Organic cocoa value chain development and impacts on food security in SIDS. The case of São Tome and Príncipe[1]

Draft

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Abstract

Agrifood systems face increasing pressure to deliver economic viability, environmental sustainability, and improved nutrition under growing climate vulnerability. These challenges are particularly acute in Small Island Developing States (SIDS), where structural constraints limit productivity-led transformation and exposure to external shocks heightens food and nutrition insecurity risks. In such contexts, strategies that emphasize quality rather than quantity - such as participation in organic certification schemes - are promoted as pathways to integrate smallholders into global markets while supporting rural development. Yet rigorous evidence on their food and nutrition security impacts remains limited, especially for SIDS.

This study evaluates the effects of participation in an organic-certified cocoa value chain project in São Tomé and Príncipe on dietary diversity and food security of small-scale farmers. Using ex-post quasi-experimental data, the study investigates the pathways through which organic certification impacts smallholder livelihoods, with a focus on dietary diversity and food security.

Findings reveal that organic certification enhances household dietary diversity and reduces food insecurity, primarily through increased income from crop sales rather than crop diversification and increased home consumption. Improvements in dietary diversity extend beyond direct beneficiaries, suggesting positive spillover effects within communities, whereas reductions in food insecurity are concentrated among participating households. Furthermore, households managed by women exhibited stronger gains in food security and dietary diversity, highlighting the importance of gender dynamics. This study contributes to the limited literature on the nexus between sustainability certifications and food security, offering evidence from a highly vulnerable context where data and research are scarce.

Keywords: smallholders; organic farming; value chain development; food security.

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1. Introduction

Agricultural certification schemes have been on the rise for the last two decades, promising sustainable production for the environment, producers and workers. However, studies conducted to date, including systematic reviews, yield varying results on whether these schemes are delivering the desired outcomes. In the growing body of research on agricultural certification, the evidence predominantly has focused on production outcomes, with much of it centered around Fairtrade certification. In contrast, social outcomes and other types of certifications, including organic, remain less explored.

While there is evidence that that farmers certified under a sustainability standard receive higher output prices and earn higher income from certified production (1,2), the impact on yields and social outcomes (3) is more mixed. In fact, evidence is inconclusive for sustainability standards in general (2), and even leans towards lower yields, particularly for lower organic certification schemes (1). Evidence is even more limited in fragile contexts like those of Small Island Developing State (SIDS) where agrifood systems are constrained by their remoteness and overreliance on food imports.

In this paper, we address this gap by examining the impacts of organic cocoa value chain development on food security in São Tomé and Príncipe, a SIDS. Using impact assessment data, we explore the pathways through which organic farming can influence smallholder livelihoods beyond agricultural outputs, with a focus on food security and nutritional diversity outcomes. Additionally, we also investigate differential impacts among different types of households to check for heterogenous effects.

This paper makes two key contributions. First, this study contributes to this underdeveloped literature by examining the effects of organic certification on food and nutrition security in São Tomé and Príncipe, a SIDS where farmers face structural constraints such as low productivity, limited infrastructure, and climate vulnerability. Second, this paper provides new evidence on the connection between organic cocoa value chain development and food security, analyzing impact pathways in a country where data and evidence are scarce. This contribution is especially significant, given that a small percentage of global scientific research is dedicated to regions that are highly vulnerable to climate change and hunger (4).

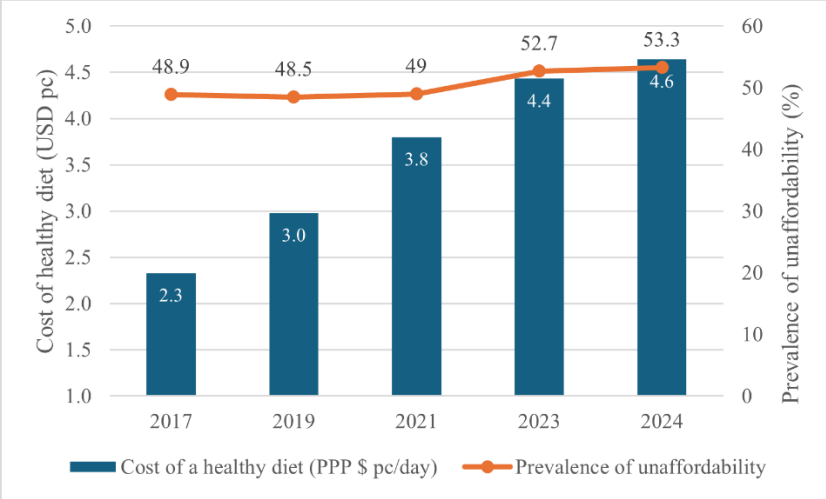
2. Context and intervention

The Democratic Republic of São Tomé and Príncipe (STP), a SIDS and one of the Least Developed Countries (LDCs) until 2024, is located off the western coast of Central Africa in the Gulf of Guinea. Despite significant economic progress, with GDP per capita doubling between 2010 and 2022, poverty remains widespread, affecting up to 31% of the population living on less than $4.20 per day (2021 PPP), among which almost 13% survived on less than $3.00 per day, according to latest estimates (5). STP faces challenges typical of small, insular states, including structural vulnerabilities that hinder its ability to manage shocks and achieve balanced budgets (6), import dependence for basic goods and fossil fuels, remoteness and limited production capacity which drive up costs and restrict economic diversification. This makes STP particularly susceptible to external shocks, including those from climate change and global economic shifts. Agriculture, employing 17% (5) of the workforce and contributing 19.3% of GDP, is central to STP's economy but is dominated by a narrow export base, particularly cacao and palm oil, which accounted for over 54% and 32% of exports in 2022, respectively (7). Agrarian reforms in the 1990s redistributed state-owned farms to smallholders, but these farmers face low productivity, inadequate infrastructure, and limited market demand. Additionally, smallholders are increasingly vulnerable to natural disasters exacerbated by climate change, with limited capacity to adapt.

Limited food production and heavy reliance on imports make access to healthy diets and food security major challenges for SIDS. Many of these nations are grappling with the double burden of malnutrition, experiencing both undernourishment and rising rates of obesity. The cost of healthy

diets in São Tomé and Príncipe has been steadily increasing, with estimates suggesting that more than half of the population cannot afford one (8). This has resulted in a 54% prevalence of moderate food insecurity, 14% severe food insecurity, and a 16.4% prevalence of undernourishment. Additionally, approximately 44% of women of reproductive age suffer from anemia, significantly higher than the SIDS average of 29%. There has also been a concerning rise in obesity among adults, increasing from 11.8% in 2012 to 16.5% in 2022, and the prevalence of overweight children has nearly doubled, from 2.5% to 4.7% (8).

Figure 1. Cost of health diets in Sao Tome and Principe



Source: Author's own elaboration based on SOFI 2024 (9)

The government of STP has sought to address the country's vulnerabilities and development challenges by enhancing the capacities of producers through the Participatory Smallholder Agriculture and Artisanal Fisheries Development Programme (PAPAFPA) and the Smallholder Commercial Agriculture Project (PAPAC), both supported by the International Fund for Agricultural Development (IFAD). These initiatives were designed with the primary objective of improving the livelihoods of rural communities by increasing their revenues and ensuring greater food security. The projects – referred hereby as treatment – focused on developing and strengthening producers' associations within four cooperatives, which promoted the inclusive value chain development of certified organic market products (cocoa, coffee and pepper) and the professionalization of smallholder farmers. The projects aimed to enhance producers' technical capacity, strengthen cooperatives, and improve product quality to secure better and more stable prices through contractual arrangements. By reducing exposure to price volatility, the interventions sought to increase and stabilize income and food security while strengthening resilience to market and climate shocks. The analysis focuses on cocoa, the most widely produced commodity.

3. Conceptual framework

Sustainability certifications, such as Organic, Fair Trade, and Rainforest Alliance, are widely recognized for influencing smallholder farmers' living standards through various mechanisms. While their economic effects, particularly the impact on farmers' incomes, have been well-documented (10–12), the potential influence of these certifications on food security remains less explored in the literature. Most research on certification impacts has traditionally focused on economic and environmental outcomes, leaving a gap in understanding the broader social effects, especially those related to nutrition and food security (13).

Although nutritional outcomes are not typically the primary focus of sustainability certification schemes, there is growing evidence that certifications can indirectly affect dietary quality. Certifications often improve market access and smallholder incomes, which can enhance farmers'

purchasing power and expenditures (14) and, consequently, their ability to afford diverse and nutritious foods (15). For instance, improved incomes from certified production may allow households to purchase higher-quality foods, contributing to better nutrition security (16).

Certifications are expected to influence all four pillars of food security (availability, access, utilization, and stability) although these impacts can vary, yielding both positive and negative outcomes (13). While economic benefits, such as increased income and market access, may improve food security through better access to food, certification schemes (especially organic ones) may also impose restrictions that affect yields (17–19), thus influencing food availability. Our research focuses on examining the effects of organic certification, which remains one of the least studied certifications in terms of its impact on food security.

According to the Food and Agricultural Organization of the United Nations (FAO), food security is achieved when "all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (20). Based on this definition, we propose two primary pathways through which organic certifications could influence food security: income pathway and diversification and home consumption pathway.

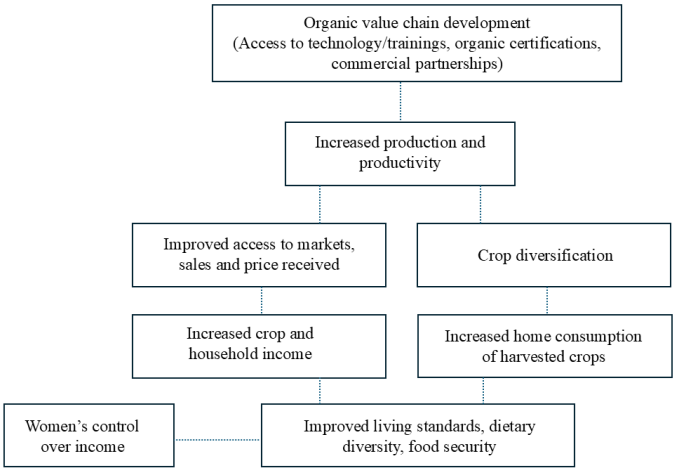
Income Pathway. Organic certifications, like other sustainability certifications, can influence smallholder income by providing access to premium markets and higher prices for certified produce (12,21). This increase in income can improve households' ability to purchase a wider variety of foods, enhancing dietary diversity and nutritional outcomes (15,22). Evidence from smallholders in Ghana highlights how certifications can improve household welfare and, by extension, food security (16). Songsermsawas et al. (23) further support this by showing how value chain improvements in Pacific regions like Papua New Guinea and the Solomon Islands have positively influenced food security through enhanced agricultural productivity, market access, and diversification. However, the benefits may vary depending on the degree of income earned and the household's expenditure priorities, which can be influenced by factors such as household head gender (24).

Diversification and Home Consumption Pathway. Organic farming promotes crop diversification by encouraging the cultivation of a broader range of crops, which can enhance both dietary quality and food security for smallholder farmers (19). By growing a diverse array of crops, farmers may increase their household's direct access to nutritious foods, thereby improving food utilization (25). However, organic farming's restrictions on synthetic fertilizers and pesticides could result in lower yields, which may negatively impact food availability and stability for producers (12,26). The trade-off between improved dietary diversity through diversification and potential yield reductions is a key tension that this research seeks to explore.

Household dynamics, particularly the role of gender in decision-making, are critical to understanding the impacts of organic certification on food security. Research suggests that gender influences how income is used within households, with women more likely to invest in food security and children's nutrition than men (25). For example, Chiputwa & Qaim (16) found that certification schemes in Uganda had distinct effects based on gender, further highlighting the need to consider gendered impacts in food security research.

In this paper, we aim to explore which of these pathways—income or diversification—drives improvements in food security for smallholder farmers engaged in organic-certified cocoa production in São Tomé and Príncipe. By focusing on a Small Island Developing State (SIDS), where food system constraints are greater due to remoteness and high dependency on imports, we contribute new evidence to the limited literature on the relationship between organic certifications and food security. This research will also examine whether the impacts of organic certification are homogeneous across different household types, particularly considering gender dynamics (27).

Figure 2. Conceptual framework



Source: Authors' own elaboration

4. Data and methods

Sample design and data

The data used in this study was collected between September and November 2018 as part of the joint impact evaluation of the IFAD PAFPA and PAPAC projects. The impact evaluation was based on ex-post quasi-experimental data, as reliable baseline data was unavailable for both the treatment and control groups. Sample design to identify the counterfactual replicated the targeting strategy used by the project to recruit participants. The quantitative data collection was approached in three stages. The first stage consisted of the identification of possible counterfactual communities through expert-based knowledge and validation. Counterfactual communities were defined as the ones that would meet the cooperatives inclusion criteria and were similar to the beneficiary communities prior to the start of the projects. This exercise identified a list of 36 communities which had never benefitted from the projects and could therefore be considered as "pure" control communities. Second, following the identification of treated and non-treated communities, an enumeration or listing of the producers' households was conducted within the relevant communities. This exercise consisted of an inventory of producers' households in the 108 communities where the projects took place and in the 36 (control) communities that were not targeted by either project but that qualified, according to the experts and cooperatives' assessment, as being eligible. It served as the starting point for sampling producers' households across these communities of interest. This was a fundamental step prior to the main household survey because it allowed to randomly select the required number of households from the eligible populations of interest. The listing questionnaire captured mostly eligibility criteria and treatment intensity. Using this information, matching algorithms based on fixed characteristics of the farmers (e.g. biographic and geography-related), their productive profile (crops farmed, plants and yields) and eligibility criteria at the baseline (which, in the questionnaires, was set in 2008) were used to find a valid counterfactual group of producers' households. The quantitative data consisted of two separate questionnaires: one administered to a sample of 1,404 households and another to a sample of 126 leaders/key member of communities and/or producers' associations. The household survey collected information mainly on household level indicators related to agricultural production, consumption, wealth, income, vulnerability and social capital.

Empirical strategy

The objective of this study is to estimate the impact of cocoa organic certification on food security and dietary diversity of households that participated in the projects' value chain development. We estimate the average treatment effect on the treated (ATT). While data was collected carefully and mimicked targeting criteria, additional steps were implemented to establish a robust counterfactual for impact estimation. The final sample data was pre-processed using a propensity score matching algorithm to match treatment and control households based on observable characteristics. This approach helps minimize the sensitivity of our results to the specification of the linear regression (28). As a result, the household included in the analysis are statistically comparable in terms of observable traits. To estimate ATT we employ the Inverse Probability-Weighted Regression Adjustment (IPWRA) estimator, using the common support sample. For robustness check we also employ a propensity score matching (PSM) based on the 5 nearest neighbors (see Appendix for more details on the estimator).

IPWRA estimators are suitable for observational studies where the selection into treatment is not random, but rather a choice made by the subjects under study. IPWRA addresses the endogeneity associated with this self-selection (into treatment) by modelling both the outcome and the treatment to account for the non-random treatment assignment. For this reason, it is said to be "doubly robust", which means that only one of the two models (either the participation equation or the outcome equation) must be correctly specified to consistently estimate the treatment effects (29,30).

Heterogeneous effect. To test for heterogenous effects within the IPWRA regression framework described above, the treatment indicator is interacted with one dichotomous variable of interest at a time (i.e women-headed households, young headed households, poor household, household with a member with disability, experience with cocoa, sex of parcel owner, small parcel type of crop).

5. Results

Descriptive results

While the counterfactual group was carefully constructed to mimic beneficiaries in the absence of the project, we further ensure statistical comparability between treatment and comparison households using propensity score matching. Table 1 shows the statistical balance of household-level covariates before and after matching. The results indicate that the covariates are appropriately balanced between the treatment and comparison groups. The matched sample size is 1338 households (626 treated and 712 comparison), we then further restrict the sample excluding the households that did not grow cocoa but only certified coffee and pepper. The final sample size to estimate impacts is of 1154 farming households (537 treated and 617 control). In terms of characteristics, of both farmers groups, the majority of households sampled are male-headed, with an average household head age of 47 years and around five years of education. The average household size is nearly five members. Sampled farmers are generally smallholders, owning 1.6 parcels of an average area of about two hectares. Almost all of them own the land they farm. The average annual household income per capita is 12 000 dobras (approximately 465 USD), with households typically having two income sources. Notably, 70% of their total income comes from crop production, underscoring the significance of agriculture as a primary income source. This heavy reliance on crop activities is likely to have important implications for households' access to food.

Table 1: Descriptive statistics of household level covariates before and after matching

	Before matching				After matching			
	Treatment	Control	p-value	% Bias	Treatment	Control	p-value	% Bias
Household head: female	0.22	0.28	0.012**	12.51	0.23	0.23	0.82	1.35
Household head: age	46.97	46.88	0.914	0.53	46.64	46.03	0.47	4.33
Household head education: (years)	5.00	4.87	0.380	5.00	5.01	4.99	0.92	0.63
Household Size	4.48	4.14	0.005***	12.19	4.38	4.38	0.98	0.14
Dependency ratio	0.88	0.91	0.592	0.74	0.89	0.88	0.91	0.69
Household experienced any shock in the last 5 years	0.43	0.48	0.072*	7.67	0.44	0.43	0.66	2.80
Durables Asset Index	2.01	1.90	0.130	8.30	2.01	1.85	0.08*	11.30
Household in the lowest quintile of number of rooms at baseline	0.76	0.76	0.899	3.69	0.78	0.79	0.76	1.93
Household had pickaxe at baseline	0.46	0.36	0.000***	16.41	0.44	0.44	0.79	1.74
Area parcel (ha.)	2.00	1.83	0.188	7.26	2.00	1.80	0.15	8.64
Non farm income (lcu)	2.01	2.40	0.087*	9.39	2.01	2.29	0.29	6.82
HH owns a cellphone	0.65	0.65	0.918	0.56	0.65	0.64	0.75	2.06
Cocoa yields (kg/ha)	6.99	6.73	0.003***	18.37	6.99	6.73	0.01***	18.34
No. of observations	660	744			626	712		

Note: *** p<0.01, ** p<0.05, * p<0.1. Point estimates are sample means. Non-farm income is calculated using the inverse hyperbolic sine transformation. Cocoa yields is log transformed. Durable asset index is calculated using the principal component analysis. Source: Authors' own elaboration

Table 2 shows the descriptive statistics of the outcome variables on dietary diversity (HDDS and FCS) and food security (proxied by FIES). We present here the aggregate scores, while their breakdown by component is reported in the appendix. For all the indicators, treatment households have significantly different scores, meaning that treatment households are more likely to be food secure and have greater dietary diversity. On average, households consume 8 out of 12 food groups, with cereals and grains being the most commonly consumed, aside from the widespread intake of sugar/sweets and oil/butter consumed by 96 and 99 percent of household respectively, which aligns with rising rates of overweight and obesity. However, consumption of fruits, vegetables, and proteins is also notable, with over 50% of households regularly consuming these food groups.

Additionally, 72% of households meet the minimum dietary diversity indicator by consuming 5 or more food groups. Notably, 71% of households consume mineral-rich green leafy vegetables, while 55% consume vitamin A-rich vegetables and fruits.

Table 2: Descriptive statistics of household level dependent variables

	Treatment		Control		
	N	Mean/SE	N	Mean/SE	p-val
FIES (aggregate)	626	3.85	632	4.33	0.002***
HDDS	626	8.68	632	8.28	0.001***
FCS	626	62.74	632	59.83	0.014**

Note: *** p<0.01, ** p<0.05, * p<0.1. Point estimates are sample means

Impact results

Table 3 and Table 4 present the impacts of organic certification on dietary diversity, measured through the HDDS and FCS, respectively, while Table 5 examines food insecurity using the IPWRA estimator. The estimated ATT coefficients are expressed as percentage changes to facilitate result interpretation. We also report potential outcome (PO) mean, which represents the outcome for the control group.

The results indicate that the development of the organic cocoa value chain has a positive and significant impact on dietary diversity, as measured by HDDS and FCS, for treatment households compared to the control group. These improvements are primarily driven by significantly higher consumption of fruits, milk, and condiments, both in terms of overall consumption and frequency. However, there is also an increase in the consumption of sugar and sweets, which can be considered a less positive outcome.

Specifically, the overall HDDS and FCS scores were 5% and 6% higher, respectively, among organic certified farmers compared to their non-certified counterparts. Certified households were 26% more likely to have consumed fruits in the last seven days and consumed fruit 22% more frequently. They were also 19% more likely to consume milk and dairy products, with a 19% higher frequency. Additionally, certified farmers were 42% more likely to consume spices and condiments, with an 84% higher weekly frequency. Lastly, certified households showed a higher likelihood of consuming sweets and fats, with an 8% increase in frequency.

Table 3. Impact Estimates on dietary diversity (Household Dietary Diversity)

	HDDS	Cereals	Tubers and roots	Vegetables	Fruits	Meat	Legumes	Milk	Eggs	Sweets	Spices
ATT	0.49***	0.02	-0.05	-0.01	0.11***	0.04	-0.03	0.11***	-0.01	0.05***	0.10***
PO mean	7.79	0.83	0.77	0.78	0.43	0.72	0.7	0.57	0.57	0.91	0.24
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	1035	1035	1035	1035	1035	1035	1035	1035	1035	1035	1035

Note: * p<0.1, ** p<0.05, *** p<0.01,

Table 4. Impact Estimates on dietary diversity (Food Consumption Score)

	FCS	Cereals, grains, roots, tubers	Pulses, legumes, nuts, seeds	Dairy	Fruits	Meat, fish, eggs	Vegetables	Oils, fats and butter	Sugar and sweets	Condiments and spices
ATT	3.36***	0.08	0.07	0.54***	0.32**	0.12	0.14	0.13	0.47***	0.74***
PO mean	61.2	3.64	3	2.89	1.47	5.06	2.62	6.58	5.59	0.88
Controls		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs		1035	1035	1035	1035	1035	1035	1035	1035	1035

Note: * p<0.1, ** p<0.05, *** p<0.01,

The positive impacts of more diversified diets are also reflected in food security outcomes, with organic certified households being 12% less likely to experience food insecurity compared to non-certified farmers. Breaking down the FIES, we observe that certified households are 12% less likely to worry about running out of food, 13% less likely to have skipped meals, 24% less likely to have run out of food entirely, and 38% less likely to have gone without eating for an entire day.

Table 5. Impact estimates on self-reported food insecurity (Food Insecurity Experience Scale)

	FIES	Worried about lack of food at home	Unable to eat healthy and nutritious food	Ate only a few types of food	Skipped meals	Ate less than he/she should	Ran out of food	Was hungry but did not eat	Went the whole day without eating
ATT	-0.50***	-0.08**	-0.05	-0.02	-0.08**	-0.05	-0.11***	-0.05	-0.05***
PO mean	4.3	0.69	0.72	0.61	0.61	0.67	0.45	0.44	0.13
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	1025	1025	1025	1025	1025	1025	1025	1025	1025

Note: * p<0.1, ** p<0.05, *** p<0.01

Heterogeneous effects

Table 6 presents the results of the heterogeneity analysis, which focuses on relevant heterogeneity dimensions to explore gender and household vulnerability dynamics. For each of the outcome variables for dietary diversity and food security, the table examines the heterogeneity by gender proxied by sex of the household head, sex of the household member that manages household money, sex of the household member that manages the parcel and harvest use and earnings. We also explore heterogeneity by proxies of household vulnerability, such as a young household head, a household member with a disability, household below the poverty line and a parcel size below average. The results indicate that households where women manage finances or make decisions about harvest use have lower food insecurity (as measured by the FIES) and higher dietary diversity scores compared to households where men take on these roles. This finding aligns with existing literature (CITE), supporting the hypothesis that when women control household finances, both dietary diversity and food security tend to improve. Contrary to expectations, we find that households with a member with a disability exhibit greater dietary diversity than those without. Additionally, young-headed households and those with smaller-than-average parcel sizes report lower levels of food insecurity compared to their counterparts.

Table 6: Treatment effects heterogeneity

Interaction of treatment with	FIES	HDDS	FCS
Female headed household	-0.04	0.21	-0.84
	(-0.275)	(-0.218)	(2.003)
Young Headed household	-0.61**	0.23	3.07
	(0.29)	-0.201	(1.974)
Female manages household money	-0.47*	0.33*	2.17
	(0.276)	(0.187)	(1.892)
Female manages parcel	-0.27	0.18	-0.22
	(0.224)	(0.189)	(1.786)
Female makes decision about harvest use	-0.58**	0.41**	1.82
	(0.236)	(0.180)	(1.677)
Female manages harvest earnings	-0.52**	0.41**	2.61
	(0.224)	(0.177)	(1.726)
HH has a member with disability	-0.15	0.42***	2.72*
	(0.182)	(0.154)	(1.546)
HH below the poverty line	-0.09	-0.00	1.23
	(0.201)	(0.161)	(1.544)
Parcel size below average	-0.34*	0.13	-0.72
	(0.186)	(0.146)	(1.434)
Controls	Yes	Yes	Yes
Observations	1035	1035	1035

Note: * p<0.1, ** p<0.05, *** p<0.01, Standard errors in parentheses

Impact mechanism and discussion

Building on the conceptual framework (see Figure 2) we examine the different channels that could lead to improved dietary diversity and food security. We hypothesized that organic certification could lead to improved food and nutrition security outcomes through two pathways: income increase from crop sales and/or higher diversification and harvest home consumption.

Table 7 shows that the development of the organic cocoa value chain resulted in significant increases in production. Organic farmers experienced 39%, 44%, and 30% higher harvests of cocoa, fruit, and cocoa yields, respectively. In terms of harvest use, organic farmers allocated a larger share of their harvest to sales. These higher production levels were also reflected in increased sales quantities of both cocoa and fruit, leading to 50% higher overall income from crop sales with respect to the control group.

Improved food security through diversification and higher home consumption was not evident in this case. There was no significant difference in the number of crops grown between the groups, and organic farmers allocated a smaller share of their harvest to home consumption compared to the control group.

Table 7. Impact estimates on production, market access and home consumption

	Production				*Share of harvest used for*		*Access to markets*		
	Harvest cocoa (kg)	Harvest fruit (kg)	Yields cocoa	Number of crops grown	Home consumption	Sales	Sales quantity cocoa (kg)	Sales quantity fruit (kg)	Value of crop sales (lcu)
ATT	384.4***	1095.6***	0.30***	0.02	-0.04***	0.06***	382.4***	878.8***	0.49***
PO mean	990	2502.2	6.69	3.48	0.15	0.81	954.4	1989.9	9.2
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	1154	1154	1035	1146	1137	1137	1146	1146	1126

Note: * p<0.1, ** p<0.05, *** p<0.01. Cocoa yields and value of crop sales are log transformed

6. Conclusion

This study provides robust evidence that organic cocoa certification positively impacts dietary diversity and food security in São Tomé and Príncipe. Certified households benefit from increased income through improved market access and higher crop yields, enabling better food consumption patterns. However, the anticipated benefits of diversification and home consumption were not observed, suggesting that income-driven pathways play a more significant role in enhancing food security in this context.

Gender dynamics emerged as a critical factor, with female-managed households showing greater improvements in dietary and food security outcomes. This finding underscores the need to design interventions that empower women to maximize the benefits of certification schemes.

The results highlight the potential of sustainability certifications to contribute to food security in SIDS, despite the structural and environmental challenges these countries face. Future policies should focus on leveraging the income pathways while addressing constraints related to production diversification and ensuring that interventions are inclusive and gender-sensitive. Further research is recommended to explore long-term impacts and to assess the replicability of these findings in other SIDS contexts.

References

1. Meemken EM. Do smallholder farmers benefit from sustainability standards? A systematic review and meta-analysis. Global Food Security. 2020 Sep;26:100373. doi:10.1016/j.gfs.2020.100373

2. Oya C, Schaefer F, Skalidou D, McCosker C, Langer L. Effects of certification schemes for agricultural production on socio-economic outcomes in low- and middle-income countries: a systematic review. Campbell Systematic Reviews. 2017 Jan;13(1):1–346. doi:10.4073/csr.2017.3

3. DeFries RS, Fanzo J, Mondal P, Remans R, Wood SA. Is voluntary certification of tropical agricultural commodities achieving sustainability goals for small-scale producers? A review of the evidence. Environ Res Lett. 2017 Jan;12(3):033001. doi:10.1088/1748-9326/aa625e

4. Porciello J, Skidan V, Ambikapathi R, Boonabaana B, Guerra J, Lidder P, et al. The State of the Field for Research on Agrifood Systems [Juno Reports] [Internet]. CABI; 2024 Jun [cited 2024 Sep 15]. (Juno Reports). Report No. Available from: https://www.cabidigitallibrary.org/doi/10.1079/junoreports.2024.0001 doi:10.1079/junoreports.2024.0001

5. World Bank. World Development Indicators. https://data.worldbank.org/; 2024.

6. UNCTAD. UNCTAD Strategy to support Small Island Developing States. UNCTAD; 2024 Apr. Report No.

7. BCSTP. Balanca Comercial Produto (2013-2024) [Internet]. 2024. Available from: https://bcstp.st/Banco-Central?x=wOgqPO8BlRrdHdPOd1%2BEuA==&&z=mCLJy8EbGDua1xVDQp043w==

8. FAO. The State of Food Security and Nutrition in the World 2024 [Internet]. FAO; IFAD; UNICEF; WFP; WHO; 2024 [cited 2024 Sep 15]. Available from: https://openknowledge.fao.org/handle/20.500.14283/cd1254en doi:10.4060/cd1254en

9. FAO, IFAD, UNICEF, WFP, WHO. The State of Food Security and Nutrition in the World 2025. Addressing high food price inflation for food security and nutrition [Internet]. Rome, Italy: FAO; IFAD; UNICEF; WFP; WHO; 2025 [cited 2026 Mar 2]. 234 p. (The State of Food Security and Nutrition in the World (SOFI); no. 2025). Available from: https://openknowledge.fao.org/handle/20.500.14283/cd6008en doi:10.4060/cd6008en

10. Becchetti L, Costantino M. The Effects of Fair Trade on Affiliated Producers: An Impact Analysis on Kenyan Farmers. World Development. 2008 May;36(5):823–42. doi:10.1016/j.worlddev.2007.05.007

11. Jena PR, Chichaibelu BB, Stellmacher T, Grote U. The impact of coffee certification on small-scale producers' livelihoods: a case study from the Jimma Zone, Ethiopia. Agricultural Economics. 2012 Jul;43(4):429–40. doi:10.1111/j.1574-0862.2012.00594.x

12. Meemken EM, Spielman DJ, Qaim M. Trading off nutrition and education? A panel data analysis of the dissimilar welfare effects of Organic and Fairtrade standards. Food Policy. 2017 Aug;71:74–85. doi:10.1016/j.foodpol.2017.07.010

13. Schleifer P, Sun Y. Reviewing the impact of sustainability certification on food security in developing countries. Global Food Security. 2020 Mar;24:100337. doi:10.1016/j.gfs.2019.100337

14. Knößlsdorfer I, Sellare J, Qaim M. Effects of Fairtrade on farm household food security and living standards: Insights from Côte d'Ivoire. Global Food Security. 2021 Jun;29:100535. doi:10.1016/j.gfs.2021.100535

15. Sibhatu KT, Krishna VV, Qaim M. Production diversity and dietary diversity in smallholder farm households. Proc Natl Acad Sci USA. 2015 Aug;112(34):10657–62. doi:10.1073/pnas.1510982112

16. Chiputwa B, Qaim M. Sustainability Standards, Gender, and Nutrition among Smallholder Farmers in Uganda. The Journal of Development Studies. 2016 Sep;52(9):1241–57. doi:10.1080/00220388.2016.1156090

17. Beuchelt TD, Zeller M. The role of cooperative business models for the success of smallholder coffee certification in Nicaragua: A comparison of conventional, organic and Organic-Fairtrade certified cooperatives. Renew Agric Food Syst. 2013 Sep;28(3):195–211. doi:10.1017/S1742170512000087

18. Mitiku F, Nyssen J, Maertens M. Certification of Semi-forest Coffee as a Land-sharing Strategy in Ethiopia. Ecological Economics. 2018 Mar;145:194–204. doi:10.1016/j.ecolecon.2017.09.008

19. Seufert V, Ramankutty N, Foley JA. Comparing the yields of organic and conventional agriculture. Nature. 2012 May;485(7397):229–32. doi:10.1038/nature11069

20. FAO. World Food Summit. Rome, Italy: FAO; 1996 Nov. Report No.

21. Chiputwa B, Spielman DJ, Qaim M. Food Standards, Certification, and Poverty among Coffee Farmers in Uganda. World Development. 2015 Feb;66:400–12. doi:10.1016/j.worlddev.2014.09.006

22. Dompreh EB, Asare R, Gasparatos A. Sustainable but hungry? Food security outcomes of certification for cocoa and oil palm smallholders in Ghana. Environ Res Lett. 2021 May;16(5):055001. doi:10.1088/1748-9326/abdf88

23. Songsermsawas T, Mabiso A, Arslan A, Chiarella C, Savastano S. Agricultural value chains and food security in the Pacific: Evidence from Papua New Guinea and Solomon Islands. Global Food Security. 2023 Dec;39:100719. doi:10.1016/j.gfs.2023.100719

24. Quisumbing A. Gender differences in agricultural productivity: a survey of empirical evidence. [Internet]. Washington, DC.: International Food Policy Research Institute; 1995. (FCND Discussion Paper). Report No. Available from: https://hdl.handle.net/10568/157059

25. Panneerselvam P, Hermansen JE, Halberg N. Food Security of Small Holding Farmers: Comparing Organic and Conventional Systems in India. Journal of Sustainable Agriculture. 2010 Jan;35(1):48–68. doi:10.1080/10440046.2011.530506

26. Krumbiegel K, Tillie P. Sustainable practices in cocoa production. The role of certification schemes and farmer cooperatives. Ecological Economics. 2024 Aug;222:108211. doi:10.1016/j.ecolecon.2024.108211

27. Iddrisu M, Aidoo R, Abawiera Wongnaa C. Participation in UTZ-RA voluntary cocoa certification scheme and its impact on smallholder welfare: Evidence from Ghana. World Development Perspectives. 2020 Dec;20:100244. doi:10.1016/j.wdp.2020.100244

28. Imbens GW, Wooldridge JM. Recent Developments in the Econometrics of Program Evaluation. Journal of Economic Literature. 2009 Mar 1;47(1):5–86. doi:10.1257/jel.47.1.5

29. Bang H, Robins JM. Doubly Robust Estimation in Missing Data and Causal Inference Models. Biometrics. 2005 Dec;61(4):962–73. doi:10.1111/j.1541-0420.2005.00377.x

30. Wooldridge JM. Inverse probability weighted estimation for general missing data problems. Journal of Econometrics. 2007 Dec;141(2):1281–301. doi:10.1016/j.jeconom.2007.02.002