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# Sustainable but hungry? Food security outcomes of certification for cocoa and oil palm smallholders in Ghana

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## Abstract

Cocoa and oil palm are the major commodity crops produced in Ghana and livelihood options for hundreds of thousands of rural households. However, their production has negative environmental and socioeconomic impacts. Certification standards have been promoted as a market-led mechanism to ensure their sustainable production. Even though food security does not feature in the theory of change of most certification standards, there are interesting intersections. This paper assesses the food security outcomes of certification adoption among cocoa and oil palm smallholders in Ghana. We analyse 608 household surveys from two study sites using propensity score matching and multiple standardized metrics of food security such as the Food Consumption Score (FCS), the Household Food Insecurity Access Scale (HFIAS) and the Coping Strategies Index. Certified cocoa/oil palm farmers are more food secure than uncertified farmers and food crop farmers across most indicators and group comparisons. However, the differences are for most indicators not substantial or statistically significant (except the HFIAS). In fact, 65% and 68% of the certified cocoa and oil palm farmers are vulnerable to food insecurity in terms of the FCS. These results suggest that even though certification adoption can improve the livelihoods and yields of farmers, in reality it has marginal effect on food security. Certification standards would need to emphasize food security in their guidelines, theories of change and support packages to smallholders if they are to enhance food security and have a truly positive effect on the sustainability of cocoa and oil palm production.

## 1. Introduction

Rural food insecurity is a major sustainability challenge in sub-Saharan Africa (SSA) [1]. Currently a large fraction of the rural population lacks access to sufficient safe and nutritious food [2]. There has been a growing interest on how the competition between food and non-food cash crops affects food security in SSA [3–6]. Engagement in the production of such crops can have radically different food security outcomes mediated through different mechanisms depending on the crop, production model and the socioeconomic and environmental context [7].

Concurrent to the expansion of non-food commercial crops in SSA (and other parts of the world) strong efforts have sought to increase the sustainability of their production [8]. Certification standards is one of the most prominent of such efforts and entails the adoption of environmentally and socially responsible production practices to improve the sustainability of production [9–11]. Sustainability standards have targeted most non-food commercial crops in SSA including cocoa, coffee, oil palm, sugarcane and cotton [12, 13].

Though not always explicitly articulated in their theories of change, the adoption of certification standards, can affect directly and indirectly farmers' food security in a positive or negative manner [14, 15]. Some of the positive impacts manifest through (a) enhanced farmer income (through yield improvements and premiums payment) that are used to buy food [14, 16, 17], (b) adoption of good agricultural practices through better access to extension services [10], (c) access to credit and agricultural inputs through closer connections with companies and/or ability to form farmer groups [10, 18]. The knowledge and inputs from cash crop certification is sometimes applied to improve the productivity of other food crops within these farms, and further increase food crop yields and income [14]. Conversely, certification adoption might have negative food security outcomes through (a) increased production costs due to audits and changes in production practices, which may disrupt access to food [18–20], (b) displacement of food crops to specialize in cash crop production [14, 21]. However, many systematic reviews have pointed the lack of extensive evidence on the food security impacts of certification in developing countries based on rigorous analysis and standardized criteria [13, 14, 22, 23].

This intersection between non-food cash crop production, certification and food security are particularly important in countries such as Ghana that rely on such crops for rural livelihoods and the national economy. Ghana is the 2nd largest producer of bulk cocoa and the 8th largest producer of crude palm oil in the world [24–26], but at the same time experiences almost endemic rural poverty and food insecurity [5, 27, 28]. Cocoa is cultivated by approximately 800 000 households [29], and oil palm by 600 000 households, in both cases mostly on small plots (<2 ha) [30]. Although oil palm and cocoa are major sources of rural income [31, 32], many of the smallholders engaged in their production are poor and food insecure [5, 28]. Both crops have also been associated with negative environmental impacts such as water pollution [24, 33], deforestation [34–36] and biodiversity loss [37, 38].

Certification has been promoted aggressively in Ghana to improve the performance of both sectors [13, 14], but in very different ways among farmers [10, 25, 39]. Cocoa certification is purely voluntary, with license buying companies (LBCs) and group administrators assisting the interested smallholders [18]. Oil palm certification is driven by large plantations, which 'force' (but also support) their scheme smallholders to adopt certification, with independent oil palm smallholders largely not adopting certification unless assisted by NGOs [25].

The above suggests possibly divergent food security outcomes between smallholder certification contexts. However, there is a lack of knowledge on how certification adoption affects food security (especially through comparative studies), as most literature focuses on impacts related to yields and income [17, 18, 40]. Scholars have pointed the need to both understand better the food security outcomes of certification adoption, as well as improve standards to increase the food security of smallholders [13, 14, 22, 23].

**Table 1.** Key characteristics of the study sites [42] [22 Aug 2020], reprinted by permission of the publisher (Taylor & Francis Ltd, http://www.tandfonline.com.).

| Characteristics | Oil palm | Cocoa |
|---|---|---|
| District | Mpohor | Assin north Municipal |
| Population | 42 923 | 161 341 |
| Rural population (%) | 74.8 | 64.2 |
| Vegetation | Tropical rainforest | Semi-deciduous forest |
| Certification start | 2014 | 2009 |
| Certification adopters | Scheme smallholders | Independent smallholders |
| Annual rainfall (mm) | 1300–2000 | 1500–2000 |
| Poverty incidence (%) | 40.4 | 24.4 |

Source: adapted from [42].

This paper assesses the impact of certification adoption on the food security of oil palm and cocoa smallholders in Ghana. We use the propensity score matching (PSM) approach and three composite indicators of food security, namely the Food Consumption Score (FCS), the Household Food Insecurity Access Scale (HFIAS) and the Coping Strategies Index (CSI). Section 2 outlines the study sites, and data collection and analysis methods. Section 3 presents the food security impacts of certification and section 4 synthesizes the main results, and offers policy and practice recommendations.

## 2. Methodology

### 2.1. Study sites

We focus on two different study sites containing smallholders with different engagements in oil palm and cocoa production. Smallholders in Ghana (incl. cocoa and oil palm), cultivate small pieces of land (typically <5 ha) for subsistence or selling [25, 41]. Scheme smallholders in oil palm areas enter credit or contractual arrangements to sell all of their output to a core plantation (usually operated by a large company), while independent smallholders sell them to varying processors. The cocoa site is located in the semi-deciduous forests of Assin North Municipal and the oil palm study site in the tropical rainforest zone of the Mpohor district, both located in southern Ghana (table 1, figure 1).

The cocoa study site contains smallholders certified through UTZ and Rainforest Alliance under the initiative Mars Partnership for African Cocoa Communities of Tomorrow (iMPACT). These are the most popular cocoa certification schemes in Ghana certifying farmers since 2009 and thus increase the possibility of observing certification impacts (box S1 (available online at stacks.iop.org/ERL/16/055001/mmedia), SEM). Approximately, 75% of the population in the broader area is

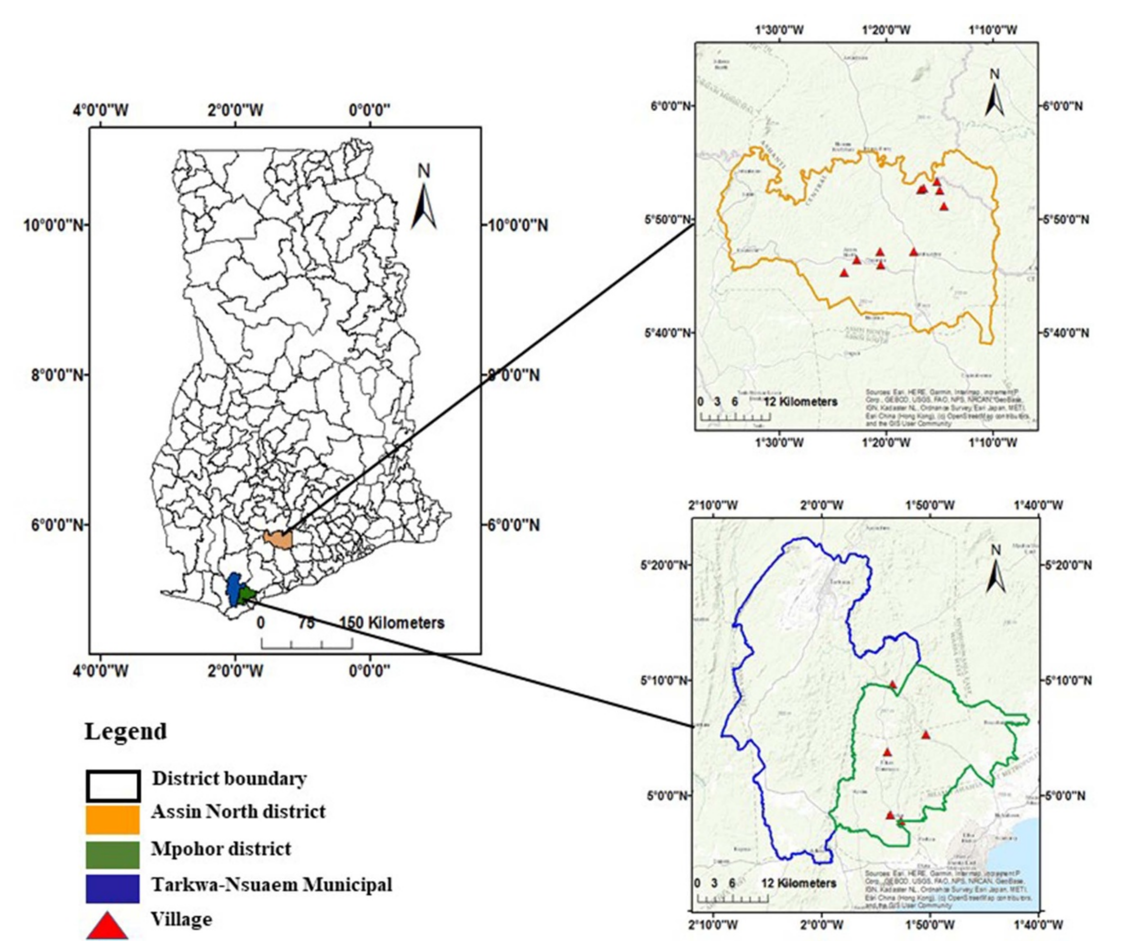


**Figure 1.** Map of Ghana (left) and location of study sites (right).

involved in agriculture, including a high output of certified and non-certified cocoa [43]. The poverty rate stands at 24%, which is relatively low compared to Ghanaian standards [44].

The oil palm site contains certified scheme smallholders under the Benso Oil Palm Plantation (BOPP), a large oil palm plantation, which has been RSPO-certified since 2014. BOPP is one of the earliest certified plantations in Ghana, as oil palm certification is fairly new (section 1; box S1 SEM). Oil palm production is the major farming activity in the district [45], which also contains other large oil palm mills such as Norpalm Ghana Ltd. Apart from these large plantations (and their surrounding scheme smallholders), the region contains many independent small- and medium-sized oil palm producers considering the large local demand for fresh fruit bunches (FFBs). However, the poverty rate stands at about 40%, which is relatively high for Ghana [44].

### 2.2. Data collection

We conducted structured household surveys with smallholders with different types of engagement with cocoa/oil palm certification, namely: (a) certified cocoa/oil palm smallholders (treatment group), (b) uncertified cocoa/oil palm smallholders (control group 1), and (c) food crop farmers (control group 2). In total we conducted approximately 100 surveys with each group, for a total of 608 surveys across the two sites (table S1 SEM) [42].

Household surveys were conducted between August–September, 2018 (cocoa site) and August–September, 2019 (oil palm site). The structured questionnaires included both open- and close-ended questions to elicit: (a) demographic and socioeconomic household characteristics, (b) agricultural practices, (c) income and expenses, and (d) food security. Trained local enumerators collected the household surveys through face-to-face using tablets.

Data collection was conducted simultaneously with a study of the livelihood outcomes of certifications [42], following the protocol design and quality assurance approach proposed for studies in industrial crop settings of SSA [46]. In summary, we follow different sampling approaches across study groups due to the variability in available information and production modalities between sites [42]. This largely reflects differences in cocoa and oil palm value chains, as well data availability (table S1 and box S1, SEM). A major consideration that influenced sampling was the possibility of knowledge spillover between certified and uncertified farmers within the same community (or surrounding communities) regarding the recommended production practices [42]. Possible spillover effects complicate the actual impact assessment of certification, and should be eliminated as much as possible [18, 47].

To avoid spillover effects we selected uncertified cocoa/oil palm farmers (control 1) and food crop farmers (control 2) from communities that do not contain certified farmers. For the cocoa study site, we set a minimum distance of 13 km between certified and uncertified cocoa communities in line with other studies (e.g. 7 km in [18]) [42]. For the oil palm study site, we allowed for a distance of about 21 km between certified and uncertified communities [42].

### 2.3. Data analysis

#### *2.3.1. Main analytical variables*

Standardized metrics have recently gained attention for assessing food security at the household level due to their consistency, robustness, and ability to reduce many of the complications associated with nutritional surveys [48, 49]. Popular metrics include the FCS [50], HFIAS [51, 52] and the CSI [53], which despite their narrow viewpoint [54], have large explanatory power and relevance for policy and practice [49].

In this paper we use the FCS, the HFIAS, and the CSI, which have been used for assessing the food security outcomes of involvement in cash crop production in SSA [5, 55, 56]. Between them, they capture different aspects of food security [5].

The FCS captures dietary diversity, food frequency and relative nutritional frequency at the household level [50]. They capture the consumption of nine food groups in the 7 d prior to the survey, and then summed up and weighed accordingly for each food group. The weighted food group scores are summed and placed within determined thresholds (poor, borderline and acceptable), with high FCS denoting higher food diversity, and thus higher food security [50].

The HFIAS captures the severity of food insecurity based on household behaviours [57]. It is a continuous measure of access to food [51, 52] elicited through nine sets of questions of progressively more severe food insecurity experienced in the 4 weeks before the survey. The questions for each situation consist of an occurrence question and a frequency question, with the scores ranging between 0 and 27 for each household. In this study we use the average HFIAS score that is calculated by dividing the individual household scores by the number of households [51]. High HFIAS score indicate high perceptions of hunger, and thus lower food security.

The CSI measures adaptation strategies during shortfalls in food availability. They are weighted based on the severity of the strategy, with changes in the index implying changes in food security. High CSI scores denote extensive use of coping strategies and hence low food security [53].

The three metrics capture rather different and complementary aspects of food security [48]: (a) CSI measures household behavioural response to food shortage, including changes in the quantity of consumed food (food stability) and food preferences (likely effect on nutrition and food utilization); (b) FCS captures dietary diversity which reflects food access and food availability; (c) HFIAS captures perceptions of hunger which reflects food access and food stability.

To put the food security analysis into perspective, we also analyse other relevant variables such as crop diversification, income and expenditure. The different indicators of income (e.g. total, off-farm, food crop, cocoa/oil palm) and expenditure (e.g. total, food, farming) are calculated through the summation of all relevant income and expenditure streams. All income and expenditures are captured in Ghanaian cedi (GHC). Crop diversification is expressed as the number of different crops produced in the household. Table S2 (SEM) outlines the different variables and indicators, which are analysed through descriptive statistics such as the independent sample *t*-test to understand differences in variable levels between farmer groups.

#### *2.3.2. Propensity score matching*

Establishing the causality of interventions or treatments is complicated by selection bias, endogeneity and systematic errors from researcher judgments [9, 58, 59]. Furthermore, in contexts such as of this study it is often not possible to use certain techniques to establish causality (e.g. randomized control trial) and there is a lack of temporal data (i.e. household data before certification adoption). Furthermore, recollection over long periods can increase uncertainty, especially pertaining to food consumption patterns. In such contexts, the PSM approach has gained popularity, as a means of establishing the impacts of different agricultural interventions [9, 12, 60, 61]. The PSM approach essentially compares non-participants with participants under similar pre-treatment observable characteristics. Differences in the outcomes are taken and attributed to involvement in the program/treatment [59, 62, 63].

The PSM estimation entails three stages. First a probit or logistic regression (binary or multinomial depending on the studied treatment) is undertaken, which provides the propensity scores [60]. Subsequently, matching is done using these propensity scores to establish the impact [58, 59]. Third, sensitivity analysis is conducted to measure at what level the unobserved covariates impose biases in the estimation [64, 65].

Following the methodological approach outlined in [42], this study undertakes three levels of comparison for each food security indicator: (a) certified vs. uncertified, (b) certified vs. food crops, and (c) uncertified vs. food crops. The first comparison essentially elicits the impacts of certification adoption, and the latter two the impact of cash crop adoption using improved (i.e. certified) and standard (i.e. non-certified) production practices respectively.

Two parameters are normally explored when estimating the treatment effects: the average treatment effect (ATE) and the average treatment effect on the treated (ATT) [62, 63]. The ATE refers to the impact of the treatment on all observations (i.e. both treatment and control), while the ATT refers to the impact of the treatment only on the treated group [59, 66]. In this paper we report only the ATT, as it is the more relevant for the context of the study.

Box S2 and table S2 in the SEM explain in more detail the PSM method and the variables used in this study to establish the propensity scores. Additional information for the different tests across all study sites and comparisons is included in the SEM, including the balancing tests (tables S13–S15 and S22–S24), histogram of propensity scores (figures S6 and S7), and sensitivity analysis (tables S16–S18 and S25–S27).

### 2.4. Study limitations

Despite its robust design, the present study has some limitations in terms of the (a) causality elicitation, (b) frequency of the survey, and (c) recollection of key indicators such as income and expenditure.

First, due to the processes employed during certification promotion, and the adoption dynamics in the study areas, it is not possible to use techniques such as randomized control trial to establish causality. Furthermore, due to the lack of appropriate baseline data it was not possible to use panel data to undertake a longitudinal analysis. Instead we use cross-sectional data that provide a point-in-time or snapshot analysis. Even though the PSM technique has gained popularity for establishing causality in such contexts that other causality elicitation techniques cannot be applied, there have been criticisms about its ability to reduce bias [67, 68].

Second, we use proxy indicators of food security, instead of direct measurements such as caloric intake, which have relatively short recollection periods (7–30 d). This, combined with the fact that the survey was one-off survey (rather than repeated during periods of different food security), increases the uncertainty of the results. To compensate for this, we undertook the survey during periods of food scarcity at the tail end of the high food insecurity period (section 2.2). The aim has been to show better the differentiated food security profiles of groups considering, overcoming some of the constraints posed by the one-off nature of the survey. In particular, the harvesting of some crops had started during the selected survey period, signifying some improvements in on-farm food availability, but not complete abundance and food security. However, indicators with longer recollection periods such as the HFIAS and CSI would reflect to some extent the periods of high insecurity (section 2.3.1).

Third, some of the major study variables such as income and expenses are self-reported. As is common in agrarian contexts of SSA, these variables consist of many different streams, which might have led to recall bias [69, 70], in that respondents made errors or even deliberately miss-reported the income or expenditures levels over the past 12 months. However, we expect any recall biases, or any possibility of over- or under-reporting to be balanced out between all the study groups.

## 3. Results

### 3.1. Basic household and farm characteristics

In the cocoa site, there is a significant difference in the age and education levels of household heads between certified and uncertified cocoa farmers, as well as between certified cocoa farmers and food crop farmers (table S6 SEM). Certified cocoa farmers have significantly larger farms only compared to food crop farmers. Both certified and uncertified cocoa farmers tend to have relatively old cocoa trees (on average 17 years old), but the former tend to cultivate improved varieties more (though the difference is not statistically significant). Although cocoa producers dedicate most of their plots to cocoa they set aside some parts of their farms for food crop production, with cassava (0.2 ha) and plantain (0.05 ha) being the most dominant food crops in terms of allocated area. Compared to food crop farmers, the farm area under food crops is significantly lower for both certified and uncertified cocoa farmers. It is worth noting that certified cocoa farmers do not have significantly better access to extension compared to the other groups, but have significantly better access to credit compared to both uncertified and food crop farmers.

In the oil palm site, fewer male-headed households are involved in certified oil palm production compared to uncertified (though insignificant) but certified farmers have significantly more male-headed households compared to food crop farmers. Furthermore, significantly more male-headed households are involved in uncertified oil palm production compared to food crop farmers (table S8 SEM). Certified farmers have significantly better levels of education compared to uncertified and food crop farmers, while uncertified oil palm farmers have in turn significantly higher levels of education than food crop farmers. All certified oil palm farmers cultivate the improved *Tenera* variety (uncertified farmers grow a mix of *Tenera* and dura varieties), but on average have significantly older trees (20 years). Certified oil palm farmers have significantly larger farms compared to other groups. Similarly, some portion of oil palm farms is used for food crop farming, with cassava (0.15 ha) and maize (0.12 ha) being on average the most dominant food crop among oil palm farmers. However, compared to food crop farmers, the farm area under food crops is significantly lower for both certified and uncertified oil palm farmers. Finally, certified farmers benefit from significantly higher number of extension visits and access to credit compared to uncertified and food crop farmers.

### 3.2. Household income, expenditures and crop diversity

Table 2 contain the food crop diversity, income and expenditures of households in the cocoa study site. Certified cocoa farmers have the highest income among all groups, followed by uncertified cocoa farmers and food crop farmers, with all differences between groups being statistically significant (table 2). Furthermore, certified cocoa farmers have significantly higher cocoa income than non-certified. The differences in total expenditures are not significant between groups, with some exceptions for specific constituents and indicators of expenditure (table 2). More relevant for this study, food expenditures (both total and per adult equivalent) are not statistically different between groups, only with the exception of higher food expenses by food crop farmers compared to uncertified cocoa farmers (by GHC 170.20). Food expenditures account for close to 17% of the total household expenditures for both certified and uncertified cocoa farmers, and 30% for food crop farmers. Food crop farmers grow significantly more types of food crops than both cocoa study groups, and certified cocoa farmers significantly more than uncertified cocoa farmers.

Table 3 contains the food crop diversity, income and expenditure for groups in the oil palm study site. Similar to the cocoa site, food crop farmers tend to grow significantly more types of food crops compared to both groups of oil palm farmers, while certified farmers grow more food crop types than uncertified farmers (though this difference is not statistically significant). In terms of income, certified oil palm farmers have significantly higher income than both uncertified oil palm farmers and food crop farmers, as well as oil palm related income. The total and per-capita food-related expenditures of certified oil palm farmers are also significantly higher compared to uncertified oil palm farmers and food crop farmers, representing about 47%, 36% and 41% of all household expenditure respectively (for total food expenditure). Overall, certified farmers have significantly higher off-farm income, farm income and total household income compared to the other groups.

### 3.3. Food security indicators

In terms of dietary diversity, the FCS results suggest that certified cocoa farmers have higher FCS (55.4) compared to uncertified farmers (53.6) and food crop farmers (54.3) (figure 2). Similarly, certified oil palm farmers have higher FCS (57.4) compared to both uncertified oil palm farmers (57.0) and food crop farmers (57.2). However, none of these differences is statistically significant between groups (table S10 SEM). These results suggest that certified farmers in both sites enjoy higher food security in terms of dietary diversity and that uncertified farmers consistently report the lowest food diversity. However, despite their higher FCS, still more than 60% of certified farmers are classified as poor or borderline food secure (figure S3 SEM).

In terms of perceptions of hunger, certified cocoa farmers have the lowest HFIAS score (2.76) compared to uncertified cocoa farmers (4.39) and food crop farmers (3.31) (figure 2). Similarly, certified oil palm farmers have the lowest HFIAS score (1.74) compared to uncertified (3.16) and food crop farmers (2.71). This implies that certified farmers in both sites have comparatively lower perceived food insecurity compared to their control groups (see SEM; figure S2 for boxplots of food security indicators). However, differences between groups are not statistically significant apart from the following comparisons (a) certified cocoa vs. food crop farmers, (b) certified vs. uncertified oil palm farmers, (c) certified oil palm farmers vs. food crop farmers (table S10 SEM).

In terms of coping behaviours, certified cocoa farmers have the lowest CSI (3.8) followed by food crop farmers (5.2) and uncertified cocoa farmers (5.5) (figure 2). Similarly, certified oil palm farmers have the lowest CSI (0.4) followed by food crop farmers (0.5) and uncertified oil palm farmers (0.7) (see SEM; figure S2 for boxplots of food security indicators). None of these differences is statistically significant between groups (table S10 SEM). However, there is a noteworthy discrepancy in scores between sites, with CSI scores in the oil palm site being much lower than in the cocoa study site. In terms of individual coping strategies, there are some differences between groups and sites, with certified farmers usually being less prone to adopt coping strategies due to their relatively better food security status as outlined above. Certified cocoa farmers mostly engage in casual labour for food or wages, purchase food on credit, and eat less preferred food (figure S4 SEM). In the oil palm site, we found only one certified oil palm farmer that resorted to eating less preferred food, limit portions per meal, and reduce the number of meals (figure S5 SEM). Food crop farmers deploy more varied coping strategies compared to other groups in both sites (figures S4 and S5 SEM).

Figure S1 (SEM) illustrates patterns in the months of food shortage between sites and groups. More specifically the patterns are similar with spikes in food shortage observed for all groups in July. However, food shortage declines from September, when some food crops are maturing for harvesting. In the period of high food shortage (July–early September), certified cocoa and oil palm farmers exhibit comparatively lower incidence of food

**Table 2.** Crop diversity, household income and expenditure for groups in the cocoa study site.

| Group | Number of food crops | Expenditure (food) (GHC) | Expenditure (food) (GHC/capita) | Expenditure (non-food) (GHC) | Expenditure (farming) (GHC) | Expenditure (farming) (GHC ha$^{-1}$) | Total household expenditure (GHC) | Cocoa income (GHC) | Food crop income (GHC) | Total off-farm income (GHC) | Farm income (GHC) | Total household income (GHC) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Certified cocoa farmers | 2.57 (0.06) | 896.00 (148.32) | 334.40 (55.15) | 4529.66 (344.63) | 1192.2 (121.84) | 526.43 (61.96) | 5165.47 (388.95) | 5836.93 (546.86) | 198.03 (74.70) | 1934.99 (236.02) | 6034.96 (591.25) | 7969.95 (717.58) |
| Uncertified cocoa farmers | 1.9 (0.09) | 855.59 (147.94) | 301.70 (47.43) | 4564.11 (347.46) | 1327.42 (163.88) | 519.85 (60.40) | 5084.36 (393.23) | 3767.99 (341.88) | 129.59 (37.33) | 1155.48 (149.87) | 3897.58 (340.94) | 5053.06 (344.08) |
| Difference | −0.67*** (0.11) | −40.41 (209.49) | −32.70 (72.74) | 34.45 (489.39) | 135.22 (204.21) | −6.58 (86.53) | −81.11 (553.09) | 2068.93*** (644.94) | −68.44 (83.501) | −779.51*** (279.59) | −2137.37*** (682.51) | −2916.89*** (795.81) |
| Certified cocoa farmers | 2.57 (0.06) | 896.00 (148.32) | 334.40 (55.15) | 4529.66 (344.63) | 1192.20 (121.84) | 526.43 (61.96) | 5165.47 (388.95) | — | 198.03 (74.70) | 1934.99 (236.02) | 6034.96 (591.25) | 7969.95 (717.58) |
| Food crop farmers | 3.90 (0.13) | 1195.78 (166.82) | 471.90 (63.95) | 3350.28 (245.11) | 694.82 (60.77) | 626.47 (72.73) | 4418.64 (336.82) | — | 673.63 (118.59) | 1162.01 (166.75) | 673.63 (118.59) | 1835.64 (214.51) |
| Difference | 1.33*** (0.14) | 299.78 (223.22) | 137.50 (84.45) | −1179.38 (422.91)*** | −497.38 (136.15)*** | 100.03 (95.55) | −746.83 (514.52) | — | 475.6*** (140.15) | −772.98*** (288.98) | −5361.33*** (603.03) | −6134.31*** (748.96) |
| Uncertified cocoa farmers | 1.90 (0.088) | 855.59 (147.94) | 301.70 (47.43) | 4564.11 (347.46) | 1327.42 (163.88) | 519.85 (60.40) | 5084.36 (393.23) | — | 129.59 (37.33) | 1155.48 (149.87) | 3897.58 (340.94) | 5053.06 (344.08) |
| Food crop farmers | 3.90 (0.13) | 1195.78 (166.82) | 471.90 (63.95) | 3350.28 (245.11) | 694.82 (60.77) | 626.47 (72.73) | 4418.64 (336.82) | — | 673.63 (118.59) | 1162.01 (166.75) | 673.63 (118.59) | 1835.64 (214.51) |
| Difference | 2.00*** (0.16) | 340.19 (222.97) | 170.20** (79.62) | −1213.83*** (425.21) | −632.60*** (174.78) | 106.62 (94.54) | −665.72 (517.76) | — | 544.04*** (124.32) | 6.53 (224.20) | −3223.95*** (360.98) | −3217.42*** (405.46) |

Note: differences estimated through $t$-test; $^{**}p < 0.05$; $^{***}p < 0.01$; standard error in parentheses; table S7 in SEM contains the confidence intervals for the different variables.

**Table 3.** Crop diversity, household income and expenditure for study groups in the oil palm site.

| Group | Number of food crops | Expenditure (food) (GHC) | Expenditure (food) (GHC/capita) | Expenditure (non-food) (GHC) | Expenditure (farming) (GHC) | Expenditure (farming) (GHC $ha^{-1}$) | Total household expenditure (GHC) | Oil palm income (GHC) | Food crop income (GHC) | Total off-farm income (GHC) | Farm income (GHC) | Total household income (GHC) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Certified oil palm farmers | 1.52 (0.08) | 4644.50 (290.58) | 2187.29 (134.43) | 5154.03 (352.11) | 2002.52 (202.13) | 489.03 (55.40) | 9798.53 (472.11) | 4209.60 (209.77) | 748.07 (172.96) | 7904.00 (813.75) | 4957.67 (258.14) | 12 861.67 (845.09) |
| Uncertified oil palm farmers | 1.65 (0.10) | 3109.30 (301.96) | 1415.82 (129.64) | 5602.92 (689.98) | 2357.22 (286.22) | 1164.64 (124.89) | 8720.22 (875.05) | 1755.78 (115.69) | 531.95 (138.80) | 4901.40 (660.56) | 2287.73 (181.49) | 7189.13 (703.45) |
| Difference | 0.13 (0.12) | −1535.20*** (419.06) | −771.46*** (186.76) | 448.89 (774.63) | 354.70 (350.40) | 675.61*** (136.63) | −1086.31 (994.63) | −2453.82*** (239.56) | −216.12 (221.76) | −3002.60*** (1048.11) | −2669.94*** (315.55) | −5672.54*** (1099.55) |
| Certified oil palm farmers | 1.52 (0.08) | 4644.50 (290.58) | 2187.29 (134.43) | 5154.03 (352.11) | 2002.52 (202.13) | 489.03 (55.40) | 9798.53 (472.11) | — | 748.07 (172.96) | 7904.00 (813.75) | 4957.67 (258.14) | 12 861.67 (845.09) |
| Food crop farmers | 3.75 (0.14) | 2715.94 (283.51) | 1195.50 (127.81) | 3895.42 (373.12) | 1357.00 (165.83) | 2245.56 (319.08) | 6611.36 (549.57) | — | 1641.28 (292.55) | 7498.55 (929.62) | 1641.28 (292.55) | 9139.82 (991.83) |
| Difference | 2.23 (0.16)*** | −1928.56 (405.97)*** | −991.78*** (185.48) | −1258.61 (513.03)** | −645.52 (261.45)** | 1756.54*** (323.85) | −3187.17*** (724.51) | — | 893.21*** (339.85) | −405.45 (1235.47) | −3316.39*** (390.16) | −3721.85*** (1303.04) |
| Uncertified oil palm farmers | 1.65 (0.10) | 3109.30 (301.96) | 1415.82 (129.64) | 5602.92 (689.98) | 2357.22 (286.22) | 1164.64 (124.89) | 8720.22 (875.05) | — | 531.95 (138.80) | 4901.40 (660.56) | 2287.73 (181.49) | 7189.13 (703.45) |
| Food crop farmers | 3.75 (0.14) | 2715.94 (283.51) | 1195.50 (127.81) | 3895.42 (373.12) | 1357 (165.83) | 2245.56 (319.08) | 6611.36 (549.57) | — | 1641.28 (292.55) | 7498.55 (929.62) | 1641.28 (292.55) | 9139.82 (991.83) |
| Difference | 2.1 (0.17)*** | −393.36 (414.20) | −220.32 (182.05) | −1707.50 (784.40)*** | −1000.22 (330.79) | 1080.92*** (342.65) | −2108.86*** (1033.31) | — | 1109.33*** (323.82) | 2597.15** (1140.41) | −646.45* (344.28) | 1950.70 (1215.97) |

Note: differences estimated through *t*-test; $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$; standard error in parentheses; table S9 in SEM contains the confidence intervals for the different variables.

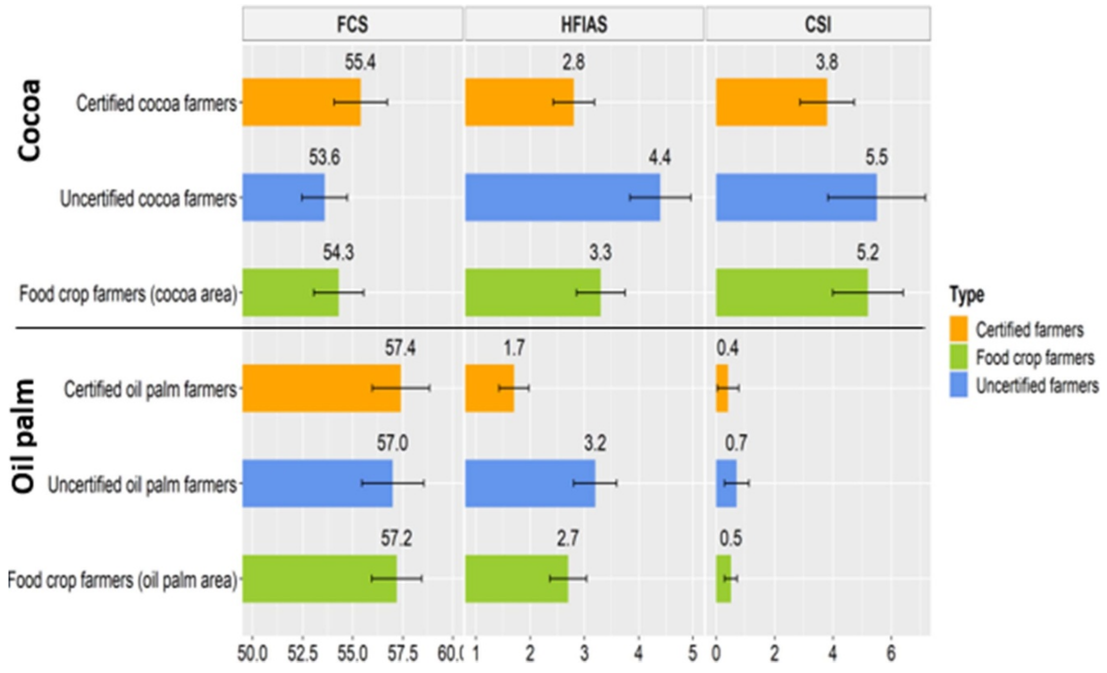


**Figure 2.** Food security of farmers in the cocoa and oil palm study site.
Note: FCS: Food Consumption Score; HFIAS: Household Food Insecurity Access Scale; CSI: Coping Strategies Index; table S10 in SEM contains the confidence intervals for food security variables.

shortage compared to other groups. However uncertified cocoa and oil palm farmers have consistently the highest prevalence of hunger among groups.

Table S11 (SEM) shows the correlations between indicators. In the cocoa study site, we observe a positive significant relationship between CSI and HFIAS for all groups: certified cocoa farmers (0.471, $p < 0.01$), uncertified cocoa farmers (0.422, $p < 0.01$) and food crop farmers (0.591, $p < 0.01$), though the relationship are relatively weak (<0.80). All other relationships between variables are not significant. Similar patterns are also evident in the oil palm site, with most significant relationships being between the CSI and HFIAS. In particular, there are weak, but statistically significant, relationships for all groups: certified oil palm farmers (0.218, $p < 0.05$), uncertified oil palm farmers (0.167, $p < 0.10$) and food crop farmers (0.387, $p < 0.01$). The only other significant relationship is between the CSI and FCS of food crop farmers (0.279, $p < 0.01$).

### 3.4. Propensity score matching analysis

Tables 4 and 5 reports the PSM analysis for the three main indicators for farmers in the two study sites (see also tables S12–S29; figures S6 and S7, SEM). When interpreting these results, it is important to keep in mind two major elements: (a) the direction and magnitude of outcome, (b) its statistical significance. As it will be discussed in section 4, the lack of statistical significance for some comparisons is an important finding in its own right that needs to be taken into consideration when discussing the food security outcomes of certification.

When comparing certified and uncertified farmers, the results suggest that engaging in certified cocoa production increases the FCS (by 2.12 points; not significant), reduces the HFIAS (−1.84 points, $p < 0.05$), and has a miniscule effect on CSI (table 4). Conversely in the oil palm site, engagement in certified oil palm production leads to lower FCS (by 1.38 points; not significant), reduces the HFIAS (by 1.38 points, $p < 0.05$) and practically unchanged CSI (table 5).

Engagement in certified cocoa farming compared to food crop farming increases the FCS (by 1.39 points), increases marginally the HFIAS (by 0.04 points) and reduces the CSI (by 0.67 points), though none of these differences is statistically significant. Interestingly, engagement in certified oil palm farming when compared to food crop farming leads to declining levels of FCS (by 2.08 points), marginal changes in HFIAS and slight increase in the CSI (by 0.47 points), though none of these differences are statistically significant.

Finally, uncertified cocoa farmers have higher FCS, significantly higher HFIAS (by 2.26 points; $p < 0.05$) and higher CSI (by 4.38 points) compared to food crop farmers. Compared to food crop farmers, uncertified oil palm farmers have lower FCS, significantly higher HFIAS (by 1.22 points, $p < 0.05$) and marginally lower CSI (by 0.1 points).

## 4. Discussion

### 4.1. Food security patterns

Table 6 summarizes the results of the PSM analysis in terms of the direction of the food security outcome

**Table 4.** Propensity score matching (PSM) analysis of food security indicators in the cocoa study site.

| Variable | Groups (observations after common support) | Treatment effect (ATT) | Balancing test | | | | Rosenbaum bounds gamma |
|---|---|---|---|---|---|---|---|
| | | | Pseudo-$R^2$ | $p$-Value LR | Mean bias | Comment | |
| Food security (FCS) | Certified cocoa farmers (89) vs. uncertified cocoa farmers (99) | 2.12 (2.27) | 0.005 | 1.000 | 3.7 | Good matching | 1.10 |
| | Certified cocoa farmers (79) vs. food crop farmers (85) | 1.39 (3.12) | 0.008 | 0.975 | 5.4 | Good matching | — |
| | Uncertified cocoa farmers (74) vs. food crop farmers (90) | 4.26 (2.98) | 0.011 | 0.941 | 6.8 | Somewhat good matching | 1.10 |
| Food security (HFIAS) | Certified cocoa farmers (89) vs. uncertified cocoa farmers (99) | $-1.84^{**}$ (0.86) | 0.005 | 1.000 | 3.7 | Good matching | 1.80 |
| | Certified cocoa farmers (79) vs. food crop farmers (85) | 0.04 (0.65) | 0.008 | 0.975 | 5.4 | Good matching | — |
| | Uncertified cocoa farmers (74) vs. food crop farmers (90) | $2.26^{**}$ (0.91) | 0.011 | 0.941 | 6.8 | Somewhat good matching | 1.60 |
| Food security (CSI) | Certified cocoa farmers (89) vs. uncertified cocoa farmers (99) | 0.00059 (1.69) | 0.005 | 1.000 | 3.7 | Good matching | — |
| | Certified cocoa farmers (79) vs. food crop farmers (85) | −0.67 (1.91) | 0.008 | 0.975 | 5.4 | Good matching | 1.40 |
| | Uncertified cocoa farmers (74) vs. food crop farmers (90) | 4.38 (3.20) | 0.011 | 0.941 | 6.8 | Somewhat good matching | 1.20 |

Note: $^{**}p < 0.05$ , standard error in parentheses; increase in FCS levels denotes a positive effect to food security through increased dietary diversity; increase in HFIAS and CSI levels denotes a negative effect on food security through increased perceived hunger and use of coping strategies respectively.

for each indicator (i.e. increase, decrease), and the statistical significance of the outcome. In terms of direction, the results suggest that (a) certified cocoa and oil palm farmers perform better across most food security indicators compared to uncertified farmers and food crop farmers (with some exceptions between certified oil palm farmers vs. food crop farmers, see section 4.2 for possible explanation), and (b) food crop farmers perform better across most indicators compared to uncertified cocoa and oil palm farmers.

However, despite the relatively consistent trends across indicators in terms of the direction of the outcome, the results are not always statistically significant. The only exception are the clear-cut trends that certified farmers have significantly better HFIAS levels than uncertified farmers, and that uncertified farmers have significantly worse HFIAS levels than their control groups (table 6). This suggests that in both study areas the uncertified farmers show clear signs of perceived hunger, and thus food insecurity (see section 4.2).

The generally better food security outcomes for certified farmers in terms of direction reflect studies that have linked certification adoption with higher caloric and micronutrient intake, largely through income gains [16]. Many studies have alluded to this possible link between certification and food security via income, but have been mostly articulated expectations or qualitative findings rather than robust analytical evidence [12, 71–75].

However, the food security gains of certification are not always substantial or statistically significant (section 3.4, table 6), while a large proportion

**Table 5.** Propensity score matching (PSM) analysis of food security indicators in the oil palm study site.

| Variable | Groups (observations after common support) | Treatment effect (ATT) | Balancing test | | | | Rosenbaum bounds gamma |
|---|---|---|---|---|---|---|---|
| | | | Pseudo-$R^2$ | p-Value LR* | Mean bias | Comment | |
| Food security (FCS) | Certified oil palm farmers (97) vs. uncertified oil palm farmers (92) | −1.38 (2.75) | 0.005 | 0.998 | 4.2 | Good matching | 1.00 |
| | Certified oil palm farmers (63) vs. food crop farmers (85) | −2.08 (3.22) | 0.014 | 0.935 | 9.6 | Somewhat Good matching | 1.00 |
| | Uncertified oil palm farmers (89) vs. food crop farmers (83) | −1.43 (3.44) | 0.005 | 0.999 | 4.0 | Good matching | — |
| Food security (HFIAS) | Certified oil palm farmers (97) vs. uncertified oil palm farmers (92) | −1.38** (0.63) | 0.005 | 0.998 | 4.2 | Good matching | 2.40 |
| | Certified oil palm farmers (63) vs. food crop farmers (85) | 0.01 (0.68) | 0.014 | 0.935 | 9.6 | Somewhat Good matching | — |
| | Uncertified oil palm farmers (89) vs. food crop farmers (83) | 1.22 (0.58)** | 0.005 | 0.999 | 4.0 | Good matching | 1.10 |
| Food security (CSI) | Certified oil palm farmers (97) vs. uncertified oil palm farmers (92) | −0.67 (0.75) | 0.005 | 0.998 | 4.2 | Good matching | 13.00 |
| | Certified oil palm farmers (63) vs. food crop farmers (85) | 0.47 (0.69) | 0.014 | 0.935 | 9.6 | Somewhat Good matching | — |
| | Uncertified oil palm farmers (89) vs. food crop farmers (83) | −0.10 (0.65) | 0.005 | 0.999 | 4.0 | Good matching | 7.00 |

Note: *$p < 0.10$; **$p < 0.05$, standard error in parentheses; increase in FCS levels denotes a positive effect to food security through increased dietary diversity; increase in HFIAS and CSI levels denotes a negative effect on food security through increased perceived hunger and use of coping strategies respectively.

of certified farmers are vulnerable to food insecurity (section 3.3). The former reflects relatively meta-analyses pointing that certification adoption does is not translated to clear-cut food security gains, which are often uncertain [14, 22, 23]. The latter reflect studies pointing that certified farmers often face challenges in meeting their food needs, despite obtaining certain benefits (e.g. training, infrastructure development, savings) [76–79].

### 4.2. Factors mediating food security patterns

When unravelling the factors mediating the food security outcomes of certification, the differences in the promotion and adoption of certification between the two cropping systems become important. Cocoa production is largely smallholder-based, with the government facilitating the promotion of sustainable cocoa production due to the crop's strategic importance for the national economy and foreign exchange generation [80, 81]. The government is essentially the sole purchaser and seller of Ghanaian cocoa on the world market, but does not make strict sustainability compliance demands from farmers. LBCs act as the intermediaries, and are essentially the main channels introducing certification to smallholders that try to broaden their market options by meeting the production expectations of international buyers [40, 47, 82]. Certification adopt decisions are mediated by specific household characteristics [40, 83], and are often followed with support in the form of inputs, credit and extension services. These affect the adoption and compliance with standards, but also cocoa yields, income, and occasionally other socioeconomic outcomes.

Oil palm production is typically undertaken in hybrid systems comprising large plantations

**Table 6.** Summary of food security outcomes of certification across different indicators and group comparisons.

| Comparisons | | FCS | HFIAS | CSI |
|---|---|---|---|---|
| Cocoa | Certified cocoa farmers vs. Uncertified cocoa farmers | | | |
| | Certified cocoa farmers vs. food crop farmers | | | |
| | Uncertified cocoa farmers vs. food crop farmers | | | |
| Oil palm | Certified oil palm farmers vs. uncertified oil palm farmers | | | |
| | Certified oil palm farmers vs. food crop farmers | | | |
| | Uncertified oil palm farmers vs. food crop farmers | | | |

Note: Results are based on the PSM analysis (tables 4 and 5). Yellow colours imply decline of food security based on specific indicator; blue colours indicate improvement of food security, black colour indicates very marginal effect. Deep colours imply statistically significant difference; light colours indicate not statistically significant effect.

surrounded by smallholders. Oil palm sales are much less centralized compared to cocoa, with individual companies being involved in international and national trade. BOPP, TOPP, GOPDC and Norpalm are the main plantations that have adopted certification, as a means of enhancing their ability to compete in international markets (box S1, SEM). These big players literally 'force' their scheme smallholders to adopt certification, offering some extension support. Smallholders outside such schemes generally avoid certification due to its high cost, lack of supportive structures, and strong domestic demand for uncertified palm oil [25].

Considering the above, the observed patterns in tables 4–6 might be mediated by the combined (but differentiated between sites) effect of three major underlying mechanisms: (a) higher incomes and food expenditures for certified farmers, (b) improved access to extension and credit for certified farmers that has spillover effects for food crop production, (c) low crop and income diversification for uncertified farmers. It is worth reminding we conducted the surveys during the tail-end of the high food insecurity period (section 2.4), which might have affected some of the observed patterns considering the relatively low food availability, and the payment modalities that could affect access to food as discussed below [42, 84].

Certified cocoa farmers have significantly higher total income and off-farm income than uncertified farmers [18, 42], which possibly allows them to spend significantly more on food, indicating a better access to food [23] (table 2). Certified cocoa farmers have also higher income from food crops sales compared to uncertified farmers (though not significantly higher), possibly suggesting greater food crop production, and thus better food availability (table 2). This can be a function of: (a) the significantly higher crop diversity and access to credit (tables 2 and S6 SEM), which might have a positive spillover effect on food crop production [40, 85] and/or (b) the actual payment modalities. Discussions with the extension staff of the LBC supporting the cocoa farmers highlighted that certified farmers received training about the role of food crop diversity for food security. They also received their premiums in July (i.e. beginning of the low food availability period) that might have offered them an extra ability to access food during a critical time of the year (personal communication: AgroEco Louis Bolke Institute).

Conversely, uncertified cocoa farmers are less diversified in terms of food crops and off-farm income than both the certified cocoa farmers and the food crop farmers (table 2), all of which have a reportedly positive effect on different aspects of food security [40, 86, 87]. As a result, they spend significantly less on food purchases compared to the certified cocoa farmers and food crop farmers (though not significantly) (table 2). This suggests their much lower access to (and availability of) food, which might be compounded by the fact that food prices in the study areas tend to increase due to mining activities and the extensive cultivation of non-food crops such as cocoa and rubber [45, 88–90].

Some similar patterns are also evident in the oil palm site, with the major exceptions being the low crop diversity among both oil palm groups and the different direction of the FCS outcomes (though they remain statistically insignificant) (table 6). Thus, the relatively lower performance of certified farmers for some indicators might not be due to the actual income, off-farm income and ability to buy food, as all these variables are significantly higher compared to uncertified oil palm and food crop farmers (table 3), but due to the payment modalities and the timing of receiving the off-farm income. In more details, BOPP and other large oil palm mills take long to process the payments for FFB (sometimes over a month after supply). This might reduce access to food during this critical time of the year, hence complicating farmer response to food insecurity. As a result, some independent oil palm smallholders reportedly sell FFB to smaller agro-processing facilities that pay lower returns (personal communication: BOPP). Yet, certified oil palm smallholders do not have this option, as they are contractually obliged to sell their oil palm output to BOPP (section 2.1).

However, the differences are in most cases not substantial or statistically significant (tables 4–6). In fact, as many as 65% and 68% of the certified cocoa and oil palm farmers respectively are vulnerable to food insecurity in terms of the FCS (figure S4 SEM). This may reflect chronic food insecurity that may be occasionally exacerbated due to food price spikes (especially during the lean period), weather shocks, and pest/disease outbreaks [91–93]. In addition, despite their generally high off-farm incomes, certified cocoa farmers may be still vulnerable to food insecurity due to their heavy dependence on cocoa income (table 2) and occasional pest/disease outbreaks and extreme weather variations [94, 95]. The above further highlight the need to strengthen structures that could enhance the food security of certified farmers that go beyond the current focus towards on cocoa yields and income (section 4.3).

Finally, we should note the gender make-up across the different groups. In the cocoa site, men are predominately the household heads for all groups, with no statistically significant difference between groups (table S6, SEM). This is not surprising given the prevailing male-dominated land tenure arrangements in Ghana [96], and that cocoa, as a cash crop, is considered a men's crop [40, 42, 95]. Similar patterns are also seen among certified and uncertified oil palm smallholders, largely for the same reasons. However, significantly more women-headed households are involved in food crop production in the oil palm site (table S8, SEM). This alludes to a (possibly unintended) 'exclusion' of women from the oil palm sector, especially considering the generally larger farming areas needed for economically viable oil palm cultivation that women cannot obtain easily, and that the scheme smallholder areas were consolidated and allocated many decades ago, when gender relations were even more traditional [25]. In our opinion, certification standards can hardly be blamed for such imbalances (or even become a solution), as this is a wider agrarian issue in Ghana. However, it is also fair to argue that as certification standards operate in such agrarian contexts, gender imbalances need to be appreciated when promoting certification or implementing interventions to enhance its food security outcomes (section 4.3).

### 4.3. Policy implications and recommendations

Agricultural development and food security (and their linkages) have been core elements of agricultural policy throughout SSA. This has been most notably within the continental framework of the Comprehensive African Agriculture Development Programme (CAADP), whose importance has been re-affirmed in Agenda 2063 of the African Union [97, 98]. As many SSA economies (Ghana included) rely heavily on the smallholder-based production of food and commodity crops, current agricultural policies have sought to balance the profitability and sustainability of smallholder-based agriculture on the one hand, and food security on the other hand [99–103]. However, many of the policies seeking to contribute to these dual goals in Ghana such as investing for food and jobs and the Tree Crops Policy, have failed to ensure widespread food security among smallholders [100].

Market- and business-led initiatives such as certification have been promoted in this policy context to drive the sustainable and profitable production of commodity crops. However, for most certification schemes food security neither is a clearly articulated target or standard, nor is particularly prominent in their theories of change [39, 104, 105]. Instead it is often expected that food security will 'miraculously' emerge through improvements in agricultural practices, yields and income [14, 23, 71, 75].

This 'expectation' seems to be quite obvious in our results as well, considering that despite certified farmers having higher yields and income (section 3.2) [13, 76], certification adoption has low or uncertain food security outcomes (section 3.4, table 6) [14, 22, 23]. On a broad scale, this clearly points to the need to rethink the mechanisms through which certification standards are expected to enhance food security. Arguably, certification standards should be strengthened on that front by adding clearly food security in their theories of change, improving their support packages to smallholders, and considering payment modalities and local market dynamics.

In terms of improving support packages, our results suggest the importance of crop and income diversification (section 4.2). Diversification can ensure some level of food production and income generation (and thus some degree of food availability and access) and prevent over-specialization, and its risks due to commodity price fluctuations and weather variability [106, 107]. Emphasizing on the importance of diversification and how it could be achieved (e.g. by investing premium payments) could be integrated in the training offered to smallholders. Furthermore, the relevant training components could target both the major male and female decision-makers in the household. Even though women-headed households are underrepresented among certified groups (sections 3.1 and 4.2), women contribute significantly to food crop production and secondary income generation activities [108] that might be good options respectively for crop and income diversification. In any case we expect that the most appropriate diversification strategies (and related portfolios) would be context-specific. This would require a good understanding of the local context, and an adaptive approach in its implementation.

Finally, payment timing and market dynamics might explain some of the observed food security patterns (section 4.2). Thus, at least some efforts should be made to ensure that cocoa/oil palm buyers do not compromise the ability of certified farmers to purchase food during periods of food insecurity by delaying payment. However, more research would be necessary to understand better their mechanisms and overall magnitude in different contexts, and how they can be harnessed to enhance food security. If found to be significant factors then there should be attempts to reduce the payment processing downtime, at least during the periods of high food insecurity.

## 5. Conclusions

This study explored how the adoption of cocoa and oil palm certification intersects with food security. We find that the adoption of certification standards improves the levels of most food security indicators for most group comparisons, though the results are mostly not statistically significant (with the exception of the HFIAS). This suggests the rather low or uncertain effect of certification on food security, especially considering that most certified smallholders seem to be rather vulnerable to food insecurity, at least during high food insecurity periods. Most of the observed trends seem to be mediated by the higher income and income diversification of certified farmers (and crop diversity for certified cocoa farmers), with payment modalities also possibly playing some role.

Our results show clearly that the livelihood benefits of certification do not automatically translate in improved food security outcomes, possibly because food security is not considered properly in their theories of change, at least for oil palm and cocoa certification schemes. Thus there is a real need to (a) integrate more meaningfully food security in the criteria and theories of change of certification standards, (b) improve the support packages offered to smallholders, and (c) consider in more concreted terms payment modalities and local market dynamics. For (a) it would require coordinated action between the different stakeholders engaged in certification standard development and implementation, and for (b)–(c) an understanding that some of the most appropriate solutions might be very context-specific.

## Data availability statement

The data that support the findings of this study are available upon reasonable request from the authors.

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