (10.28)	51.03 (11.62)	0.578
Gender (female=1)	0.21 (0.41)	0.21 (0.41)	0.13 (0.35)	0.297
Household members (number)	4.10 (1.29)	4.12 (1.27)	3.90 (1.45)	0.372
Main labor (number)	2.78 (1.10)	2.81 (1.11)	2.57 (1.01)	0.254
Farming experience (years)	18.58 (11.30)	19.20 (11.36)	11.52 (7.74)	0.000***
Farm size (ha)	0.86 (0.65)	0.85 (0.61)	1.06 (1.02)	0.094*
Soil quality				
Alluvial (yes=1)	0.53(0.50)	0.55 (0.50)	0.27 (0.45)	0.002***
Gray (yes=1)	0.22 (0.41)	0.23 (0.42)	0.13 (0.35)	0.242
Acid sulphate (yes=1)	0.12 (0.33)	0.12 (0.32)	0.20 (0.41)	0.176
Salinity intrusion (yes=1)	0.11 (0.32)	0.11 (0.32)	0.10 (0.31)	0.832
Polluted (yes=1)	0.16 (0.37)	0.15 (0.36)	0.27 (0.45)	0.095*
Farm location, near				
River (yes=1)	0.51 (0.50)	0.53 (0.50)	0.37 (0.49)	0.094*
Truck road (yes=1)	0.23 (0.42)	0.23 (0.42)	0.20 (0.41)	0.697
Motorbike road (yes=1)	0.35 (0.48)	0.34 (0.48)	0.40 (0.50)	0.537
Land road (yes=1)	0.28 (0.45)	0.27 (0.44)	0.37 (0.49)	0.251
Loan (yes=1)	0.14 (0.35)	0.12 (0.33)	0.37 (0.49)	0.000***
Off-farm income (yes=1)	0.73 (0.44)	0.75 (0.44)	0.60 (0.50)	0.083*
Supporting scheme (yes=1)	0.91 (0.29)	0.90 (0.30)	1.00 (0)	0.072*
Income per hectare (×1000 VND/ha)	101732 (156324)	88868 (137262)	250094 (259060)	0.000***
Perception of farming difficulties				
Lack of capital	2.29 (1.54)	2.29 (1.54)	2.37 (1.50)	0.783
Low technology	2.48 (1.34)	2.47 (1.35)	2.67 (1.27)	0.438
Input quality risk	2.45 (1.49)	2.46 (1.51)	2.33 (1.15)	0.656
Land degradation	3.01 (1.54)	3.06 (1.55)	2.43 (1.28)	0.032**
Number of observations (*N*)	376			

SD in parentheses. * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level. Source: The authors' own analysis.

Impact of food certification on farmers' economic benefits and farming difficulties

This section presents the original results from the OLS and ordered probit model, accompanied by the estimated treatment effects derived from PSM to improve the method's robustness. In general, both the regression analysis results (Table 2) and the outcomes of the propensity score matching (Table A1 in the Appendix) largely converge in a similar direction, indicating consistency and robustness in the empirical results and conclusions. Overall, the main empirical finding is that food certification is positively associated with farmers' income but does not significantly reduce perceived farming difficulties in the short term (Table 2).

Table 2. Empirical results by using OLS and the ordered probit model

	Income	Log Income	DC	DT	DI	DLD
Food certification	125542***	0.438***	–0.101	0.056	–0.009	–0.194
Buyers						
Trader (yes=1)	–529	0.038	0.121	0.577***	0.139	0.028
Processor (yes=1)	38300*	0.258**	0.021	0.402**	0.171	–0.113
Cooperative (yes=1)	–85705**	–0.235	–0.218	0.21	–0.664**	0.238
Exporter (yes=1)	–42956	–0.187	–0.301	0.744*	–0.135	–0.615
Retailer (yes=1)	74579	0.43	–0.803	–1.532**	–0.769	–1.825***
End-user (yes=1)	30218	0.162	–0.191	0.651***	0.078	0.299
Education of head	7390***	0.045***	–0.042*	–0.048**	0.006	–0.008
Age of head	747	0.006	0.004	0.003	0.008	–0.01
Gender of head (female=1)	–53246***	–0.206**	–0.009	–0.270*	–0.098	0.046
Household members	12351*	0.056*	–0.097*	0.048	–0.04	0.05
Main labor	–11088	–0.04	0.048	–0.031	0.001	–0.023
Farming experience	–1011	–0.006*	–0.003	–0.018***	–0.007	0.011*
Farm size	–18639	–0.108*	–0.042	0.107	0.004	–0.146
Soil quality						
Alluvial (yes=1)	–51729**	–0.304**	–0.457**	–0.053	–0.119	–0.223
Gray (yes=1)	–33266	–0.262**	–0.22	0.396**	0.088	0.012
Acid sulphate (yes=1)	–80146***	–0.455***	0.437**	0.192	0.15	0.512**
Salinity intrusion (yes=1)	–2513	–0.108	–0.136	0.064	0.004	0.31
Polluted (yes=1)	36692	0.013	–0.22	0.428*	0.096	–0.505**
Farm location, near						
River (yes=1)	–13468	–0.055	–0.073	0.006	0.05	0.018
Truck road (yes=1)	34372*	0.170*	–0.057	–0.049	–0.284*	–0.255
Motorbike road (yes=1)	1486	–0.028	0.073	0.034	–0.229	–0.12
Land road (yes=1)	–13445	–0.079	–0.053	0.081	–0.267*	–0.252*
Loan	36902*	0.233**	0.692***	–0.116	0.181	–0.048
Off-farm income	–63406***	–0.289***	0.018	0.342**	0.347**	0.067
Supporting scheme	62083**	0.315**	0.371*	0.18	0.304	0.565***
Constant	36257	0.197				
Thresholds						
μ1			–2.330***	–1.141**	–1.055**	–2.084***
μ2			–0.41	0.173	0.219	–0.960*
μ3			0.023	0.706	0.822	–0.41
μ4			0.424	1.544***	1.332***	0.053
μ5			0.870*	2.325***	1.810***	0.788
Number of observations (*N*)	376					

Coefficient estimates are reported. * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.
Source: The authors' own analysis.

The findings from OLS reveal a significant positive impact of FCs on farmers' income. Specifically, FC farmers demonstrate a 44% higher income than non-FC producers, amounting to an increase of 125 000 VND (compared to 124 000 VND in PSM). These findings match anticipated expectations and corroborate findings from earlier studies.

Regarding farming difficulties, the ordered probit results suggest that food certification does not significantly reduce farmers' perceived farming difficulties in the short term. Farming difficulties remain strongly associated

with structural constraints such as limited capital, fragmented land, technology adoption, and production conditions rather than certification status alone. This finding highlights that certification adoption, while potentially beneficial for long-term economic and sustainability outcomes, does not automatically alleviate operational and managerial challenges faced by smallholder farmers.

Different buyers can provide different advantages for farmers. Supplying food products to processors leads to 26% increase in farmers' income, equivalent to an increase of 38 000 VND. Conversely, selling products to cooperatives diminishes producers' income by 86 000 VND. Nonetheless, collaborating with cooperatives alleviates input-related challenges. Farmers selling to retailers typically encounter fewer issues related to low technology usage and land degradation. Surprisingly, partnerships with processors and exporters pose heightened challenges for farmers. The potential explanation for these results is that processors and exporters usually require more stringent product quality standards and production practices, while retailers' demands are less strict. Higher education and having more family members are linked to higher income for farmers and help with farming work. While female heads of households earn comparatively less, they contribute to mitigating technological farming difficulties. Unusually, both fertile and infertile soils negatively impact farmers' income. Favorable farm positioning augments economic benefits and decreases input-related challenges. Significantly, capital loans and supporting programs can result in food producers' economic benefits but do not alleviate financial capital and land degradation difficulties. Interestingly, when farmers make more money from off-farm jobs, their on-farm income tends to decrease, and they face more difficulties in their agricultural business (Table 2).

4.2 Qualitative findings

This section shows the findings of the qualitative analysis, which explores and understands how FCs affect economic benefits and sustainable development. In general, FCs' impact on economic benefits and sustainability is contingent upon various factors and contextual conditions. Furthermore, FCs' effectiveness evolves through diverse stages, necessitating long periods to attain economic and sustainability advantages.

Types and levels of food certifications

While FCs mainly aim to indicate quality and enhance consumer trust, different FCs serve distinct purposes (e.g., economic, social, or environmental goals), adhere to diverse standards, and operate under various practice systems. Moreover, disparities in the prestige and brand value of certification bodies yield notable variations in the efficacy of FCs. For instance, a certified coffee cooperative director stated, "Our Fairtrade coffee products have higher prices in European markets. That amount can be used only for community support and cooperative development activities." In this cooperative, farmers have obtained other FCs for their coffee products (i.e., 4C and VietGAP), and Fairtrade is their additional and higher-level certification.

Local and global FCs can affect economic benefits and sustainable development differently. A food consumer stated, "I trust European Organic certification more and am willing to pay a higher price for it. But I don't have as much confidence in VietGAP certification, so I would only pay a little extra for it."

Organic certification incurs higher input costs, including labor and organic fertilizer expenses, while initial periods witness reduced yields on organic farms. Short-term economic benefits can only improve if sale prices offset these costs. An organic vegetable cooperative director noted, "Growing organic vegetables requires a lot of labor and organic fertilizer, is not suitable for large-scale farming, and only brings in a small higher price, which can sometimes lead to losses."

Overall, qualitative evidence suggests that the effectiveness of food certifications varies considerably across certification types, levels, and institutional credibility. Higher-level and internationally recognized certifications (e.g. Fairtrade, European Organic) tend to generate greater market access and price premiums, while local

certifications (e.g. VietGAP) may provide more limited economic returns depending on consumer trust and implementation conditions.

Consumers' awareness, trust and willingness to pay

Vietnam's food markets have faced various issues, such as poor food safety, low product quality, food safety scandals, rise in foodborne diseases, and limited certification (Hoang and Nguyen, 2019b; Hoang *et al.*, 2023; Tran, 2013). Therefore, consumers' awareness and trust in FCs and willingness to pay a price premium for certified products are closely related to economic benefits. Firstly, food consumers need to understand the nature and value of FCs. This knowledge fosters their trust and appreciation for the advantages of certified food products. Consequently, consumers are willing to pay significantly higher prices for these certified products. This willingness to pay a premium enhances the income of food producers and promotes sustainable farming practices. For instance, a food consumer said, "Previously, I used only to buy regular food products. But after knowing about the health benefits of organic food, my family and I now mostly eat organic products, even though they are more expensive." On the other hand, another consumer stated, "At first, I don't understand the health benefits of organic products and can't see the difference between regular, VietGap and Organic food products, so I am not sure about buying certified food products."

Consumers' awareness and behavior regarding certified food products depend on their backgrounds and income levels. One dairy consumer noted, "I believe that people with more education, income and knowledge are more likely to choose healthy and sustainable food products. In contrast, those with lower income and less education might not have the conditions or time to think about buying these certified food products."

Our market survey of 52 food consumers demonstrated an average willingness to pay a 13% premium for VietGAP food products (Fig. 2). However, concerns have arisen regarding the integrity of VietGAP certification due to scandals involving certain suppliers and retailers using counterfeit VietGAP labels. As a result, consumer trust and willingness to pay a premium have diminished. Another food consumer emphasized, "I am willing to pay extra for the VietGAP food products. Genuine certification is very important to me. Now, my trust in this certification is weakened because there are fake VietGAP labels on products in supermarkets."

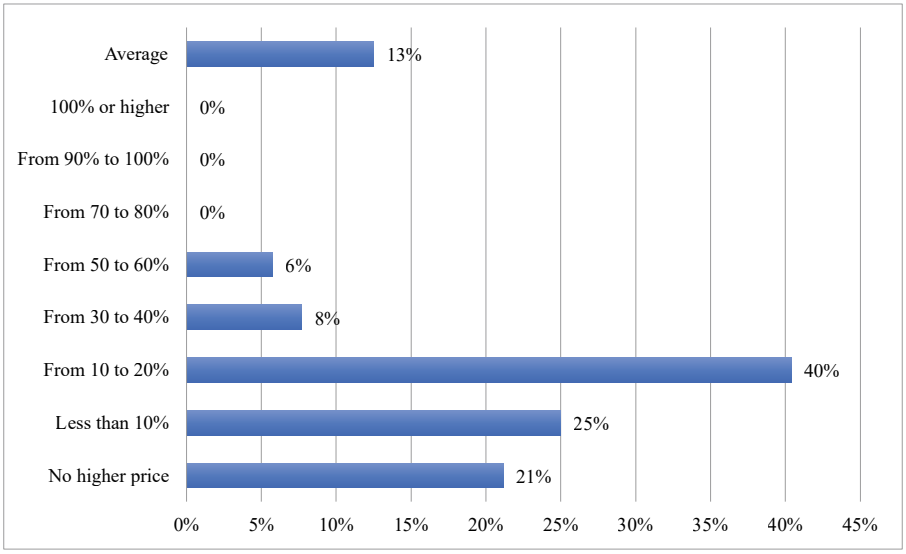

Figure 2. Rate and amount of consumers are willing to pay a premium for VietGAP products. Source: Authors' own survey and analysis.

Qualitative findings suggest that consumers' awareness, trust, and willingness to pay premiums are critical conditions determining the economic benefits of certified food products. Certification effectiveness therefore depends not only on production standards but also on consumer confidence, market transparency, and effective enforcement against fraudulent certification practices.

Output markets and market segments

A strong connection between certified food production and output markets is crucial for farmers to gain economic benefits and encourage them to adopt sustainable practices through FC. They need to sell their certified food products at premium prices. However, in Vietnam's local markets, certified food producers frequently encounter challenges selling their products or are compelled to sell them at regular prices due to insufficient market linkages and an oversupply of food products. An organic vegetable producer complained, "Growing organic vegetables requires a lot of work and money, but the companies do not buy these vegetables at the agreed-upon price or volume. This makes it difficult for us to sell our products at the expected price and make a profit."

Different market segments exhibit a range of requirements, behaviors, and characteristics among food consumers. Consequently, certified food producers can achieve economic benefits and maintain sustainable practices only by aligning with appropriate FCs and meeting specific market demands. Furthermore, FCs are essential for accessing higher-tier market segments and export markets, especially in developed countries. For example, a certified coffee producer said, "To enter European markets, certifications like 4C, RFA, or Fairtrade are essential. Only the EU market is willing to pay higher prices for certifications like Fairtrade, while these certifications are not important to Vietnamese coffee buyers."

Generally, qualitative evidence indicates that FCs generate higher economic benefits when farmers are connected to suitable market segments and reliable output markets that recognize and reward certified products. This helps explain why certification effectiveness varies across crops, market orientations, and domestic versus export markets.

Farmer's capacity and farm environments

The adoption and effectiveness of FCs are critically dependent on farmers' capabilities and farming environments, especially in the context of stringent FCs. These factors are intertwined with farmers' educational backgrounds, farming knowledge and skills, farm size, technology and management advancements in farming, and the availability of capital and input resources. Notably, small-scale farming operations can increase certification expenses and reduce the benefits of economies of scale, thereby raising production costs. For example, a director of a rice processing firm stated, "Small and scattered rice fields make it very difficult to use modern technologies to obtain certifications and increase the costs of getting FCs." A fruit farmer group leader also stressed, "These fruit farmers' limited knowledge and skills make it difficult to effectively apply new technology and implement good practices to achieve FCs."

Furthermore, the quality of soil and water, climate patterns, and surrounding ecology significantly impact the efficacy and benefits of FCs. When farm quality and environmental conditions do not meet the necessary standards for certification, considerable efforts and costs are required to improve farm conditions and protect crops. For instance, a certified fruit farmer indicated, "Switching from old farming methods to organic fruit cultivation in this region requires a lot of time and money to improve the soil and farm conditions." Another organic vegetable farmer added, "Nearby vegetable fields use chemical fertilizers and pesticides that aren't allowed in organic farming. This affects my vegetable farms. Therefore, I have to use various methods and efforts to protect against these potential effects."

Overall, qualitative findings suggest that certification effectiveness strongly depends on farmers' capabilities, farm resources, and environmental conditions. Limited skills, capital, fragmented land, and unsuitable farming environments may reduce the economic and sustainability benefits of certification, particularly among small-scale farmers.

Types of crop

Different crops and food products have different farming methods and economic results, leading to dissimilar effects when applying for FCs. The economic benefits and sustainable advantages of these FCs differ among crops because of their unequal needs for inputs and farming conditions. Perennial crops, such as coconut and large fruit trees, require fewer direct inputs such as fertilizers, pesticides, and water. In contrast, annual plants like vegetables and rice need significant inputs and protection. For instance, a certified coconut farmer highlighted, "Coconut is strong and needs only a little fertilizer and pesticide. This makes it easier and cheaper to switch to organic farming." Conversely, a certified vegetable farmer explained, "Vegetables need a lot of nutrients and water, and pests can easily harm them as they grow. I have to use a lot of water, fertilizers, and pesticides to grow and protect them". Increased use of inputs and protective measures can lead to reduced economic benefits and an increased environmental footprint.

Moreover, consumer perceptions and preferences for certified food products vary depending on the type of food. Certification expectations mainly focus on items without protective peels (e.g., vegetables and guava), prompting consumers to be more willing to pay a premium for these certified products. In contrast, products with peels or thick skins (e.g., coconut and pomelo) tend to elicit comparatively less concern regarding certifications. For example, a food consumer stated, "We eat vegetables directly. Thus, it is very dangerous if vegetables still contain toxic substances. So, they need a certification. Fruits like coconut or grapefruit have hard shells; they are safer."

Overall, qualitative evidence suggests that the economic and sustainability outcomes of certification differ substantially across crop types because of varying input requirements, farming conditions, and consumer perceptions. Crops requiring intensive inputs and protection may face greater certification costs, whereas crops with lower input requirements may achieve certification more easily and at lower cost.

Process or stages of implementing food certification: short- and long-term impacts

The effectiveness of FCs can vary across different implementation stages. In the initial (short-term) stages, applying FCs may lead to higher costs and lower crop yields on certified farms due to initial capital investment, compliance with FC standards, adoption of new management practices, and integration of modern technology. Simultaneously, immediate significant price increases in certified products may be absent. Therefore, the economic benefits of FCs in the short term may be limited or even negative, and their contribution to sustainable development may be unclear.

However, FCs can enhance farmers' capabilities and skills, increase product quality, promote adherence to good practices, facilitate market access, foster linkages, and improve working conditions in the long term. Over time, consumers' awareness of FCs grows, and their willingness to pay premiums for certified products increases. As a result, FCs can lead to more significant economic benefits and contribute more significantly to sustainable development in the medium or long term. A certified coffee farmer said, "In the beginning, I had many problems and expenses. I had failures and losses, so I had to keep trying and learning to succeed. If I gave up halfway, I would lose everything." Another organic vegetable farmer noted, "My new organic farms and vegetable products are not well-known yet. The market for these products is uncertain, and customers don't know much about them. Customers will need time to become familiar with the products and be willing to pay more for them."

Overall, qualitative findings indicate that the benefits of food certifications evolve over time. While certification adoption may create short-term costs and implementation challenges, longer-term benefits are more likely to emerge through improved farmer capabilities, market access, consumer trust, and production quality.

Food certification and sustainable development

FCs can contribute to achieving multiple SDGs, especially in the long term. FCs improve food product quality, increase selling prices, and ensure the output markets, which help eliminate poverty, create decent work and increase farmers' income. Developing a food sector or value chain can enhance economic growth. For example, an agricultural economic expert said, "Certified food products can have more stable markets and prices. This will create good jobs and stable income for farmers and contribute to the local economy." FCs can help reduce inequalities by boosting farmers' income and establishing safer and better working conditions. A local government officer noted, "Besides increasing product prices, organic standards do not allow using toxic chemical fertilizers and pesticides, so it is safe for farmers."

FCs can promote infrastructure and innovation in food production by increasing investment in machines, equipment, infrastructure, training, and continuous learning to meet FC standards and market demand. In addition, FCs serve as a marketing tool to communicate with consumers, providing them with information, enhancing their awareness and trust, and promoting responsible consumption. For example, a vegetable consumer said, "For me, food certification means quality and safety. It gives me more information and understanding about sustainable farming methods, and I will buy certified food products more." Another dairy consumer added, "I prefer to buy certified dairy products because I know that organic products pay more attention to the health (welfare) of the dairy cows."

FCs can enhance the achievement of multiple social SDGs. FCs increase and stabilize food supply, productivity, and farmers' income, especially in the long term; thus, they contribute to achieving no poverty and zero hunger goals. In nature, FCs indicate and notify consumers of good agricultural practices. In other words, they can ensure food quality and safety for consumers, thereby protecting and improving consumers' health. For example, a vegetable consumer stated, "Regular foods often have a lot of chemical fertilizers and pesticide residues. So, I buy certified vegetables to keep my family and me healthy." Adopting good agricultural practices can also protect and improve farmers' health. Another certified vegetable farmer noted, "Using fewer chemical fertilizers and pesticides helps keep our water and air clean, so protecting *my health, my family's, and my neighbor's*. Using chemical pesticides is very dangerous." FCs can enhance gender equality by promoting women's participation in agribusiness, training courses and extension services, household decision-making processes, and ensuring fair employment and income. For example, a male certified coffee farmer said, "Here, women take part in most activities and decisions on the farm, just like men. In some cases, women are even given more importance and have a stronger voice in the family."

FCs can enhance the education of certified farmers through training schemes provided by certification providers, governments, enterprises, and other organizations to ensure compliance with FC standards. FCs are crucial in fostering trust and promoting responsible consumption among consumers. They ensure accountability and compliance among producers, enhance the traceability and safety of products, and bolster credibility and transparency throughout the food value chains. Additionally, FCs mandate that farmers maintain detailed production records and reports and that cooperatives operate with transparent and democratic governance systems, thereby fostering justice and robust institutions. For example, an organic vegetable farmer said: "I must join many technical and farm management training courses to produce certified food products. I also get free training programs from the government, JICA, projects and firms." Another certified coffee cooperative member explained, "We must keep clear records and reports on using fertilizers and pesticides. Also, our cooperative needs to hold meetings with all members for important decisions and openly share reports on the cooperative's revenue, expenditure, and activities supported by Fairtrade."

Especially, FCs are closely related to sustainable agricultural practices and environmental sustainability. Adherence to the good agricultural standards of various certification schemes (e.g., Fairtrade, VietGAP, Organic, RFA) requires farmers to reduce or eliminate harmful inputs (chemical fertilizers, pesticides), efficiently use water resources and energy (gasoline, electricity), protect forest and ecological landscapes, and uphold environmental values to achieve FCs. Consequently, these certifications positively impact the achievement of environmental SDGs. For example, an organic vegetable farmer said, "I can't use chemical fertilizers and pesticides on my organic vegetable farm, especially the toxic ones—it's not allowed. Also, certified agricultural methods help me use gasoline and electricity more efficiently for irrigation." Another leader of a certified coffee cooperative widely noted, "To export coffee to the EU market with Fairtrade, we have to follow many strict standards, such as using limited chemical fertilizers and pesticides, not deforesting, not using child labor, using Fairtrade premium for the community welfare, and supporting women's rights."

Overall, qualitative evidence suggests that food certifications can contribute to multiple dimensions of sustainable development, although their impacts remain context-dependent and vary across certification schemes, implementation stages, and farming conditions. The sustainability benefits of FCs are therefore more likely to emerge when certification standards are effectively implemented and supported by markets, institutions, and farmer capabilities.

4.3 Discussion

Our quantitative and qualitative results indicate that FCs can significantly increase farmers' income and contribute to achieving multiple SDGs. Different FCs with different purposes and standards can help to achieve different SDGs (Ikram *et al.*, 2021). This mixed-method research identifies critical links between FCs and specific SDGs that contribute to the literature and is consistent with previous studies. FCs can impact poverty alleviation, hunger elimination, and health and well-being enhancement. This study suggests that FCs can provide meaningful economic and sustainability benefits for smallholder farmers in developing-country contexts, although the magnitude of these benefits may vary depending on certification schemes, market access, institutional support, and farm conditions, thereby contributing significantly to SDG 1 (e.g., Liu *et al.*, 2020; Mitiku *et al.*, 2017). FCs can also solve hunger issues (SDG 2) by increasing food supply, productivity, and livelihoods through good practices (e.g., Dompreh *et al.*, 2021) while conserving natural resources for future food availability. The qualitative findings show that FCs can improve farmers' and consumers' health and well-being (e.g., Annunziata *et al.*, 2019; Sellare *et al.*, 2020) by diminishing harmful chemical fertilizers and pesticides and increasing food quality and safety. The income-related findings further suggest that the economic benefits of FCs are not uniform but depend on market access, certification costs, crop characteristics, and farmers' capacities. Qualitative evidence indicates that certification benefits are more likely to emerge when certified products are linked to premium or stable markets and when farmers receive sufficient technical and institutional support.

FCs can enhance farmers' capacity and education (SDG 4) through various training schemes when they apply good agricultural practices. Moreover, FCs can promote gender equality (SDG 5) by creating opportunities for women in agriculture, encouraging their involvement in household decision-making processes, providing access to training courses and agricultural extension services, and ensuring fair employment and farming income (e.g., Meemken and Qaim, 2018). FCs include various standards for efficient water use, effective wastewater management, water quality preservation, and minimizing harmful inputs to water resources (e.g., Waldman and Kerr, 2014), thereby supporting the achievement of SDG 6. The findings show that FCs can increase farmers' income and likelihood, create better and safer working conditions, and contribute to local economic growth, thereby contributing to SDG 8 (Kimura and Rigolot, 2021) and SDG 10. However, FCs can exacerbate income inequalities among farmers by focusing excessively on surveillance and market demands while neglecting ultra-marginal farmers (Getz and Shreck, 2006).

FCs promote responsible production by setting standards and encouraging efficient resource use, waste reduction, and ethical practices. They enhance responsible consumption by increasing transparency and traceability, ensuring consumer access to ethically and environmentally friendly food products, and raising consumer awareness and willingness to pay a premium for certified products. Consequently, FCs foster responsible consumption and production, aligning with SDG 12 (e.g., Brach *et al.*, 2018; Nguyen *et al.*, 2017). Furthermore, FCs promote sustainable practices such as agroforestry, forest and biodiversity conservation, reduced chemical use, and efficient water management. They incentivize the adoption of climate-smart agriculture, reduce greenhouse gas emissions, and increase resilience to climate change, thereby advancing SDG 13 (e.g., Birkenberg *et al.*, 2021) and SDG 15 (e.g., Sellare *et al.*, 2020). The qualitative analysis shows that FCs help build consumer trust and promote responsible consumption, ensure producer accountability and democracy, enhance product traceability and safety, and boost credibility and transparency in the food supply chain, thereby fostering justice and strong institutions – SDG 16 in food value chains.

These findings also provide several managerial implications for agribusiness stakeholders. Food certification should not be treated merely as a technical compliance mechanism but as a strategic decision requiring alignment between certification schemes, crop types, market segments, and farmers' capacities. For farmers, cooperatives, and agribusiness firms, strengthening market linkages, technical support, and capability development is essential to enhance certification effectiveness and economic benefits. In addition, policymakers and certification bodies should improve institutional support, consumer trust, and certification enforcement to maximize the sustainability and livelihood benefits of FCs.

5. Conclusion

Recent literature highlights the growing importance of FCs in global food value chains, attracting significant attention from stakeholders. FCs are a powerful tool for enhancing economic benefits and sustainable development. However, previous studies still indicated divergent or contradictory evidence of the influence of FCs on economic benefits and sustainable development. At the same time, there is still a need for more research on links between FCs and SGDs. This study uses a mixed-method approach to examine the influence of FCs on farmers' income and sustainable development in Vietnam.

Quantitative results show that FCs increase farmers' income by 44%, roughly 125 000 VND. However, FCs fail to reduce farming challenges. Selling food products to processors increases farmers' income by 38 000 VND, while supplying to cooperatives decreases income by 86 000 VND. Unexpectedly, partnerships with processors and exporters raise farmers' challenges. Both fertile and infertile soils reduce farmers' income. Capital loans and support programs boost economic benefits but do not adequately address financial capital and land degradation issues. Higher off-farm income correlates with lower on-farm income and more farming difficulties.

The qualitative analysis highlights several factors affecting the effectiveness of FCs, including the types and levels of certifications; consumer awareness, trust, and willingness to pay; output markets and market segments; farmer capacity and farm environments; crop types; and the implementation stages of certification. FCs can significantly impact sustainable development in various ways. Specifically, they contribute to achieving multiple SDGs, such as poverty eradication (SDG 1), hunger alleviation (SDG 2), good health and well-being (SDG 3), quality education (SDG 4), gender equality (SDG 5), clean water and sanitation (SDG 6), better work and economic growth (SDG 8), reduced inequalities (SDG 10), responsible consumption and production (SDG 12), climate action (SDG 13), life on land (SDG 15) and justice and strong institutions (SDG 16).

The findings highlight the important role of FCs in improving farmers' well-being and promoting sustainable development, particularly in developing-country contexts and among smallholder farmers. However, certification effectiveness depends on contextual conditions and should not be uniformly promoted. From a managerial perspective, food certifications should be implemented selectively according to crop types,

market requirements, and farmers' capabilities rather than uniformly promoted. Strengthening market access, technical assistance, consumer trust, and institutional enforcement is essential to improve the effectiveness and sustainability outcomes of certification systems. In global trade, stronger and more effective implementation of FCs can contribute to advancing multiple SDGs in both developed and developing markets.

The findings of this study should be interpreted in light of limitations. First, although purposive and snowball sampling enabled access to certified and non-certified farmers in practice, the findings may reflect the characteristics of the study context and therefore should be generalized with caution. Second, while sustainability is examined through economic, social, and environmental dimensions aligned with relevant SDGs, some sustainability outcomes are indirectly captured and may benefit from more detailed measurement in future studies. Third, although econometric methods and PSM were employed to strengthen empirical estimation, certification decisions may still be influenced by unobserved contextual factors. Finally, as this study focuses on VietGAP certification and predominantly smallholder farming conditions in Vietnam, certification effectiveness may differ across certification schemes, crops, institutional environments, and geographical contexts. Future research may further examine the drivers, barriers, and enabling conditions of FC adoption and effectiveness across different farming systems and settings.

Authors' contributions

VH: Conceptualization, methodology, validation, investigation, analysis and writing. CN: investigation, analysis and writing.

Conflict of interest

There are no competing interests related to this research and publication.

Data availability

Primary data that have been collected by the authors team are available upon request.

Ethics statement

This article does not contain any studies with human or animal participants.

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Appendix

Table A1. Econometric results using PSM.

	Income	Capital	Tech	Input	Land Deg.
Food certification	123993***	–0.046	0.144	0.039	–0.087
Buyers					
Trader (yes=1)	1849	0.088	0.518***	0.111	–0.043
Processor (yes=1)	35237*	–0.047	0.313*	0.108	–0.247
Cooperative (yes=1)	–76267*	–0.273	0.074	–0.715**	0.099
Exporter (yes=1)	–27390	–0.368	0.552	–0.199	–0.772*
Retailer (yes=1)	31564	–0.227	0.586**	0.049	0.223
End-user (yes=1)	7607***	–0.041*	–0.050**	0.006	–0.008
Age	987	0.006	0.004	0.01	–0.007
Gender	–53384***	–0.06	–0.340**	–0.144	–0.056
Household members	12554*	–0.092*	0.053	–0.036	0.058
Main labor	–11598	0.049	–0.025	0.003	–0.018
Farming experience	–1083	–0.003	–0.018***	–0.007	0.011*
Farm size	–13813	–0.028	0.1	0.015	–0.127
Soil quality					
Alluvial (yes=1)	–49021**	–0.436**	–0.04	–0.101	–0.192
Gray (yes=1)	–31422	–0.211	0.394**	0.093	0.02
Acid sulphate (yes=1)	–78276***	0.444**	0.191	0.156	0.517**
Salinity intrusion (yes=1)	5934	–0.072	0.106	0.057	0.405*
Polluted (yes=1)	49971	–0.162	0.432*	0.142	–0.421*
Farm position, near					
River (yes=1)	–12564	–0.074	0	0.048	0.012
Truck road (yes=1)	32055	–0.055	–0.027	–0.277*	–0.229
Motorbike road (yes=1)	–17	0.077	0.051	–0.222	–0.097
Land road (yes=1)	–9330	–0.044	0.072	–0.260*	–0.238
Loan	36881*	0.714***	–0.081	0.201	–0.003
Off-farm income	–54259***	0.066	0.360***	0.386***	0.137
Constant	62544				
Thresholds					
μ1		–2.497***	–1.242**	–1.200**	–2.328***
μ2		–0.601	0.053	0.059	–1.251**
μ3		–0.169	0.583	0.659	–0.716
μ4		0.232	1.418***	1.169**	–0.262
μ5		0.677	2.192***	1.648***	0.467

SD in parentheses.

* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level. Source: The authors' own analysis