Sustainable practices in cocoa production. The role of certification schemes and farmer cooperatives

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Contents

Abstract

Many small-scale cocoa producers in Côte d'Ivoire and Ghana grow cocoa on unshaded or low-shaded cocoa plots. This has dire consequences for farm biodiversity, resulting in lower species richness and depleted soils. To measure the extent of sustainable agricultural practices' use in the cocoa sector, we develop a scale that incorporates dimensions of agroforestry, soil conservation, pest and disease management and farm sanitation. We use a representative data set of more than 1700 cocoa producers in Côte d'Ivoire and Ghana to assess farmer participation in different organizational structures and market channels and their roles in promoting sustainable practices. We apply a multinomial endogenous switching regression model to control for potential selection bias and derive the average treatment effect of the treated (ATT) and the untreated (ATU) for three participation options: 1) certification scheme only, 2) farmer cooperative only and 3) both. In Côte d'Ivoire, econometric results show that joint participation in both a certification scheme and a farmer cooperative leads to a significantly higher sustainability score than alternative options. In comparison, certification scheme membership shows the highest effect in Ghana. Different findings may be explained by differences in the organization of the cocoa value chain across the two countries. Governmental extension services in Ghana provide support to cocoa farmers, which otherwise farmer cooperatives would potentially offer.

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1 Introduction

The expansion of agricultural cash crop commodities is seen as a major threat to biodiversity and ecosystem preservation (Hagger et al., 2017). The cocoa sector has received particular attention in recent years due to continued reports on farmer poverty, child labour and high levels of deforestation. With demand for cocoa expected to increase with rising consumption of chocolate in emerging countries such as India, China and Brazil (Jagoret et al., 2014), cocoa producing areas are likely to expand, further exacerbating such concerns. At the same time, many small-scale farmers opt for unshaded or low-shaded cocoa (Ruf, 2011), often converting primary forest land into full sun cocoa plantations. This has both negative environmental and economic effects as full-sun plantations depend on costly input use and hybrid cocoa varieties which require replanting after 15-20 years (Gockowski et al., 2013). Even so, this model, which was developed in the 1960ies (Jagoret et al., 2014) has been long favoured by farmers due to expectations of it generating higher yields and quick returns on investment (Asare et al., 2016). Intercropping of shade trees and other agroforestry practices have declined over time, further disincentivized by the lack of tree tenure for small-scale farmers and their exclusion from the timber market (Ruf, 2011). This has dire consequences for the biodiversity on cocoa farms and cocoa regions. Schulze et al. 2004 show that completely unshaded production systems have significantly lower species richness in comparison to shaded cocoa systems. On the other hand, a number of studies have identified the environmental and ecological benefits of agroforestry systems to biodiversity (Asigbaase et al., 2019; Blaser et al., 2017; De Beenhouwer et al., 2013; Bisseleua et al., 2009; Steffan-Dewenter et al., 2007) without causing an increase in pests and diseases (Armengot et al., 2020).

1.1 Literature Review

The literature on the cocoa value chain is predominantly focused on its economic relevance for farmers, assessing prices, income and productivity of farmers and its potential contribution to poverty reduction and food security (van Vliet et al., 2021; Waarts et al., 2021; Kongor et al., 2018). A few studies have assessed how cocoa agroforestry systems and individual agroecological practices such as intercropping can impact yields and incomes of farmers (Cerda et al., 2014; Asare et al., 2019; Bisseleua et al., 2009; Steffan-Dewenter et al., 2007; Opoku-Ameyaw et al., 2012). Asare et al. (2019) conclude that an increase in canopy cover of shade trees from 0% to 30% can double cocoa yields in Ghana. Other findings are more mixed. While ecologically diverse and low-intensity cocoa systems with medium to high shade tree cover show improved vegetation structure and ecosystem functions, either no clear relationship between biodiversity and profitability is identified in Cameroon (Bisseleua et al., 2009) or there is a trade-off between biodiversity and yields in Indonesia (Steffan-Dewenter et al., 2007).

Against this background has the relevance of public standard setting and private certification schemes in the agricultural sector increased substantially over the past years, including for cocoa. Many of the standards aim to limit environmental degradation through the promotion and requirement of sustainable production practices' use. Approximately 30% of the global cocoa production is estimated to be certified (Willer et al., 2019), concentrated in Côte d'Ivoire (Uribe-Leitz and Ruf, 2019). A number of studies have particularly looked at the role of private sustainability schemes such as Fairtrade or Rainforest Alliance for improving cocoa farmers' and workers' wages, yields, incomes, food security and household living standards (Meemken et al., 2019; Dompreh et al., 2021; Fenger et al., 2017; Iddrisu et al., 2020; Knößlsdorfer et al., 2021). To the best of our knowledge, there is no study focusing on agronomic outcomes of certification schemes in the cocoa sector. We therefore look beyond the sector and broaden our review. Among the literature on perennial crops, the coffee sector has received particular attention, finding rather mixed results on the effects of sustainability standards and certification. Studies conclude that (eco)-certification leads to more environmental-friendly practices in coffee production, such as lower chemical input use in Costa Rica (Blackman and Naranjo, 2012), better environmental management in Colombia (Rueda and Lambin, 2013; Ibanez and Blackman, 2016) and higher biodiversity and carbon storage in Uganda, Nicaragua and Brazil (Vanderhaegen et al., 2018; Hagger et al., 2017; Hardt et al., 2015). However, not all studies find such positive effects. Elder et al. (2013) conclude that Fairtrade certification does not have a strong impact on farming practices of coffee farmers in Rwanda. DeFries et al. (2017) review 20 studies on certification in coffee that rigorously analyse differences between treatment and control groups and found inconsistent results across environmental, economic and social benefits. Limited effects of certification on sustainable agricultural practices (SAP) use in small-scale farms have been associated with scale mismatch between farms and the dependence of biodiversity maintenance at larger landscape level (Tscharnke et al., 2015; Holzschuh et al., 2007).

Certifying bodies and institutions working with and supporting farmers often use existing organizational structures at the producer level. Here, farmer cooperatives are attributed a central role in rural development as they market agricultural output, facilitate capacity development and provide access to services such as inputs or loans (Francesconi and Wouterse, 2015). Therefore, recurring efforts have been made to promote farmer cooperatives in the cocoa sector. Estimations on the extent of cooperative membership in the main cocoa growing countries vary greatly, from between 15% in Ghana (Bymolt et al., 2018) to 20-50% of farmers in Côte d'Ivoire (Löhr et al., 2021). While there is a substantial amount of literature identifying the benefits of small-scale farmer organization for farmers in general (Mojo et al., 2017; Fischer and Qaim, 2012, Markelova et al., 2009), there has been very little focus on the cocoa sector especially in Ghana and Côte d'Ivoire. One reason for this may be the perceived lack of ownership of farmer cooperatives. In Côte d'Ivoire, cooperatives seem to have been more of a way to "organise the countryside" (Woods, 1999) and therefore a government-controlled process of setting-up cooperatives rather than a movement of collective action (Uribe-Leitz and Ruf, 2019). Studies point out their poor management, lack of financial resources and inability to support farmers (Löhr et al., 2021; Bymolt et al., 2018). An exception is a study by Calkins and Ngo (2010) that identifies cooperative membership to have a positive income and well-being effect. However, since they use one-way anova and t-tests to detect significant difference across the different groups rather than regression analysis that addresses selection bias, the study allows only for limited conclusions. Similarly, other studies focus on providing descriptive information of farmer access to inputs, training and information by cooperatives (Bymolt et al., 2018; Ingram et al., 2017).

1.2 Research gap

Very few studies rigorously identify agricultural practices in cocoa production that balance ecological and economic considerations. At the same time, little is understood how farmers can be supported and encouraged to adopt more sustainable practices. To address these gaps, we formulate two research questions:

1) To what extent do cocoa farmers apply sustainable practices?
2) Do organizational structures and market channels support cocoa farmers to apply more sustainable agricultural practices?

We consider two major impact pathways that can lead to the adoption of more sustainable farming practices, namely certification schemes and farmer cooperatives. Certification regulations and sustainability standards promote the adoption and application of SAP, such as intercropping, integrated pest management or circular farm management. Sustainable agricultural practices are often associated with limiting the use of pesticides, herbicides and chemical fertilizer (Kleemann and Abdulai, 2013). However in the African context this cannot always be considered a conscious decision in favour of the environment but rather is the result of resource constraints of farmers, lack of market access or of knowledge. We therefore focus on the application of practices that reflect an active decision rather than a default option and develop SAP scale accordingly.

Smallholder agriculture is often regarded as inefficient and lacking economy of scale to take full advantage of its natural endowments and bargaining power. Cooperatives that provide farmers with a shared space for capacity development, acquiring inputs jointly, bargaining for better market conditions and prices therefore is considered an important pathway to strengthen small farmer's market power (Bymolt et al., 2018). We particularly account for the interrelatedness of certification schemes and farmer cooperatives, as standards and cooperatives can mutually support each other despite essentially having different objectives (Develtere and Pollet, 2005).

To do so, we develop a multinomial endogenous switching regression model that controls for the endogeneity of the decision to participate in (1) a certification scheme, (2) a farmer cooperative or (3) both. This is modelled through a probit regression. At a second stage the effect of the farmer participation on the use of SAP is estimated through applying an ordinary least squares regression with selectivity correction terms (Manda et al., 2021).

We describe our study area and data, including the development of the SAP scale in section 3 and outline our estimation strategy and model specification in section 4. We discuss the empirical results in section 5, which is followed by our conclusion and policy implications in section 6.

2 Study Area and Data

2.1 Study Area

The research area covers the cocoa regions in both Côte d'Ivoire and Ghana, the two largest cocoa producing countries world-wide in terms of scale of production. In 2019, together they accounted for approx. 61% of global cocoa production (ICCO, 2020). In 2019/ 2020 (the year of the data collection for this study), Côte d'Ivoire produced almost 2.1 mil metric tons and Ghana 770 thousand metric tons of the overall 4.7 mil metric tons produced world-wide (ICCO, 2020). Cocoa contributes substantially to government revenues and the rural economy in both countries. For example, the cocoa industry employs about 60% of the national labour force in agriculture in Ghana (Ntiamoah and Afrane, 2008).

Notwithstanding the type of production system or the varieties cultivated, both Côte d'Ivoire and Ghana show relatively low yields in comparison to other cocoa producing countries. Studies show that average yields in Côte d'Ivoire range between 300 – 500 kg/ ha (Ingram et al., 2017; Bymolt et al., 2018) and between 400 – 500 kg/ ha in Ghana (Bymolt et al., 2018; Kongor et al., 2018), but Abdulai et al., 2020 estimate that in good conditions yields could go up to over 2000 kg/ ha in Ghana. Besides the old age of cocoa trees, reasons for these comparatively low yields are often attributed to the high prevalence of pests and diseases in West African cocoa production, including insect pests such as mirids, capsids, caterpillars or stemborers, weed pests such as mistletoe, fungi such as black pod disease or virus infections such as swollen shoot disease. It is estimated that black pod disease has led to losses between 30 and 50% in Ghana (Opoku et al., 2000). Poor management practices often exacerbate the challenges that farmers already face.

Cocoa production in Côte d'Ivoire and Ghana is mostly characterized by unshaded or low-shaded cocoa production. Perceptions on agroforestry practices are often negatively associated with ecological services, such as the development of pests and diseases (Ruf, 2011). At the same time, it is believed that cocoa hybrids prefer full sun rather than shaded systems (Ruf, 2011).

2.2 Sampling and Data Collection

A representative survey of cocoa producers was implemented by the Centre Ivoirien de Recherche Économique et Sociale (CIRES) in Côte d'Ivoire and Ghana through the application of a multi-stage sampling strategy. First, regions where purposefully selected in the cocoa growing areas in Côte d'Ivoire and Ghana. Cocoa production usually takes place between 10o North and 10o South of the equator where climatic conditions are most favourable for cocoa growing. Villages were then randomly selected from existing population census data. A list of all cocoa farmers was developed in all selected villages and enumeration areas, from which cocoa farmers were then randomly selected to be interviewed.

Data collection was implemented between August 2019 and January 2020, which mostly coincided with the main harvesting season. The structured questionnaire was predominantly administered to the self-identified head of the household and contained questions on household demographics, farm and farming characteristics, cocoa commercialisation as well as access to and availability of inputs, services and markets. The survey was implemented with a team of local field assistants that were well-trained on interview techniques.

The data set includes 1.745 cocoa producing households from altogether 146 villages. In Côte d'Ivoire 1.219 households were interviewed and 527 in Ghana.

2.3 Measuring sustainability in cocoa production

We aim to identify the extent to which farmers in Côte d'Ivoire and Ghana apply sustainable farm management practices in cocoa production, where chemical input application, pesticide use and biodiversity reduction are major environmental concerns (Ntiamoah and Afrane, 2008). As there is no common understanding in the literature of what can be considered as SAP in cocoa, we construct a scale that takes into account the multiple dimensions contributing to farm level sustainability. We define SAP as practices that maintain a diverse ecosystem for biodiversity preservation on the one hand (for example through tree diversification on cocoa plots) and yield optimisation on the other hand (through containing diseases and pests etc.). This means that through the application of SAP farmers can create a dynamic and ecologically based production system that can contribute to yield increase and therefore provide social, economic as well as environmental benefits (Asare and David, 2011).

We select SAP indicators based on both the information from peer-reviewed articles but also on the knowledge from practitioners and producers reflected in farming manuals, e.g. "Manual for cocoa extension in Ghana" (Ghana Cocoa Board, 2018). We match this to the data available in our data set. The Committee on Sustainability Assessment (COSA) provides us with further guidance as one of the few conceptual models on sustainable practices available for developing countries (Schader et al., 2014). Overall, some of the indicators we formulate should be considered as minimum requirements rather than the preferred level of sustainable practices. For example, Waldron et al. (2015) identify that 100 shade trees per hectare would not only improve farm biodiversity but also increase cocoa yields by up to 50%. However, we chose to follow the recommendation from the "Manual for cocoa extension in Ghana" which advocates for 15 shade trees per hectare as we believe this to be more reasonable in current cocoa production.

We also consider the cost effectiveness of approaches since large investments are usually not feasible for small cocoa farmers. As mentioned in section 2, we do not include low input use of chemical inputs such as pesticides, herbicides and fertilizer as indicators for sustainable practices. Low input use could be a result of lack of financial resources or market access rather than environmental considerations.

Table 1 provides an overview of the ten selected individual indicators, which are grouped into four dimensions that we identify as SAP in cocoa production. Each of the four dimensions, namely agroforestry, soil conservation, pest and disease management and cocoa tree and farm sanitation, is weighted equally with 0.25. Following Dubbert et al. (2021), we transform the data into a scale between 0 and 1 for easier interpretation. Our sustainability scale is not without limitations. Our outcome variables are based on a survey and therefore reliant on the information provided by farmers themselves. They may have an interest in portraying their farming practices more sustainable than they actually are. Future research should identify more objective methods to measure the extent of the application sustainable agricultural practices.

Table 1. Sustainable Agricultural Practices (SAP) scale in cocoa production

	Measurement	Explanation
Agroforestry		
Shade trees	Whether the household grows at least 15 shade tree per hectare (e.g. Terminalia sp., Milicia xcels, Khaya ivorensis, Terminalia ivorensis, etc.)	Shade trees contribute to soil conservation and reducing soil erosion. Different shade levels can protect cocoa crops from weed and other parasitic plants as well as some pests and diseases and provide for nutritional balance. Banana and plantain are not considered shade trees.
Tree diversity	Whether the household grows at least two different varieties of trees per ha on their cocoa farm to establish good shade levels for all stages of cocoa	Diversification of species is beneficial to biodiversity. Tree diversity can also help manage different types of pests and diseases (e.g. as barriers to infected cocoa trees). Banana and plantain trees are included here.
Soil conversation		
Organic fertilizer use	Whether or not the household applies organic fertilizer to cocoa	Organic fertilizer (compost incl. cocoa pods, animal manure, chicken dung etc.) rather than the (over-) use of chemical fertilizer is less harmful on soil biodiversity.
Manual weeding	Whether or not the household manually weeds the cocoa plot(s)	Manual rather than chemical weeding is preferred to maintain a rich farm biodiversity. Chemical weeding often kills more than weeds and contributes to groundwater pollution.

Intercropping	Whether or not the household produces more than 1 food or cash crop on at least 1 of their plot(s)	Increasing crop diversity through intercropping can enhance pollination, soil fertility, disease regulation and biological control.
Pest and disease management		
Pruning	Whether or not the household prunes his/ her cocoa trees	Enables proper air circulation which improves wind-pollination, resulting in better pod setting. Reduces incidence of pests and diseases.
Insect population count	Whether or not the household has implemented an insect population count in last 12 months	Estimate medium- to long-term insect risk to plan appropriate measures rather than applying insecticides without good knowledge of the insects present
Observation of insects before treatment	Whether or not the household has established the presence of insects (through observation) before performing a treatment	Estimate short-term treatment measure based on the presence of insects
Cocoa tree and farm sanitation		
Sanitary harvest	Whether or not the household performs sanitary harvesting	Cutting the black, rotten or sick pods with disease and destroy them to avoid the spreading of diseases. Doing it manually rather applying fungicides, herbicides etc. is preferred from an agroecological perspective.
Progressive replantation of cocoa farm	Whether or not the household replants young cocoa trees under old trees or next to old or dead trees	Continuous replantation of cocoa farm reduces the likelihood of further land expansion as dead or old trees are replaced.

3 Estimation strategy

We identify two impact pathways related to organizational structures and market channels, which we expect to have a positive effect on the use of SAP: 1) farmer participation in certification schemes and 2) membership in farmer cooperatives. Table 2 presents an overview of the different participation strategies of farmers in organizational structures and market channels in our sample. In Côte d'Ivoire about 13% of farmers and about 20% of farmers in Ghana report to be a member of a cooperative. Further, about 16% and 25% of cocoa producers grow certified cocoa in Côte d'Ivoire and Ghana respectively. Relatively little verified information is provided in the literature about farmer membership in cooperative with estimates ranging from 21% in Côte d'Ivoire and 11% in Ghana (Bymolt et al., 2018). Because of the more formalized nature of certification schemes, information is more available albeit somewhat inconsistent across sources. Potts et al. (2014) estimate that approximately 29.3% of Ivorian and 15.9% Ghanaian cocoa farmers are – predominantly Rainforest1 – certified. Rather, Bymolt et al. (2018) report that only 7% of farmers in Côte d'Ivoire to and 24% in Ghana confirm their certification status.

Table 2. Overview of cocoa farmer participation in organizational structures and market channels

	Côte d'Ivoire		Ghana	
	Farmer Cooperative	No Membership in Farmer Cooperative	Farmer Cooperative	No Membership in Farmer Cooperative
Certification Scheme	96 (7.88%)	97 (7.96%)	41 (7.78%)	93 (17.65%)
No Participation in Certification Scheme	65 (5.33%)	961 (78.84%)	62 (11.76%)	331 (62.81%)

To assert that a farmer is indeed certified, we use the following information: (1) whether the farmer reports to sell certified cocoa or is unsure about it and (2) whether the farmer has participated in a training. Certification schemes, such as Rainforest Alliance, oftentimes require farmers to have participated in at least one training on good agricultural practices in order to qualify for certification. For cooperative membership we include farmers that confirm membership in a registered cooperative. There are also other entities in place that may support farmers, such as farmer groups or producer associations. However, we believe effects to be greatest for legally established cooperatives with defined rights and obligations for members. Nonetheless, this could mean that our findings potentially underestimate the impact of cooperatives regarding the sustainable practices as farmers who receive support through more informal farmer groups would be included in the control group. As can be observed in table 2, certification schemes and farmer cooperatives are not mutually exclusive structures but farmers chose to participate in either a certification scheme, a cooperative, or both.

Moreover, the participation of cocoa famers in certification schemes and farmer cooperatives is considered to be non-random. Underlying factors such as motivation or environmental awareness might drive the use of SAP. This selection bias occurs when unobservable factors influence both the error terms of both the selection and outcome equation, leading to the correlation in the error terms (Kleemann and Abdulai, 2013). Not accounting for selection bias could lead to biased results and overestimate the farmer participation in organizational structure and market channels. To model the interrelatedness of participation options as well as address possible selection bias, we apply a multinomial endogenous switching model - a variant of the instrumental variable approach (Midingoyi et al., 2019). It consists of two stages, namely the selection regression and the outcome regression. First, the farmer decision to participate in a certification scheme and/ or a farmer cooperative is modelled through a multinomial probit selection regression. Second, the effect of the farmer participation in such organizational structures and market channels on the use of SAP is estimated through applying an ordinary least squares regression with selectivity correction terms (Manda et al., 2021).

1 The UTZ certification program merged with Rainforest Alliance in January 2018.

3.1 Multinomial selection regression

Farming households are assumed to aim for utility maximisation given constraints such as resources or information. Therefore, participation in certification schemes and farmer cooperatives will only be attractive if the expected benefits outweigh the costs of labour and time resources associated with more stringent production standards, compliance with record and book keeping or mandatory participation in meetings (Tesfaye and Tirivayi, 2018). The utility function can therefore be as follows:

$$U_{ij} = X_i \alpha_j + \varepsilon_{ij} \quad (1)$$

where maximum utility U is derived by farmer i through selecting option j, where j = 0, 1...M (M indicating the number of options). X_i is a vector of control variables of household and farm characteristics. α_j is vector of the parameters to be estimated and ε_{ij} denotes the error term. The assumption is that farmers will select option (j) of which the expected utility is higher than another choice (k), therefore $U_{ij} > U_{ik}$. While we cannot observe the utility of a choice, we observe cocoa farmers' decision to participate in organizational structures and market channels:

$$D_i = \begin{Bmatrix} 1 \ if \ D_{i1} & > max_{k \neq 1} D_{ik} \\ \vdots & \vdots \\ M \ if \ D_{iM} & > max_{k \neq M} D_{ik} \end{Bmatrix} \quad (2)$$

where D represents a variable that denotes that farmer i will chose to participate in a certification scheme (1), a farmer cooperative (2) or both (3). The probability that farmer i will chose option j can be specified as follows:

$$P_{ij} = \frac{\exp(X_i \alpha_j)}{\sum_{k=1}^{M} \exp(X_i \alpha_k)} \quad (3)$$

3.2 Multinomial endogenous switching regression (MESR)

To analyse the effect of farmers' participation in different organizational structures and market channels on the use of SAP we apply multinomial endogenous switching by information maximum likelihood estimation (FIML). Here, farmers select between four regimes

$$\begin{cases} Regime\ 1: \ y_{i1} = Z_i \beta_1 + \mu_{i1} \quad if\ D = 1 \\ \quad \vdots \qquad \vdots \qquad \vdots \\ Regime\ M: y_{im} = Z_i \beta_m + \mu_{im} \quad if\ D = M \end{cases} \quad (4)$$

Where y_{im} is the SAP scale of the ith farmer in regime m. Here, regime 1 represents the participation in a certification scheme, regime 2 represents the participation in a farmer cooperative and regime 3 represents the participation in both. When $D = 0$ the farmer participates in neither and therefore is considered a non-participant. Z_i is a vector of observed characteristics at the household level (such as age, gender and education of household head), farm level characteristics (such as land size, cocoa tree age, soil richness, disease incidence). We further add village level characteristics (such as the road quality and electricity) to account for the fact that organizational structures and market channels are not randomized over villages but often require a minimum level of infrastructure (Ding and Abdulai, 2020). We also control for the different agro-ecological zones in Côte d'Ivoire and Ghana by including geographical indicators. μ_{im} and μ_{i1} are the error terms.

The coefficient β_m in equation (4) captures the impact of the different regime participation on the use of sustainable agricultural practices. While β_m estimates at the second stage are expected to be consistent as separate outcome regressions are estimated for each participation option, the inclusion of selection correction terms is recommended (Marenya et al., 2020). To use the same explanatory variables in the selection and the outcome equations may not enable the identification of the different outcome equations and lead to multicollinearity problems (Midingoyi et al., 2019). Accordingly, we include an exclusion restriction that directly affects the selection variable, here the participation in certification schemes and farmer cooperatives, but not the outcome variable, here the SAP scale (Di Falco et al., 2011). Based on the literature, we select distance measurements to the closest buyer of certified cocoa and the farmer cooperative. Distance measures are commonly used as they have proven to be viable instruments particularly in African agriculture, where information, communication, transport and market limitations often impede farmers to participate in specialized market channels or group organizations (Mojo et al., 2017). To validate our instruments we perform simple falsification tests and confirm that the instrument affects the decision to participate in a certification scheme or a farmer cooperative but does not affect the use of SAP among the control group. The outcome equation can therefore be specified as follows:

$$\begin{cases} Regime\ 1:\ y_{i1} = Z_i\beta_1 + \sigma_1\lambda_{i1} + \omega_{i1}\ \ if\ D = 1 \\ \qquad \vdots \qquad\qquad \vdots \qquad\qquad \vdots \\ Regime\ M: y_{im} = Z_i\beta_m + \sigma_m\lambda_{im} + \omega_{im}\ \ \ if\ D = M \end{cases} \tag{5}$$

where σ is the covariance between ε (error term of the selection equation) and μ (error term of the outcome equation). λ is the bias correction coefficient that is computed from the estimated probabilities in the probit selection equation. ω is the error term with an expected value of zero. A disadvantage of the two-stage estimation procedure are the resulting biased standard errors (Ding and Abdulai, 2020). The standard errors in equation (5) are therefore bootstrapped.

3.3 Estimation of the treatments and counterfactual effects

Based on the model, we derive the average treatment effects of the treated (ATT) and the untreated (ATU) based on the expected outcomes of the individual participation options in organizational structures and market channels (Kumar et al., 2019). The expected outcome values of farmers that decide to participate in farmer cooperatives, certification schemes or both (as observed in the sample), are computed as follows:

$$\begin{cases} E(Y_{i1} \mid D_i = 1) = Z_i\beta_1 + \sigma_1\lambda_1 \\ E(Y_{i2} \mid D_i = 2) = Z_i\beta_2 + \sigma_2\lambda_2 \\ E(Y_{i3} \mid D_i = 3) = Z_i\beta_3 + \sigma_3\lambda_3 \end{cases} \tag{6}$$

The counterfactual outcome of farmers, had they not decided to participate, is derived as:

$$\begin{cases} E(Y_{i0} \mid D_i = 1) = Z_i\beta_0 + \sigma_0\lambda_1 \\ E(Y_{i0} \mid D_i = 2) = Z_i\beta_0 + \sigma_0\lambda_2 \\ E(Y_{i0} \mid D_i = 3) = Z_i\beta_0 + \sigma_0\lambda_3 \end{cases} \tag{7}$$

The expected outcome of farmers that decided not to participate in farmer cooperatives, certification schemes or both (as observed in the sample), is estimated as follows:

$$\{E(Y_{i0} \mid D_i = 0) = Z_i\beta_0 + \sigma_0\lambda_0 \tag{8}$$

The expected outcome values of non-participating farmers, had they decided to participate (counterfactual), are computed as follows:

$$\begin{cases} E(Y_{i1} \mid D_i = 0) = Z_i\beta_1 + \sigma_1\lambda_0 \\ E(Y_{i2} \mid D_i = 0) = Z_i\beta_2 + \sigma_2\lambda_0 \\ E(Y_{i3} \mid D_i = 0) = Z_i\beta_3 + \sigma_3\lambda_0 \end{cases} \tag{9}$$

The average treatment effects of both the treated (ATT) and the untreated (ATU) are defined as the differences between equations (6) and (7) and (8) and (9) respectively.

4 Results and discussion

4.1 Descriptive Statistics

Table 3 provides an overview of the descriptive statistics of the variables used in the regression analysis as control and instrumental variables, separately presented for Côte d'Ivoire and Ghana. We compare the different treatment groups (only certified, only member of a farmer cooperative and both) to non-participants. Additionally, we present the full sample per country.

We note that cocoa farmers in Côte d'Ivoire and Ghana differ from each other in a number of characteristics. With 3-4 years of schooling, cocoa farmers in Côte d'Ivoire have received less formal education than farmers in Ghana, who have attended school between 7-8 years. In Côte d'Ivoire particularly cooperative members have attended school the longest, while in Ghana there are no significant differences amongst the sub-groups. Female household heads in Ghana, even though overall more involved in cocoa production than in Côte d'Ivoire, are much less likely to be certified or engaged in cooperatives.

Ivorian farmers are also more likely to have migrated from either elsewhere in Côte d'Ivoire or from a neighbouring country to the farm they currently own, lease or farm on behalf of their owners. Within Ghana migrants are more involved in organizational structures or market channels, potentially more actively aiming to integrate into support systems and networks. Conditions that enable farmers to access information and markets, such as good road networks or mobile phone coverage is relatively similar across the two countries. However, 85% of Ghanaian farmers have access to electricity in comparison to about 50% of farmers in Côte d'Ivoire. In Ghana, farmers engaged in organizational structures and market channels have better access to technology such as mobile phones than non-participants.

Similarities also exist across cocoa farm characteristics including size, age of trees, terrain and soil conditions. Diseases are common in both countries with more than half of the farmers reporting that their cocoa farms are severely affected by black pod disease, a fungus. The swollen shoot virus, which requires the entire removal of the infected tree, is somewhat more common in Côte d'Ivoire than in Ghana. With slightly more than 3.6 ha, average cocoa farm sizes are similar in both countries. This is somewhat different than what is generally reported in the literature, where cocoa farms in Côte d'Ivoire are noted to being larger than in Ghana, ranging between 4.17 – 4.31 ha (Bymolt et al., 2018; Balineau et al., 2017). However, it should be noted, that often no differentiation is being made between the total farm size of cocoa farmers and the size of their cocoa plots only. Here, we only consider the sum of cocoa plots. Amongst farmers clustered into the different sub-groups, especially those with large farms and richer soils engage in organizational structures and market channels.

Table 3 Descriptive statistics of selected variables across different sub-groups

	Côte d'Ivoire					Ghana				
	Full sample Côte d'Ivoire	Only Certified	Only member in farmer cooperative	Both, certified and member in a farmer cooperative	Neither certified nor member of a cooperative	Full sample Ghana	Only Certified	Only Member in farmer cooperative	Both, certified and member in a farmer cooperative	Neither certified nor member of a cooperative
Female HH Head	0.06	0.03	0.05	0.02*	0.07	0.27	0.13***	0.13***	0.24	0.34
Age HH Head (yrs)	47.29 (12.87)	49.30* (12.31)	45.91 (13.01)	49.59* (12.59)	46.94 (12.92)	52.08 (12.83)	54.01 (14.52)	49.29 (11.55)	53.32 (10.61)	51.91 (12.74)
Migrant2	0.50	0.48	0.49	0.53	0.50	0.23	0.28**	0.39***	0.32**	0.17
Education (yrs)	3.49 (4.16)	3.08 (4.08)	4.94*** (4.00)	4.50*** (4.49)	3.33 (4.12)	7.35 (4.21)	7.78 (4.44)	7.03 (4.41)	7.66 (3.26)	7.25 (4.21)
Dependency ratio3	0.93 (0.76)	1.06 (0.78)	0.71** (0.71)	0.88 (0.69)	0.94 (0.77)	0.85 (0.86)	0.82 (0.76)	0.92 (0.88)	1.07* (1.12)	0.82 (0.84)
Mobile phone ownership	0.87	0.86	0.95**	0.84	0.86	0.81	0.86*	0.84	0.98***	0.77
Home accessible by vehicle	0.86	0.94**	0.92*	0.90	0.84	0.85	0.90	0.65***	0.88	0.87
Electricity	0.51	0.60**	0.49	0.67***	0.49	0.85	0.85	0.77	0.95*	0.85
Cocoa farm size (ha)	3.75 (2.99)	3.92 (3.66)	4.34* (3.31)	4.47*** (3.13)	3.62 (2.87)	3.63 (3.51)	4.35*** (4.38)	4.18** (2.83)	3.98 (4.80)	3.28 (3.11)
Age of cocoa trees (yrs)	14.14 (7.83)	15.52* (8.29)	14.20 (7.72)	14.96 (8.86)	13.92 (7.67)	14.55 (8.72)	14.35 (8.50)	15.16 (9.00)	17.97*** (8.52)	14.03 (8.68)
Distance to plot (km)	4.26 (3.97)	3.88 (3.53)	3.78 (3.08)	5.15** (4.82)	4.24 (3.97)	3.03 (2.47)	3.27 (2.34)	2.56 (2.03)	2.55 (2.07)	3.12 (2.61)
Suitable terrain4	0.70	0.71	0.57**	0.78*	0.70	0.66	0.61	0.68	0.73	0.66
Rich soil	0.74	0.72	0.80	0.88***	0.73	0.78	0.81	0.90***	0.95***	0.73
Severely affected by black pod disease	0.53	0.43**	0.46	0.44**	0.55	0.59	0.71**	0.37***	0.56	0.60
Severely affected by swollen shoot	0.29	0.24	0.14***	0.28	0.30	0.16	0.18	0.13	0.29**	0.14
Distance to certified buyer (km)	34.75 (28.57)	24.09*** (25.31)	25.69*** (24.39)	15.00*** (18.28)	38.41 (28.80)	26.37 (36.21)	16.23*** (19.41)	22.33 (45.95)	21.34 (54.98)	30.62 (34.27)
Distance to cooperative (km)	21.44 (28.31)	14.74*** (19.85)	7.61*** (11.48)	8.06*** (15.42)	24.38 (30.01)	16.53 (22.22)	23.34 (23.60)	3.14*** (6.29)	2.60 (5.64)	18.87 (23.33)
N	1,219	97	65	96	961	527	93	62	42	331

* (p < 0.1), ** (p < 0.05) and *** (p < 0.01) for ttest of continuous variables and chi2 test for categorical variables. Standard deviations in parenthesis.

2 Household Head was not born in the region where (s)he currently lives and farms
3 Household ratio of working age adults to dependents (children or elderly)
4 Majority of cocoa plot(s) of household are flat plots either on hilltops or plateaus

In addition to household and farm characteristics, we are interested in reviewing the Sustainable Agricultural Practices scale and its individual indicators in more detail (Table 4). The data indicates that agroforestry practices like shade trees is more common in Ghana than in Côte d'Ivoire. Nonetheless, full-sun or low-shade cocoa production is most common in both countries as has been described by the literature (Uribe-Leitz and Ruf, 2019). 9% of Ghanaian farmers overall report to grow at least 15 shade trees per hectare on their cocoa plots – a number that even rises to 34% amongst those that are both certified and a member of a cooperative. In comparison, only about 6% of farmers in Côte d'Ivoire have a minimum of 15 shade trees on their plots. The majority of certified farmers in both Côte d'Ivoire and Ghana grow at least two tree species in addition to cocoa on their cocoa plots.

Some practices are common in cocoa production, such as pruning, manual weeding or sanitary harvesting. Most farmers state to have pruned their cocoa trees in the past three years. This differs from other research findings. Foundjem-Tita et al. (2017) collected data in 2014/2015, in which only about 17% of farmers in Côte d'Ivoire pruned their farms in the previous five years. Potentially increased efforts within the cocoa sector to promote tree pruning have contributed to these changes. In Côte d'Ivoire, particularly certified farmers and members of a cooperative weed their farms manually rather than chemically.

Other practices are much less widespread. Organic fertilizer is only used by an average of 3% of farmers in Côte d'Ivoire and Ghana. This might be due to lack of knowledge or access to inputs like manure. Integrative pest management practices such as regular insect counts are also uncommon. But particularly certified farmers in Côte d'Ivoire observe insects before treatment for a more targeted approach to pest control while certified farmers in Ghana are least likely to do so across all comparison groups. Progressive replantation is a method to continuously replace cocoa trees that are either sick or old to avoid the replacement of an entire cocoa plot or expanding into forest lands. Particularly farmers that are both certified and members of farmer cooperatives practice progressive replantation to rejuvenate their farms.

Overall, the SAP scale is not necessarily higher for farmers engaged in marketing or organizational structures. In Côte d'Ivoire, certified farmers and those additionally being members of a farmer cooperative have higher SAP scale score of 0.08 and 0.12 respectively than the control group. In Ghana, only farmers with joint certification and cooperative membership have a significantly higher sustainability score of 0.64 in comparison to the control group of non-participation with a value of 0.52.

Table 4. Descriptive statistics of Sustainable Agricultural Practices

	Côte d'Ivoire					Ghana				
	Full sample Côte d'Ivoire	Only certified	Only member in farmer cooperative	Both, certified and member in a farmer cooperative	Neither certified nor member of a cooperative	Full sample Ghana	Only certified	Only member in farmer cooperative	Both, certified and member in a farmer cooperative	Neither certified nor member of a cooperative
Agroforestry										
Shade trees (>=15/ha)	0.06	0.06	0.08	0.06	0.06	0.15	0.22***	0.18	0.34***	0.11
Tree diversity(>=2 on plot)	0.45	0.59***	0.38	0.69***	0.42	0.42	0.65***	0.47*	0.51**	0.34
Soil conservation										
Organic fertilizer use	0.04	0.05	0.07**	0.06*	0.03	0.03	0.05	0.02	0.02	0.03
Manual weeding	0.68	0.81***	0.77**	0.80***	0.65	0.82	0.77	0.79	0.78	0.84
Intercropping	0.54	0.46*	0.40***	0.49	0.57	0.59	0.66	0.58	0.66	0.57
Pest and disease management										
Pruning	0.82	0.88	0.68***	0.93***	0.82	0.84	0.91**	0.87	0.98***	0.80
Insect population count	0.16	0.11	0.14	0.21	0.16	0.05	0.05	0**	0.05	0.06
Observation of insects before treatment	0.59	0.80***	0.57	0.83***	0.55	0.60	0.46***	0.52*	0.76	0.64
Cocoa tree and farm sanitation										
Sanitary harvest	0.69	0.70	0.58*	0.79**	0.68	0.77	0.74	0.82	0.90**	0.75
Progressive replantation of cocoa farm	0.42	0.53**	0.46	0.56***	0.39	0.50	0.43	0.48	0.76***	0.50
Weighted SAP scale (re-scaled 0-1)	0.49 (0.19)	0.56*** (0.17)	0.46 (0.24)	0.60*** (0.14)	0.48 (0.18)	0.53 (0.20)	0.55 (0.19)	0.53 (0.21)	0.64*** (0.18)	0.52 (0.20)
N	1,219	97	65	96	961	527	93	62	41	331

* (p < 0.1), ** (p < 0.05) and *** (p < 0.01) for ttest of continuous variables and chi2 test for categorical variables. Standard deviations in parenthesis.

4.2 Determinants of participation in certification schemes and farmer cooperatives

Table 5 presents the parameter estimates from the probit selection equation from the first stage of the multinomial endogenous switching regression model. The dependent variable represents a binary choice of the decision for cocoa farmers to either 1) participate in a certification schemes, 2) be a member of a farmer cooperatives or 3) both. The decision to participate in such organizational structures and market channels may be influenced by household and farm plot characteristics as well as by the access to services that foster information exchange and market access.

The results reveal that female cocoa farmers in both Côte d'Ivoire and Ghana are less likely to participate in certification schemes or farmer cooperatives. This might be due to less access to information or networks where knowledge on such existing structures could be shared. Potentially it might also be too time consuming for women farmers to engage in these specific marketing bodies and organizations, which require participation in meetings for joint decision-making or trainings related to production, harvesting and drying practices. As expected, indicators of connectivity such as mobile phone ownership have a positive effect on participation in organizational structures or market channels, especially in Ghana and particularly for joint involvement in certification and cooperatives. Results further show that farm characteristics affect farmers' involvement in organizational structures or market channels, particularly plot distance and the soil quality. The greater the distance to plots, the less likely it is for cocoa farmers in Ghana to involve themselves in farmer cooperatives. This again may be because of time constraints due to travel requirements.

Our instrumental variables are in line with our expectations and the literature. They show that distance is negatively correlated with membership in certification schemes and farmer cooperatives. The results are much more indicative in Côte d'Ivoire than in Ghana, potentially because Ghanaian farmers are more endowed and can potentially overcome such distance either through vehicle ownership or public transport.

Table 5. Multinomial parameter estimates of the selection model of farmer's participation in participate in farmer cooperatives and certification schemes in Côte d'Ivoire and Ghana

	Côte d'Ivoire						Ghana					
Variable	Only certified		Only member in farmer cooperative		Both, certified and member in a farmer cooperative		Only certified		Only member in farmer cooperative		Both, certified and member in a farmer cooperative	
	Coefficient	Std. Err.	Coefficient	Std. Err.	Coefficient	Std. Err.	Coefficient	Std. Err.	Coefficient	Std. Err.	Coefficient	Std. Err.
Female HH Head	-1.061***	0.279	-0.193	0.475	-0.857***	0.310	-1.724***	0.442	-0.940***	0.344	-0.224	0.491
Age HH Head (yrs)	0.005	0.007	0.004	0.009	0.000	0.008	0.008	0.019	-0.008	0.019	0.016	0.025
Migrant	-0.241	0.184	-0.256	0.196	0.196	0.192	0.713	0.442	0.370	0.459	0.563*	0.306
Education (yrs)	-0.015	0.014	0.022	0.017	0.037*	0.022	-0.022	0.049	-0.076	0.051	0.015	0.054
Mobile phone	-0.186	0.214	0.632**	0.301	-0.252	0.293	0.763**	0.319	0.507	0.415	1.532***	0.510
Home accessible by vehicle	0.375	0.343	0.310	0.308	-0.274	0.284	-0.539	0.425	-0.866**	0.381	0.069	0.456
Electricity	0.103	0.190	-0.067	0.170	0.204	0.254	-0.458	0.528	-0.075	0.324	0.622	0.471
Dependency ratio	0.155	0.108	-0.163	0.133	0.022	0.103	0.079	0.278	0.139	0.153	0.197	0.213
Cocoa farm size (ha)	0.020	0.030	0.055*	0.029	0.040	0.035	-0.005	0.034	-0.009	0.049	-0.024	0.060
Age of cocoa trees (yrs)	0.010	0.011	-0.004	0.016	0.006	0.012	-0.016	0.036	0.025	0.029	0.061**	0.027
Distance to plot (km)	-0.017	0.021	-0.004	0.030	0.023	0.032	-0.044	0.079	-0.211**	0.087	-0.195***	0.061
Suitable terrain	0.154	0.201	-0.196	0.163	0.367	0.255	-0.123	0.382	-0.321	0.362	-0.025	0.400
Rich soil	0.077	0.203	0.126	0.215	0.536***	0.192	1.704***	0.427	0.393	0.544	1.424***	0.538
Black pod	-0.004	0.206	-0.173	0.335	-0.037	0.196	0.447*	0.260	-0.524	0.485	0.127	0.405
Swollen shoot	-0.305	0.218	-0.572	0.352	-0.194	0.216	0.115	0.312	-0.358	0.417	0.087	0.325
Distance to certified buyer (km)	-0.008***	0.003	-0.000	0.004	-0.021***	0.004	-0.023*	0.014	0.010	0.007	0.011	0.009
Distance to cooperative (km)	-0.009**	0.004	-0.042***	0.008	-0.011	0.007	-0.004	0.006	-0.011	0.022	-0.029	0.115
Constant	-1.772***	0.508	-1.915***	0.535	-1.928***	0.647	-2.562***	0.847	0.851	0.850	-5.412***	1.218

The regression includes regional controls, namely five agro-ecological zones in Côte d'Ivoire and three in Ghana.

* (p < 0.1), ** (p < 0.05) and *** (p < 0.01)

4.3 **Impact of farmer's participation** in certification schemes and farmer cooperatives on Sustainable Agricultural Practices (SAP)

Table 6 shows the average effects (ATT) of participation in a certification scheme (1), a farmer cooperative (2) or both (3) on the use of SAP, based on the estimation of the multinomial endogenous switching regression model. We also calculate the counterfactual effects of non-participation of the three options, namely the average treatment effect of the untreated (ATU). The intensity of the use of sustainable agricultural practices is measured via the SAP scale (see section 2.3) ranging between 0 and 1 - with 1 being the highest achievable score. The scale includes four dimensions of sustainable farm management practices in cocoa, namely agroforestry, soil conservation, pest and disease management and cocoa tree and farm sanitation, which are weighted equally with 0.25.

In Côte d'Ivoire, the results show that farmers' participation in organizational structures and market channels indeed leads to a higher score on the sustainability scale. With an ATT of 0.243, the highest treatment effect is achieved through joint participation in a certification scheme and a farmer cooperative. This is in line with expectations as it is assumed that organizational structures such as farmer cooperatives can provide a support system for the implementation of the standards promoted and required by certification schemes.

We further note a larger ATT for cooperative membership than certification. Since 2010, Côte d'Ivoire has renewed its efforts to professionalize cooperatives in the country, mainly through the implementation of the Uniform Act on cooperative law. This push for the formalization of cooperatives has led to a "conversion" of former cocoa buyers and traders into so-called cooperatives, which do not necessarily comply with democratic processes and cooperative values of participatory action (Ruf et al., 2019). Nonetheless, this has enabled the functioning of cooperatives, including the provision of trainings and support, through the commitment of necessary resources (Foundjem-Tita et al., 2017).

Farmers not involved in organizational structures and market channels show lower scores on the SAP scale than those participating. The ATU is also positive and significant, underlining the positive effect that participation in any of the organizational structures and market channels would have. With supportive framework conditions these farmers would also adopt more sustainable agricultural practices. Again, farmer cooperative membership would lead to a much higher score on the SAP scale with an ATU of 0.292, supporting the above interpretation.

In Ghana, we note that average SAP scores are overall higher than in Côte d'Ivoire, including those of the control group. The ATT again confirms our assumed hypothesis that participation in organizational structures and market channels can support the adoption of SAP. However, in Ghana certification rather than cooperative membership has the largest effect on farmers. A number of reasons could explain such findings. Ghana has a highly regulated cocoa sector where farmers are supported through a well-established structure, facilitated by the Ghana Cocoa Board. While the setting-up of cooperatives has been promoted through governmental and non-governmental projects in recent years, individual assessments show that cooperatives only provide insufficient support, delaying the provision of services or being dormant altogether (Salifu et al., 2010).

The counterfactual effects of farmers not involved in organizational structures and market channels also show that certification plays a larger role than cooperative membership. The current functioning of farmer cooperatives would even negatively affect the uptake of SAP as can be concluded from the negative and significant albeit small ATU. Instead, it would require the joint participation in certification and a cooperative to lead to the adoption of sustainable practices.

Table 6 Impact of participation in organizational structures and market channels on the use of SAP using the MESR.

		Decision stage		Treatment effects
		To participate in organizational structures and market channels	Not to participate in organizational structures and market channels	
Côte d'Ivoire				
Certification	Yes	0.372	0.325	ATT = 0.047***
	No	0.516	0.325	ATU = 0.191***
Cooperative membership	Yes	0.507	0.338	ATT = 0.169***
	No	0.618	0.325	ATU = 0.292***
Cooperative membership and certification	Yes	0.584	0.341	ATT = 0.243***
	No	0.623	0.325	ATU = 0.298***
Ghana				
Certification	Yes	0.634	0.513	ATT = 0.121***
	No	0.586	0.461	ATU = 0.125***
Cooperative membership	Yes	0.574	0.567	ATT = 0.007
	No	0.435	0.461	ATU = -0.026**
Cooperative membership and certification	Yes	0.631	0.564	ATT = 0.068***
	No	0.695	0.461	ATU = 0.233***

* (p < 0.1), ** (p < 0.05) and *** (p < 0.01)

5 Discussion and conclusion

There have been increasing calls to enhance the economic, environmental and social sustainability of global value chains, including cocoa – also as a response to media coverage on the plight of producers in developing countries. The effects of climate change on environmental and weather conditions exacerbate the challenges agricultural producers face. At the same time, cocoa production systems based on full-sun or low-shade cocoa plots, which depend on high input use and cocoa hybrids that require replanting after 15-20 years (Gockowski et al., 2013), are increasingly regarded as environmentally but also economically unsustainable.

Agroecological practices, including agroforestry and intercropping as well as bio-based alternatives to chemical inputs, are now promoted in Côte d'Ivoire and Ghana, the two largest cocoa producers world-wide. However, the literature shows that the uptake of such practices so far has been slow as farmers favour the long-promoted low-shade system that often yields a quicker return on investment (Asare et al., 2016). Organizational structures and market channels that are close to farmers and based on long-term relationships, such as certification schemes and farmer cooperatives, can therefore play a role in encouraging farmers to adapt their production systems. In this study we use representative survey data from more than 1700 small-scale cocoa farmers in Côte d'Ivoire and Ghana to assess whether their participation in certification schemes, farmer cooperatives or both affects the use of SAP. We employ a multinomial endogenous switching regression to control for selection bias caused by observable and unobservable factors and to account for the interrelatedness of different organizational structures and market channels.

Our methodology is not without shortcomings and our results should be considered with care. We use cross-sectional data, which is based on the self-reported information provided by cocoa producers. While we aim to reduce possible selection bias through our econometric approach, we cannot fully account for it. The practices included in the development of a SAP scale have been identified for the context of Ghana and Côte d'Ivoire, where full-sun or low-shade cocoa production is common. Sustainability characteristics of cocoa production should be considered according to local production practices and conditions in order to be relevant. Nonetheless, we believe that our findings can contribute to identifying the role of local support structures for farmers in applying sustainable agricultural practices.

We find that in Côte d'Ivoire the strongest treatment effect is achieved by the joint participation in certification schemes and farmer cooperatives. These findings are in line with expectations as we assume that certification schemes can be supported and administered through organizational structures on the ground, especially when there is trust and confidence of farmers towards the institution. In Ghana, certification shows the largest treatment effect with slightly limited added value of cooperative membership. This may be explained by the highly regulated cocoa sector in Ghana, where the Cocoa Health and Extension Division of the Ghana Cocoa Board afford services and support, which potentially otherwise farmer cooperatives would provide. This econometric approach also allows us to estimate the hypothetical effects of the participation in organizational structure and market channels for those farmers currently not involved. In both countries the joint participation in certification and a cooperative would lead to the largest effects on the adoption of sustainable practices. In Ghana, again this seems to be driven by certification and in Côte d'Ivoire this seems to be driven by cooperative membership as can be seen from the average treatment effects of the untreated.

When considering the composition of the SAP scale, some agricultural practices may require more in-depth knowledge or financial resources than others, e.g. shade tree planting or organic fertilizer in comparison to pruning. Local long-term structures can help to overcome such high barriers for farmers. Nonetheless, they are no panacea. A common criticism in recent years has been that the oversupply of certified agricultural products forces producers to sell their certified produce to the conventional market without receiving a price premium (de Janvry et al., 2015). The additional labour costs to comply with the sustainability standards (Uribe-Leitz and Ruf, 2019) may therefore lead to little benefit, potentially discouraging the continuation of such schemes. With currently only a relatively small share of cocoa farmers being involved in certification schemes and sustainability standards, such prospects challenge their potential for expansion. If farmers' share was to increase, the oversupply of certified cocoa beans lead to even less benefits for producers.

Also farmer cooperatives often do not deliver the support farmers require. Their dependence on external support, contrasting economic interests, elite capture and lack of inclusiveness are some of the main criticisms (Uribe-Leitz and Ruf, 2019; Woods, 1999). Ruf et al. (2019) point out that most cooperatives in Côte d'Ivoire do not apply the values of collective decision-making and democratic management as many have been set up by former cocoa buyers and traders. Other challenges derive from the way cooperatives are administered - clashing with the realities of land ownership and farm management on the ground. Skalidou (2020) reports that in Ghana for example, farmers need to present a so-called farm passbook in order to be able to register with a farmer cooperative. However, these passbooks are usually held by the farm owners and not those managing the farm or leasing the land, leaving them without access to training or extension services offered by cooperatives. At the same time cooperatives may be constrained in improving market access or prices for farmers in the highly regulated cocoa sectors in Ghana and Côte d'Ivoire. Farmers may not see the benefits of cooperative membership if the cooperatives are unable to derive value for members equally. Even so, they can provide entry points for engagement with farmers as the results of our analysis show. As relevant players to provide advisory services for the promotion of more sustainable practices, their roles need to be acknowledged also within the "broader institutional environment" (Snider et al., 2016). Further research on farmer cooperatives – particularly the formalization of transparent roles, responsibilities and membership participation - would help to identify characteristics that support their functioning, their ownership and their service provision.

The European Commission recently proposed new regulations to limit deforestation, end child labour and reduce poverty for products imported into the European Union. For such proposals to change the operating mechanism of value chains, they need to be mindful and inclusive of all levels along the chain, including the producer level. This requires a close collaboration with and improvement of existing local structures in order to create an environment that empowers farmers and fosters sustainable cocoa production.

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List of abbreviations and definitions

ATT	Average treatment effect of the treated
ATU	Average treatment effect of the untreated
CIRES	Centre Ivoirien de Recherche Économique et Sociale
COSA	Committee on Sustainability Assessment
MESR	Multinomial endogenous switching regression
SAP	Sustainable agricultural practices

List of tables